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

Volume 2—Calculations Performed in the United States

Fissile Materials Disposition Program

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

Volume 2—Calculations Performed in the United States

Prepared by the Staffs of the Oak Ridge National Laboratory and the
Amarillo National Research Center for Plutonium

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

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ACRONYMS

ANRCP	Amarillo National Resource Center for Plutonium
ANSI	American National Standards Institute
BOL	beginning of life
BP	burnable poison
CSEWG	Cross Section Evaluation Working Group
CZP	cold, zero power
DLC	data library collection
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EALCF	energy of average lethargy causing fission
ENDF/B-VI/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
FMD	Office of Fissile Materials Disposition (DOE)
FP	fission product
GAN	Russian Safety and Licensing Authority, Gosatomnadzer
HEU	highly enriched uranium
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
LWR	light-water reactor
MINATOM	Ministry of Atomic Energy
MOX	mixed oxide
MOXFFF	Mixed-Oxide Fuel Fabrication Facility
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PWR	pressurized-water reactor
PDCF	Pit Disassembly and Conversion Facility
RF	Russian Federation
ROD	Record of Decision
RSICC	Radiation Safety Information Computational Center
S.W.G.	standard wire guage
VVER	Russian water-water reactor
WIMS	Winfrith Improved Multigroup Scheme

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ERRATA

In Volume III, page 4-115, Table 4.138, Variant 9, State s1, k_0 should be 1.5198. In the same table, Variant 9, State s6 should be 1.6950.

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

VOLUME 2—CALCULATIONS PERFORMED IN THE UNITED STATES

ABSTRACT

This volume of the progress report provides documentation of reactor physics and criticality safety studies conducted in the United States 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 September 1993, President Clinton established a policy to commit the United States to seek to eliminate, where possible, the accumulation of stockpiles of highly enriched uranium (HEU) and plutonium. The U.S. government initiated the Fissile Materials Disposition Program (FMDP)—administered by the Office of Fissile Materials Disposition (FMD) of the U.S. Department of Energy (DOE)—to perform a comprehensive review of long-term alternatives for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary, and economic considerations.

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 (LWRs) should be one of the technological options pursued by both the Russian Federation and the United States.

"On January 14, 1997, the Department of Energy . . . announced the formal Record of Decision (ROD) for the Storage and Disposition of Weapons-Usable Fissile Materials . . . The disposition strategy allows for immobilizing plutonium in glass or ceramic forms and burning plutonium as mixed oxide fuel in existing reactors."[1]

In the United States, the disposition of plutonium in existing, commercial reactors will require the establishment of two new fuel cycle facilities—a Pit Disassembly and Conversion Facility (PDCF) and a Mixed-Oxide Fuel Fabrication Facility (MOXFFF). The PCDF will contain the necessary equipment and chemical processes to convert surplus plutonium from its current physical form (most of which is metal) to plutonium oxide. The MOXFFF will contain the necessary equipment and chemical processes to fabricate mixed-oxide (MOX) fuel rods from plutonium and uranium oxide powders and load the rods into fuel assemblies.

The design and operation of both the PCDF and MOXFFF will be the responsibility of the DOE and/or its' contractors. Operations at the PCDF will be reviewed and approved by the Defense Nuclear Facilities Safety Board (DNFSB). Operations at the fuel fabrication facility will be reviewed and approved by the Nuclear Regulatory Commission (NRC).

The selection of the contractors for the facilities and the reactor site(s) for irradiation of the MOX fuel will be achieved by a competitive procurement process. Operations at the reactor(s) will be reviewed and approved by the NRC. Ownership of the MOX fuel will transfer from the U.S. government to the utility that operates selected reactor(s) after one cycle of irradiation. Transport of the MOX fuel from the fabrication facility to the reactor(s) will be the responsibility of the DOE. However, the contractor for the fuel fabrication facility will have responsibility for the design of the shipping cask for the fresh MOX fuel. Consequently, the design of the shipping cask will be reviewed and approved by the NRC and by the DOE. The "act of transporting" will require review and approval by the U.S. Department of Transportation (DOT).

Spent MOX fuel storage will be the responsibility of the utility performing the irradiation of the MOX fuel. Spent fuel storage operations will be reviewed and approved by the NRC. It is uncertain if transportation of spent fuel from the reactor(s) to a geologic repository will be responsibility of a private contractor or the DOE. If it is a private contractor, the operation will be reviewed and approved by the NRC. If transportation is by DOE, the operation will be reviewed internally by DOE. Regardless of responsibility, the "act of transporting" will be reviewed and approved by the DOT. The ultimate disposal of the spent MOX fuel will be in a geologic repository. It is uncertain whether DOE or NRC will be responsible for review and approval of repository operations, but it is certain that one or the other will. The FMDP does not have responsibility for the MOX fuel after ownership transfers to the reactor operator.

The design of all facilities and operations in the fuel cycle requires the calculation of various nuclear physics parameters; reactors must be designed to attain criticality, and all other fuel cycle facilities must be designed to avoid criticality. Most of these calculations are performed on computers with software developed after many man-years of effort. The NRC requires, via *Regulatory Guide* 3.4, Rev. 2 (1986), which endorses Ref. 3, that all software used for analyses to certify the safety of facilities or operations be verified and validated.[4] The DNFSB of the DOE also requires that the analysis of the safety of facility design and operations include validation studies for any software used in safety-related analyses.

Verification, in the context of neutron physics computer programs, is the process of ensuring that the software will solve 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. Consequently, physicist-created computational benchmarks frequently provide the simplest or "cleanest" mechanism for verifying computer programs.

"Validation is the process of demonstrating that the as-built software meets its requirements."[3] 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 selected computer programs/data library combinations.

Concurrent to the U.S. program in plutonium disposition, the Russian Federation has agreed to dispose of significant quantities of surplus Russian plutonium in Russian LWRs, specifically, in VVER-1000s. The safety review process in Russia is that all fuel cycle facilities and reactors must submit a request-for-operation to the Russian regulatory authority, Gosatomnadzor (GAN). Part of this request must be documentation that safety analysis computer programs have been verified and validated.

Because both the U.S. DOE (and its contractors) and the Russian designers must prepare validation studies for MOX fuel cycles, a collaborative effort seemed feasible and appropriate. Studies presented in this document are the initial effort in verifying and validating various U.S. computer programs for the analysis of U.S. MOX fuel cycles. This report provides documentation of verification and validation studies conducted during fiscal year 1997 and includes some revisions to the calculations—the revisions having been performed during fiscal year 1998. It partially fulfills the documentation required for regulatory approval of MOX facilities that are the responsibility of the DOE FMD. (Because spent MOX fuel operations are not the responsibility of the FMD, benchmark studies for spent fuel are not included.) These studies are also intended to provide the basis for conducting independent reviews of Russian MOX facilities if the United States is requested to do so.

1.1 REFERENCES

1. Office of Fissile Materials Disposition Weekly Report, January 14, 1997.

2. "Department of Energy to Submit Legislation for External Regulation of Nuclear Safety," Department of Energy Press Release, December 20, 1996.

3. American National Standards Institute, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," ANSI/ANS-8.1-1983.

4. Software Quality Assurance Program and Guidelines, NUREG/BR-0167, U.S. Nuclear Regulatory Commission, February 1993.

2. BENCHMARK NEEDS FOR MOX FUEL CYCLES

(R. T. Primm III)

The benchmark needs for reactor physics and criticality safety have a common goal. For both disciplines, the accuracy of the calculated, effective multiplication factor, k_{eff}, must be well known. Reactors must be designed to attain criticality, and all other fuel cycle facilities must be designed to avoid criticality. Both normal and credible abnormal conditions must be identified so that physical properties corresponding to these conditions (the moderator-to-fuel ratio and the geometry of the system) can be determined. Computer programs and data libraries used in the calculation of k_{eff} must be validated over the range of parameters that will or may exist.

The ability to calculate system response as a function of time (kinetics) is also a common goal of both disciplines. For reactor physics, the analyst must be able to predict the time-dependent performance of the neutron flux (and therefore the power of the reactor) under both normal fuel configurations and credible abnormal changes in the physical conditions of the reactor (control rod withdrawal, cold water ingress to the core, or turbine trip). For criticality safety analysts, the time-dependent behavior of a criticality accident must be postulated and studied to ensure that plant personnel are adequately shielded and that criticality alarms are placed in sufficient numbers in proper locations.

Accurate assessment of the operation of a reactor requires benchmarking of reactor physics methodologies for the calculation of power densities for small spatial regions. The magnitude and location of the "hot spot" in a fuel pin, fuel assembly, or the entire reactor core must be identified because these values will ultimately determine the maximum operating power for the reactor. This data need differentiates reactor physics from criticality safety.

Reactor physicists must certify that computational methodologies are accurate over a range of temperatures (from room temperature to reactor operating temperatures and beyond for accident analyses). Generally, criticality safety calculations only require "room temperature" data. Criticality excursions generally self-terminate prior to significant changes in the system temperature.

Because 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.

2.1 PIT DISASSEMBLY AND CONVERSION FACILITY

The PCDF will contain operations that will be conducted with pure plutonium—no mixtures of plutonium and uranium (oxide or otherwise). Benchmarks applicable to this facility design should be those in which plutonium is the only actinide, and their isolopic compositions should be representative of weapons-grade material. Critical configurations with plutonium metal and with plutonium oxide are required. A range of moderation ratios should be examined in the experimental configurations. While it is likely 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. Both single-unit and array critical configurations will be required because there will be storage configurations at both the "head" and "back" ends of the facility.

Should aqueous operations be included in the facility, single-unit and array configurations of containers filled with plutonium nitrate solution will be required as benchmarks. A range of moderation ratios should be considered.

2.2 MIXED-OXIDE FUEL FABRICATION FACILITY

The fabrication facility will receive plutonium oxide powder from the PDCF processing facility. The certification of the expected safe operation of the receiving storage and the uranium and plutonium blending operations will be based on the assumption that the uranium is not present. Consequently, benchmarks for the design of the head end of the fabrication plant and for the blending operations will be the same as those

previously described for the back end of the PCDF. Intermediate storage of MOX powder (production of a master mix which is subsequently diluted with uranium oxide), MOX pellet production, and fuel rod fabrication operations will utilize single-unit MOX critical configurations as benchmarks. Fuel rod assembly into bundles and bundle storage at the back end of the plant will require interacting array data for MOX 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 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.

Certification of the reactor core configuration requires critical experiments in which the reactivity worth of the reactor control materials is verified, the effect of the cold-to-operating temperature change on reactivity is verified, and the effect of moderator voiding is verified. Establishment of critical configurations as a function of burnup may not be feasible, but some data regarding the composition of the fuel as a function of burnup (both actinides and fission products) should be verified.

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 that the LEU-MOX interfaces will be especially important.

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 that are 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

(R. T. Primm III)

For all computations reported in this document, the nuclear data sources are the Evaluated Nuclear Data File B (ENDF) version V[1] or VI[2]. Point energy or multigroup libraries are generated from the ENDF files through the use of various cross section processing computer programs, and these libraries are then input to single or multidimensional neutron transport programs. Brief descriptions of data libraries and computational methods will be given with computational methods grouped according to dimensional modeling capability and according to the numerical method used in the solution of the Boltzman transport equation. With the exception of the HELIOS[3] program and associated data library, all of the programs and data libraries described in this section can be obtained from the Radiation Safety Information Computational Center (RSICC) at Oak Ridge National Laboratory (ORNL).

3.1 CROSS SECTION PROCESSING PROGRAMS AND DATA LIBRARIES

Two computer program systems are used to process the nuclear data used in the calculations that are reported in this document—NJOY[4] and AMPX[5]. Each system has the ability to collapse the point energy data in the ENDF files to an arbitrary number of energy groups. NJOY and AMPX can also process data into point energy libraries for use with various neutron transport programs. Currently, only NJOY can process data from the ENDF/B-VI data files. Both NJOY and AMPX can process ENDF/B-V data.

3.1.1 The NJOY Code System and Generated Cross Section Libraries

"The NJOY code consists of a set of modules, each performing a well-defined processing task. (The modules) are linked to one another by input and output files and a few common constants."[4] Among the tasks that the modules perform are reconstructing pointwise cross section data from ENDF resonance parameters and interpolation schemes, weighting and reduction of pointwise cross section data to multigroup libraries, Doppler broadening of cross section values, generating self-shielded cross sections, computing covariance matrices from ENDF uncertainties, generating neutron and photon scattering matrices, generating gamma kerma factors, and formatting multigroup cross section libraries for various physics code packages.

For the calculations documented in this report, NJOY was used to generate the ENDF/B-V and -VI versions of the Monte Carlo program, MCNP, point energy library. The system was also used to generate the 69 energy group library (ENDF/B-V based) for use with the WIMS-D4M (WIMS-D4 and D5 versions are available from RSICC) physics program. The 69 energy group structure is shown in Table 3.1 (14 fast groups, 13 resonance groups, and 42 thermal groups). Self-shielded cross sections are obtained from library values by interpolation among tabulated resonance integrals. These integrals were calculated from the point energy data through the use of the narrow resonance approximation with intermediate energy resonance correction over the resolved resonance region. The intermediate energy correction is based on homogenization of a unit cell moderator and fuel regions through the use of a heterogeneity parameter, which is related to the escape cross section for a particular geometric configuration. Each nuclide in the library was generated as an infinite homogeneous composition (no mixtures were created in the GROUPR module of NJOY). To collapse from the point energy data in the ENDF files to the 69-group structure, an energy spectra composed of the fission spectrum (fission temperature of 1.353 MeV, lower boundary for Bondarenko factor treatment of 0.64 MeV) joined to a 1/energy spectrum joined to a Maxwellian spectrum (thermal temperature of 0.0270 eV) and lower boundary for intermediate resonance calculation of 0.22 eV. The NJOY code system was also the genesis of the production procedure for the HELIOS libraries. The HELIOS libraries differ from the WIMS production scheme in that the integral transport theory program, RABBLE, was used to generate cross section tables for the resonance region. RABBLE data are based on the explicit representation of a pin cell rather than the spatial approximation contained in the GROUPR module of the NJOY system. A 190 neutron group, 48 gamma group master data base (library) is generated from ENDF/B-VI. The data base contains a spectra that can be used to collapse the library to any group

structure that is a subset of the master. SCANDPOWER provides "condensed" libraries having 34 and 89 energy groups that were generated using the spectra contained in the master data base. The group boundaries for the 34-, 89-, and 190-group HELIOS libraries are provided in Tables 3.2–3.4.

Table 3.1. The 69-group energy boundaries for WIMS

Group	Energy (MeV)	Group	Energy (eV)
1	10.0–6.0655	35	1.123–1.097
2	6.0655–3.679	36	1.097–1.071
3	3.679–2.231	37	1.071–1.045
4	2.231–1.353	38	1.045–1.020
5	1.353–0.821	39	1.020–0.996
6	0.821–0.500	40	0.996–0.972
7	0.500–0.3025	41	0.972–0.950
8	0.3025–0.183	42	0.950–0.910
9	0.183–0.1110	43	0.910–0.850
10	0.1110–0.06734	44	0.850–0.780
11	0.06734–0.04085	45	0.780–0.625
12	0.04085–0.02478	46	0.625–0.500
13	0.02478–0.01503	47	0.500–0.400
14	0.01503–0.009118	48	0.400–0.350
	Energy (eV)	49	0.350–0.320
15	9118.0–5530.0	50	0.320–0.300
16	5530.0–3519.1	51	0.300–0.280
17	3519.1–2239.45	52	0.280–0.250
18	2239.45–1425.1	53	0.250–0.220
19	1425.1–906.898	54	0.220–0.180
20	906.898–367.262	55	0.180–0.140
21	367.262–148.728	56	0.140–0.100
22	148.728–75.5014	57	0.100–0.080
23	75.5014–48.052	58	0.080–0.067
24	48.052–27.700	59	0.067–0.058
25	27.700–15.968	60	0.058–0.050
26	15.968–9.877	61	0.050–0.042
27	9.877–4.00	62	0.042–0.035
28	4.00–3.30	63	0.035–0.030
29	3.30–2.60	64	0.030–0.025
30	2.60–2.10	65	0.025–0.020
31	2.10–1.50	66	0.020–0.015
32	1.50–1.30	67	0.015–0.010
33	1.30–1.15	68	0.010–0.005
34	1.15–1.123	69	0.005–0.0

Table 3.2. HELIOS-34 group library

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
1	2.000E+07	11	4.785E+01	21	1.099E+00	31	5.692E-02
2	3.679E+06	12	2.902E+01	22	1.014E+00	32	4.275E-02
3	1.353E+06	13	0.371E+01	23	9.506E-01	33	3.061E-02
4	4.979E+05	14	0.315E+00	24	6.251E-01	34	1.240E-02
5	1.832E+05	15	6.476E+00	25	3.577E-01		
6	6.738E+04	16	5.043E+00	26	2.705E-01		
7	9.119E+03	17	3.928E+00	27	1.844E-01		
8	2.035E+03	18	2.382E+00	28	1.457E-01		
9	1.301E+02	19	1.855E+00	29	1.116E-01		
10	7.889E+01	20	1.308E+00	30	8.197E-02		

Table 3.3. HELIOS-89 group library

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
1	2.000E+07	26	5.531E+03	51	1.855E+00	76	1.523E-01
2	7.408E+06	27	3.355E+03	52	1.726E+00	77	1.457E-01
3	6.065E+06	28	2.035E+03	53	1.595E+00	78	1.116E-01
4	4.493E+06	29	1.234E+03	54	1.457E+00	79	8.197E-02
5	3.679E+06	30	7.485E+02	55	1.308E+00	80	6.700E-02
6	2.725E+06	31	4.540E+02	56	1.166E+00	81	5.692E-02
7	2.231E+06	32	2.754E+02	57	1.099E+00	82	5.000E-02
8	1.827E+06	33	1.670E+02	58	1.072E+00	83	4.275E-02
9	1.353E+06	34	1.301E+02	59	1.062E+00	84	3.550E-02
10	1.003E+06	35	1.013E+02	60	1.053E+00	85	3.061E-02
11	8.208E+05	36	7.889E+01	61	1.043E+00	86	2.049E-02
12	6.081E+05	37	6.144E+01	62	1.014E+00	87	1.240E-02
13	4.979E+05	38	4.785E+01	63	9.506E-01	88	6.325E-03
14	3.688E+05	39	3.727E+01	64	7.821E-01	89	2.277E-03
15	3.020E+05	40	2.902E+01	65	6.251E-01		
16	2.237E+05	41	2.260E+01	66	5.032E-01		
17	1.832E+05	42	1.760E+01	67	4.170E-01		
18	1.500E+05	43	1.371E+01	68	3.577E-01		
19	1.111E+05	44	1.068E+01	69	3.206E-01		
20	8.652E+04	45	8.315E+00	70	3.011E-01		
21	6.738E+04	46	6.476E+00	71	2.907E-01		
22	4.087E+04	47	5.043E+00	72	2.705E-01		
23	2.479E+04	48	3.928E+00	73	2.510E-01		
24	1.503E+04	49	3.059E+00	74	2.277E-01		
25	9.119E+03	50	2.382E+00	75	1.844E-01		

Table 3.4. HELIOS 190-group library

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
1	2.000E+07	51	4.087E+04	101	8.940E+01	151	9.920E-01
2	1.700E+07	52	3.607E+04	102	7.889E+01	152	9.710E-01
3	1.492E+07	53	3.183E+04	103	6.962E+01	153	9.506E-01
4	1.338E+07	54	2.809E+04	104	6.144E+01	154	9.100E-01
5	1.200E+07	55	2.606E+04	105	5.422E+01	155	8.764E-01
6	1.000E+07	56	2.479E+04	106	4.785E+01	156	8.337E-01
7	8.825E+06	57	2.187E+04	107	4.223E+01	157	7.821E-01
8	7.788E+06	58	1.930E+04	108	3.727E+01	158	7.300E-01
9	7.408E+06	59	1.704E+04	109	3.289E+01	159	6.700E-01
10	6.065E+06	60	1.503E+04	110	2.902E+01	160	6.251E-01
11	5.220E+06	61	1.327E+04	111	2.561E+01	161	5.700E-01
12	4.724E+06	62	1.171E+04	112	2.260E+01	162	5.300E-01
13	4.493E+06	63	1.033E+04	113	1.995E+01	163	5.032E-01
14	4.066E+06	64	9.119E+03	114	1.760E+01	164	4.500E-01
15	3.679E+06	65	8.047E+03	115	1.554E+01	165	4.170E-01
16	3.166E+06	66	7.102E+03	116	1.371E+01	166	3.577E-01
17	2.865E+06	67	6.267E+03	117	1.210E+01	167	3.206E-01
18	2.725E+06	68	5.531E+03	118	1.068E+01	168	3.011E-01
19	2.466E+06	69	4.881E+03	119	9.422E+00	169	2.907E-01
20	2.365E+06	70	4.307E+03	120	8.315E+00	170	2.705E-01
21	2.346E+06	71	3.801E+03	121	7.338E+00	171	2.510E-01
22	2.231E+06	72	3.355E+03	122	6.868E+00	172	2.277E-01
23	2.019E+06	73	2.960E+03	123	6.476E+00	173	1.844E-01
24	1.827E+06	74	2.613E+03	124	5.715E+00	174	1.523E-01
25	1.738E+06	75	2.306E+03	125	5.043E+00	175	1.457E-01
26	1.572E+06	76	2.035E+03	126	4.451E+00	176	1.116E-01
27	1.353E+06	77	1.796E+03	127	3.928E+00	177	8.197E-02
28	1.165E+06	78	1.585E+03	128	3.466E+00	178	6.700E-02
29	1.054E+06	79	1.398E+03	129	3.059E+00	179	5.692E-02
30	1.003E+06	80	1.234E+03	130	2.700E+00	180	5.000E-02
31	8.208E+05	81	1.089E+03	131	2.382E+00	181	4.275E-02
32	7.065E+05	82	9.611E+02	132	2.102E+00	182	3.550E-02
33	6.393E+05	83	8.482E+02	133	1.855E+00	183	3.061E-02
34	6.081E+05	84	7.485E+02	134	1.790E+00	184	2.550E-02
35	4.979E+05	85	6.606E+02	135	1.726E+00	185	2.049E-02
36	4.285E+05	86	5.829E+02	136	1.659E+00	186	1.240E-02
37	3.877E+05	87	5.144E+02	137	1.595E+00	187	6.325E-03
38	3.688E+05	88	4.540E+02	138	1.525E+00	188	2.277E-03
39	3.020E+05	89	4.006E+02	139	1.457E+00	189	7.602E-04
40	2.599E+05	90	3.536E+02	140	1.381E+00	190	2.540E-04
41	2.352E+05	91	3.120E+02	141	1.308E+00		
42	2.237E+05	92	2.754E+02	142	1.235E+00		
43	1.832E+05	93	2.430E+02	143	1.166E+00		
44	1.500E+05	94	2.144E+02	144	1.125E+00		
45	1.426E+05	95	1.893E+02	145	1.099E+00		
46	1.291E+05	96	1.670E+02	146	1.072E+00		
47	1.111E+05	97	1.474E+02	147	1.062E+00		
48	8.652E+04	98	1.301E+02	148	1.053E+00		
49	6.738E+04	99	1.148E+02	149	1.043E+00		
50	5.247E+04	100	1.013E+02	150	1.014E+00		

3.1.2 The AMPX Code System and Generated Cross Section Libraries

> The AMPX system ... is a collection of computer programs in a modular arrangement for generating multigroup or pointwise cross-section libraries. Starting with ENDF/B-IV- or ENDF/B-V-formatted nuclear data files, or with previously generated, psuedo-problem-independent fine-group, problem-dependent fine- or broad-group, or pointwise cross-section libraries, the system includes a full range of features needed to: (1) produce multigroup neutron, gamma-ray production, and/or gamma-ray interaction cross-section data; (2) resonance shelf-shield; (3) spectrally collapse; (4) convert cross-section libraries from one format to another format; (5) execute a one-dimensional (1-D) discrete-ordinates calculation; and (6) perform miscellaneous cross-section operations (list, punch, plot, check, etc.).[5]

The AMPX system was used to generate a 238-group library from the ENDF/B-V data file (data for five nuclides—^{14}N, ^{15}N, ^{16}O, ^{154}Eu, ^{155}Eu—were taken from ENDF/B-VI; use of ENDF/B-V oxygen results in a bias in k_{eff} that correlates with system leakage) in an "AMPX master format." [6] The group structure of the library is shown in Table 3.5. The production procedure is described in Ref. 6 and employs several modules of the AMPX system. It is a noteworthy difference between AMPX- and NJOY-generated broadgroup libraries that the AMPX master libraries require resolved resonance processing prior to use, that is, an AMPX working library must be generated. Resolved resonance treatment may be either the Nordheim Integral Treatment,[7] the narrow resonance treatment (which is an option in the GROUPR module of NJOY), or a multizone, one-dimensional integral transport calculation (as in the RABBLE processing for HELIOS). A Bondarenko factor treatment,[8] also available in NJOY, is employed for unresolved resonance self-shielding.

Table 3.5. Group boundaries for the SCALE 238-group library (ENDF/B-V LAW library)

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
1	2.00E+07	51	5.20E+04	101	4.70E+01
2	1.73E+07	52	5.00E+04	102	4.52E+01
3	1.57E+07	53	4.50E+04	103	4.40E+01
4	1.46E+07	54	3.00E+04	104	4.24E+01
5	1.38E+07	55	2.50E+04	105	4.10E+01
6	1.28E+07	56	1.70E+04	106	3.96E+01
7	1.00E+07	57	1.30E+04	107	3.91E+01
8	8.19E+06	58	9.50E+03	108	3.80E+01
9	6.43E+06	59	8.03E+03	109	3.70E+01
10	4.80E+06	60	6.00E+03	110	3.55E+01
11	4.30E+06	61	3.90E+03	111	3.46E+01
12	3.00E+06	62	3.74E+03	112	3.38E+01
13	2.48E+06	63	3.00E+03	113	3.33E+01
14	2.35E+06	64	2.58E+03	114	3.18E+01
15	1.85E+06	65	2.29E+03	115	3.13E+01
16	1.50E+06	66	2.20E+03	116	3.00E+01
17	1.40E+06	67	1.80E+03	117	2.75E+01
18	1.36E+06	68	1.55E+03	118	2.50E+01
19	1.32E+06	69	1.50E+03	119	2.25E+01
20	1.25E+06	70	1.15E+03	120	2.10E+01
21	1.20E+06	71	9.50E+02	121	2.00E+01
22	1.10E+06	72	6.83E+02	122	1.90E+01
23	1.01E+06	73	6.70E+02	123	1.85E+01
24	9.20E+05	74	5.50E+02	124	1.70E+01
25	9.00E+05	75	3.05E+02	125	1.60E+01
26	8.75E+05	76	2.85E+02	126	1.51E+01
27	8.61E+05	77	2.40E+02	127	1.44E+01
28	8.20E+05	78	2.10E+02	128	1.38E+01

Table 3.5. (continued)

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
29	7.50E+05	79	2.08E+02	129	1.29E+01
30	6.79E+05	80	1.93E+02	130	1.19E+01
31	6.70E+05	81	1.86E+02	131	1.15E+01
32	6.00E+05	82	1.22E+02	132	1.00E+01
33	5.73E+05	83	1.19E+02	133	9.10E+00
34	5.50E+05	84	1.15E+02	134	8.10E+00
35	5.00E+05	85	1.08E+02	135	7.15E+00
36	4.70E+05	86	1.00E+02	136	7.00E+00
37	4.40E+05	87	9.00E+01	137	6.75E+00
38	4.20E+05	88	8.20E+01	138	6.50E+00
39	4.00E+05	89	8.00E+01	139	6.25E+00
40	3.30E+05	90	7.60E+01	140	6.00E+00
41	2.70E+05	91	7.20E+01	141	5.40E+00
42	2.00E+05	92	6.75E+01	142	5.00E+00
43	1.50E+05	93	6.50E+01	143	4.75E+00
44	1.28E+05	94	6.10E+01	144	4.00E+00
45	1.00E+05	95	5.90E+01	145	3.73E+00
46	8.50E+04	96	5.34E+01	146	3.50E+00
47	8.20E+04	97	5.20E+01	147	3.15E+00
48	7.50E+04	98	5.06E+01	148	3.05E+00
49	7.30E+04	99	4.92E+01	149	3.00E+00
50	6.00E+04	100	4.83E+01	150	2.97E+00
151	2.87E+00	181	1.09E+00	211	2.50E-01
152	2.77E+00	182	1.08E+00	212	2.25E-01
153	2.67E+00	183	1.07E+00	213	2.00E-01
154	2.57E+00	184	1.06E+00	214	1.75E-01
155	2.47E+00	185	1.05E+00	215	1.50E-01
156	2.38E+00	186	1.04E+00	216	1.25E-01
157	2.30E+00	187	1.03E+00	217	1.00E-01
158	2.21E+00	188	1.02E+00	218	9.00E-02
159	2.12E+00	189	1.01E+00	219	8.00E-02
160	2.00E+00	190	1.00E+00	220	7.00E-02
161	1.94E+00	191	9.75E-01	221	6.00E-02
162	1.86E+00	192	9.50E-01	222	5.00E-02
163	1.77E+00	193	9.25E-01	223	4.00E-02
164	1.68E+00	194	9.00E-01	224	3.00E-02
165	1.59E+00	195	8.50E-01	225	2.53E-02
166	1.50E+00	196	8.00E-01	226	1.00E-02
167	1.45E+00	197	7.50E-01	227	7.50E-03
168	1.40E+00	198	7.00E-01	228	5.00E-03
169	1.35E+00	199	6.50E-01	229	4.00E-03
170	1.30E+00	200	6.25E-01	230	3.00E-03
171	1.25E+00	201	6.00E-01	231	2.50E-03
172	1.22E+00	202	5.50E-01	232	2.00E-03
173	1.20E+00	203	5.00E-01	233	1.50E-03
174	1.17E+00	204	4.50E-01	234	1.20E-03
175	1.15E+00	205	4.00E-01	235	1.00E-03
176	1.14E+00	206	3.75E-01	236	7.50E-04
177	1.13E+00	207	3.50E-01	237	5.00E-04
178	1.12E+00	208	3.25E-01	238	1.00E-04
179	1.11E+00	209	3.00E-01	-	1.00E-05
180	1.10E+00	210	2.75E-01		

A broad group library containing 44 energy groups was produced by collapsing the 238-group library.[9] The group structure is shown in Table 3.6 and "was designed to accommodate the following features: two "windows" in the oxygen cross section spectrum; a window in the cross section of iron; the Maxwellian peak in the thermal range; and the 0.3-eV resonance in ^{239}Pu (which, due to its low energy and lack of resonance data, cannot be properly modeled via the Nordheim integral treatment)." [9] The 238-group cross sections were collapsed into the 44-group structure using a fuel cell spectrum calculated based on a 17 by 17 Westinghouse LWR assembly fueled with LEU.

Table 3.6. Group boundaries for the SCALE 44-group library (ENDF/B-V)

Group No.	Upper group energy limits (eV)	Group No.	Upper group energy limits (eV)
1	2.00E+07	24	1.77E+00
2	8.19E+06	25	1.00E+00
3	6.43E+06	26	6.25E-01
4	4.80E+06	27	4.00E-01
5	3.00E+06	28	3.75E-01
6	2.48E+06	29	3.50E-01
7	2.35E+06	30	3.25E-01
8	1.85E+06	31	2.75E-01
9	1.40E+06	32	2.50E-01
10	9.00E+05	33	2.25E-01
11	4.00E+05	34	2.00E-01
12	1.00E+05	35	1.50E-01
13	2.50E+04	36	1.00E-01
14	1.70E+04	37	7.00E-02
15	3.00E+03	38	5.00E-02
16	5.50E+02	39	4.00E-02
17	1.00E+02	40	3.00E-02
18	3.00E+01	41	2.53E-02
19	1.00E+01	42	1.00E-02
20	8.10E+00	43	7.50E-03
21	6.00E+00	44	3.00E-03
22	4.75E+00	-	1.00E-05
23	3.00E+00		

3.1.3 Comments on Nuclear Data Libraries

MOX systems are expected to be more difficult to accurately calculate than LEU systems because some of the plutonium nuclides have absorption resonances that "overlap" uranium nuclide resonances. Data for the major capture resonances for uranium and plutonium isotopes have been tabulated by R. Q. Wright, ORNL, and are shown in Tables 3.7 through 3.14. Note that capture resonance integrals for the lowest ^{239}Pu and ^{241}Pu are not provided because the resonance integral is defined as being the 1/E-weighted value of the cross section above 0.5 eV. The capture resonance integrals were calculated from the single-level Breit-Wigner formula and are "infinite dilution" values. Both ^{238}U and ^{240}Pu have significant resonances at approximately 21, 37, and 66 eV. The ^{235}U, ^{239}Pu, and ^{241}Pu each have resonances at approximately 7 eV, and ^{235}U also has a resonance at ~21 eV. The presence of the resonance "overlaps" mandates that physics benchmark studies must evaluate the impact, where and when applicable, on calculated physics parameters of the nuclear data processing assumption that all resonances are isolated.

Table 3.7. Major ^{235}U capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
6.39	48.9	11.02
8.77	130.0	5.81
12.40	71.5	8.82
19.29	99.1	6.85
21.07	72.6	4.13

Table 3.8. Major ^{236}U capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
5.45	27.0	282.4
34.10	21.1	4.76
43.91	28.8	14.9
71.47	40.9	8.14

Table 3.9. Major ^{238}U capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
6.67	24.5	130.0
20.87	33.2	67.2
36.68	57.0	42.1
66.03	48.0	11.35

Table 3.10. Major ^{238}Pu capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
2.86	38.1	36.6
9.98	37.2	7.03
18.56	42.5	36.8
59.80	39.3	1.59
70.10	45.0	1.63

Table 3.11. Major ^{239}Pu capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
0.296	96.7	—
7.82	83.3	18.21
10.93	191.9	8.77
11.90	59.6	13.58
14.33	88.9	3.00
14.68	71.5	15.04

Table 3.12. Major ^{240}Pu capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
1.056	33.1	8402.0
20.46	35.1	23.9
38.32	43.9	29.5
41.62	46.9	25.6
66.62	83.4	17.7

Table 3.13. Major ^{241}Pu capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
0.266	110.0	—
4.28	58.1	40.01
4.58	156.7	7.83
6.93	135.4	6.94
8.61	90.2	8.23
9.62	240.0	1.80
9.92	959.4	3.05

Table 3.14. Major ^{242}Pu capture resonances

Resonance energy (eV)	Total width (eV)	Capture resonance integral (barns, infinite dilution)
2.67	24.3	1218.0
14.60	23.5	1.18
22.57	23.3	2.32
40.95	27.4	1.09
53.46	73.2	21.75
67.60	27.6	3.39

Though all of the multigroup libraries have a significant number of groups in the thermal and resonance energy ranges, none were generated using a spectra that would exist in a MOX unit cell for either a VVER or an American LWR. AMPX libraries offer the user the opportunity to input MOX unit cell characteristics as a part of generating a working library; yet, as noted previously, an LEU spectra was used to collapse the 44-group library from the 238-group library. The impact of this cross section generation deficiency can be assessed by comparison of point energy calculations to multigroup calculations or by comparing the 44- and 238-group calculations. Furthermore, the impact of computing with a relatively small number of energy groups can be assessed in a stepwise fashion by repetitive calculation of the same problem with successively smaller number of groups. When MOX fuel designs for VVERs and American LWRs are completed (or nearly so), analysts should calculate and compare the expected spectra for a unit cell with the spectra used in cross section library generation.

ENDF data files contain uncertainty estimates for the nuclear data in the library. When MOX fuel designs are finalized, sensitivity studies should be conducted to quantitatively assess the impact of nuclear data uncertainties on calculated physics parameters. The proper allocation of funds between nuclear constant measurement, integral experiments, and analysis requires that this assessment be performed.

3.2 PROGRAMS TO CALCULATE NEUTRON FLUXES, REACTION RATES, AND MULTIPLICATION FACTORS

The calculation of reactor physics parameters can be performed with computer programs employing either a stochastic (Monte Carlo) method of solution to the Boltzman transport equation or by a deterministic method involving the iterative solution of a matrix representation of the equation. For any thermal problem, the solution time for a deterministic code is a nonlinear function, increasing rapidly in value with the number of energy groups—especially when there are a large number of thermal groups. Stochastic solutions are generally linear with the ratio of increase in solution time to increase in number of energy groups being less than unity. These observations, along with the fact that geometric approximations are generally unnecessary with stochastic codes, led to the common practice of calculating benchmark problems with stochastic programs using a large number of energy groups (or with point energy libraries) and then validating the deterministic programs against the stochastic calculations. In a stepwise fashion, the stochastic and deterministic programs are executed with a succession of libraries having fewer and fewer groups until either an unacceptable agreement between calculations is obtained or the number of energy groups has been reduced to the point that economical computations can be performed. The deterministic code and its library are then considered certified for generating input to reactor design or safety calculations.

The above scheme is utilized in the modeling of fuel pins, assemblies, and even small numbers (approximately 10) of adjacent assemblies. Ultimately, "whole core" calculations must be validated through the use of "start-up" physics tests, reactor operational data, and reactor fuel cycle length.

With the advent of inexpensive, large memory, high-speed computers, the trend in recent years is to avoid or minimize the number of stochastic calculations and instead validate the deterministic code directly with experimental data. These computations involve a reasonably large number of energy groups—approximately 100—and include accurate geometric modeling due to improved geometric modeling capabilities. For the studies documented here, the traditional stochastic-deterministic pairing was followed.

3.2.1 Stochastic Methods

These methods are based on modeling the actual "life history" of a particle from its creation to its exit from the system. A geometric representation of the physical system to be studied is prepared. Characteristics of the particle population are estimated by introducing a number of particles into the model at assigned locations and velocities. Motions of the particles are simulated on the computer until the particles are either scattered, destroyed, or leak from the system. The computer program tracks the reactions that occur and provides tabulations for the user.

3.2.1.1 KENO

Two versions of this program, KENO-V.a and KENO-VI are included in the SCALE[10] system. Version VI provides enhanced geometric modeling capabilities at the expense of slower execution time than a comparable problem modeled with Version V. Note that hexagonal arrays are modeled more easily in Versions VI and V. The KENO code is limited to neutron transport, though none of the computational problems reported here required calculation of photon production or transport. KENO requires multigroup cross section data as input, though the number of energy groups is arbitrary.

3.2.1.1 MCNP

The name, MCNP, is an acronym for Monte Carlo Neutral-Particle, perhaps now N-Particle transport program.[11] In capabilities, it differs from KENO because it can transport photons, electrons, as well as neutrons, and can be executed in either continuous energy or multigroup modes.

3.2.2 Deterministic Methods

The Boltzman transport equation can discretized in energy, space, and time to form an array of coupled, linear equations that represent the fluxes at the geometric mesh points or averaged over geometric regions. For all the calculations reported in this document, steady-state conditions were assumed; no kinetics problems were solved.

Depletion problems were solved by assuming steady-state conditions for a given time interval. At the end of the interval, a step-change in system properties was calculated and applied.

3.2.2.1 One-dimensional, unit cell calculations

Infinite lattice calculations of a single fuel pin—termed unit cell calculations—were performed both for use as computational benchmarks and as part of the nuclear data processing sequence. For some of the single and multi-assembly calculations that are reported in this document, the number of energy groups was reduced from the values reported earlier in this section through the use of a unit cell calculation of the spatially dependent flux. This flux calculation was then used to weight the multigroup data appropriately.

3.2.2.1.1 XSDRNPM

The XSDRNPM program is a discrete ordinates theory-based program that can utilize energy-angular-dependent cross section data. It is an extension of an earlier program called ANISN.[12] The extensions include (among other things) the capabilities to utilize AMPX-formatted cross sections, to produce weighted cross section libraries, and to perform adjoint calculations. XSDRNPM is a part of both the AMPX and SCALE code systems.

3.2.2.1.2 WIMS

The current version of the Winfrith Improved Multigroup Scheme (WIMS)[13] solves the transport equation for lattices of fuel rods in two dimensions. The code contains several options for the solution of the transport equation including diffusion theory, discrete ordinates (S_N) theory, and collision probability theory[14]. The version of WIMS utilized in studies reported in this document is WIMS-D4M. This version was distributed with a cross section library derived from ENDF/B-V and was a modification of the WIMS-D4 program so that weighted cross section data could be generated in an ISOTXS[15] format (a formatted needed by the VENTURE and DIF3D codes described subsequently). If ENDF/B-V cross section data are to be utilized (as the case in the studies reported here), the WIMS-D4M code can be executed only for one-dimensional (1-D) problems.

3.2.2.2 Multidimensional

The calculation of peak pin and peak assembly powers requires the calculation of neutron fluxes in two and three dimensions. For calculations in which the whole core is modeled, the physically large problem being solved mandates the use of only a few energy groups and a coarse spatial mesh. HELIOS, VENTURE and DIF3D are used to model single assemblies or groups of a few assemblies. NESTLE, VENTURE, and DIF3D are used for whole-core simulations.

3.2.2.2.1 HELIOS

> HELIOS is a neutron and gamma transport code for lattice burnup in general two-dimensional geometry. ... HELIOS performs resonance shielding calculations for nuclides with resolved resonance data. ... the transport method of HELIOS is called the CCCP method, because it is based on current coupling and collision probabilities. It is actually first-flight probabilities because transmission and escape probabilities are included. For reasons of tradition, collision probabilities is retained in the solution method acronym. The system to be calculated is made up of space elements that are coupled by interface currents with each other and with the boundaries, while the properties of each space element – its responses to sources and in-currents – are obtained from (collision probabilities).[16]

3.2.2.2.2 VENTURE

"Reactor core analysis problems may be solved with application of the multigroup diffusion theory approximation to neutron transport, treating up to three space coordinates and long-time exposure (depletion)." [17] The code system is modular in nature. The flux solution is in a module called VENTNEUT. Reaction rates and power distributions are computed by separate modules. Communication between modules is accomplished by

writing data to interface files.[15] The depletion equations are solved in a separate module and can be solved for an arbitrary number of nuclides. The depletion chains and nuclides to be depleted are defined by the user.

3.2.2.2.3 DIF3D

> DIF3D solves multigroup diffusion theory eigenvalue, adjoint, fixed source and criticality (concentration search) problems in 1-, 2-, and 3-space dimensions for orthogonal (rectangular or cylindrical, triangular and hexagonal geometries. Anisotropic diffusion coefficients are permitted. Flux and power density maps by mesh cell and regionwise balance integrals are provided.... Upscattering and internal black boundary conditions are also treated.[18]

DIF3D and VENTURE are essentially equivalent in capabilities but have different origins. The use of DIF3D in the studies reported in this document is for verification of VENTURE results.

3.2.2.2.4 NESTLE

> NESTLE is a ... code that solves the few-group neutron diffusion equation utilizing the Nodal Expansion Method (NEM). NESTLE can solve the eigenvalue (criticality); eigenvalue adjoint; external fixed-source steady-state; or external fixed-source or eigenvalue initiated transient problems.... The eigenvalue problem allows criticality searches to be completed, and the external fixed-source steady-state problem can search to achieve a specified power level. Transient problems model delayed neutrons via precursor groups. Several core properties can be input as time dependent. Two or four energy groups can be utilized.... Core geometries modelled include Cartesian and Hexagonal. Three, two, and one dimensional models can be utilized with various symmetries.
>
> Thermal-hydraulic feedback is modelled employing a Homogenous Equilibrium Mixture (HEM) model, allowing two-phase flow to be treated. However, only the continuity and energy equations for the coolant are solved, implying a constant pressure treatment. The slip is assumed to be one in the HEM model. A lumped parameter model is employed to determine the fuel temperature. Decay heat groups are used to model decay heat.
>
> The thermal conditions predicted by the thermal-hydraulic model of the core are used to correct cross-sections for temperature and density effects. Cross-sections are parameterized by color (orientation of assembly in core), control rod state (*i. e.* in or out) and burnup, allowing fuel depletion to be modelled.... All cross-sections are expressed in terms of a Taylor's series expansion in coolant density, coolant temperature, effective fuel temperature, and soluble poison number density.[19]

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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 so that it is 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 created by staff members at Oak Ridge National Laboratory (ORNL). A Russian water-water reactor (VVER) computational benchmark was submitted by representatives of 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—some employing the Monte Carlo method of modeling neutron transport and others based on deterministic methods for solving the neutron transport equation. 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 (MOX) 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 burnable poison (BP) rods at various times during the assembly irradiation. A central instrumentation channel is also present.

Several calculations are to be performed at beginning of life (BOL) to provide k_{eff}, the pin power distribution, and isotopic reaction rates. The 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/MT heavy metal (HM). 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 one instrumentation tube. The geometric specifications are presented in Tables 4.1 and 4.2. The basic geometry description was taken from Ref. 1.

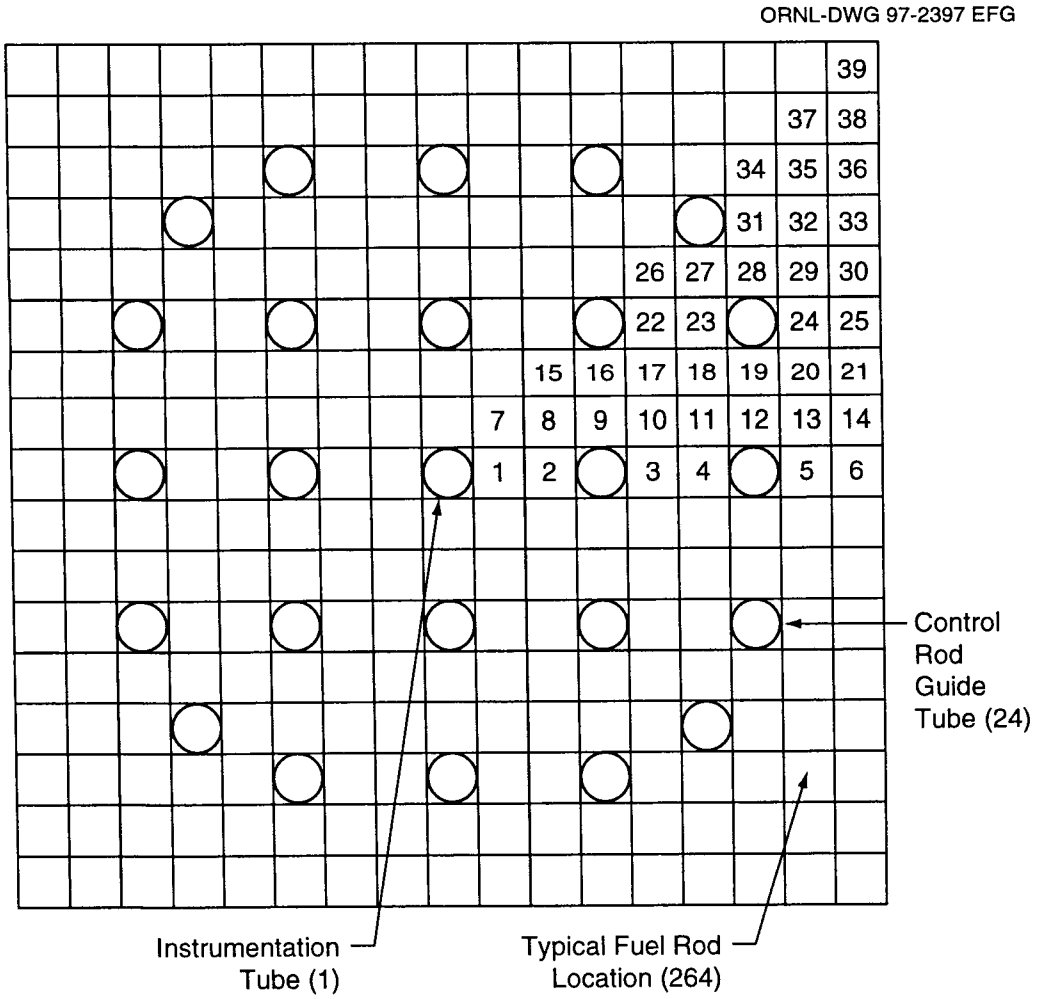


Fig. 4.1. PWR lattice geometry. When present, BP rod locations are the same as for the guide tubes.

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[a]	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

[a]TD = theoretical density.

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 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 two-dimensional (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 during 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 the subsequent

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

two cycles (the guide tubes remain). The following results are desired at each 1.5-GWd/MTHM increment (30 intervals during 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 fission products (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 during 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 WEAPONS-GRADE MOX PWR BENCHMARK CALCULATIONS (J. C. Gehin)

4.2.1 Introduction

Calculations of the PWR MOX benchmark have been performed with the KENO[4] Monte Carlo code and the VENTURE[5] diffusion-theory code by using cross sections created with the SCALE[4] system and the HELIOS[6,7] system.

4.2.2 Methods and Data

4.2.2.1 Cross section data

The reference KENO and VENTURE modules used the 238-group ENDF/B-V cross section libraries included with the SCALE system. Additional calculations were also performed with the 44-group ENDF/B-V SCALE library for comparison purposes. The HELIOS calculations were performed with the 190-group ENDF/V-VI cross section library provided with the HELIOS system. Additional calculations were also performed with the HELIOS 34- and 89-group ENDF/B-VI libraries for comparison.

The cross sections for the KENO and VENTURE calculations were created using the SCALE system. A flow diagram of the cross section processing is presented in Fig. 4.2. Starting with the AMPX master library, the CSASN sequence was used to perform the resonance shielding calculations to produce a temperature adjusted AMPX working cross section library. Then, several one-dimensional discrete-ordinates calculations were performed for the unit cell model and supercell models for the guide tubes and the burnable absorber pins.

Burnup-dependent cross sections were created by repeating the cross section generation process using precomputed values of the nuclide concentrations. The precomputed values of the nuclide concentrations were obtained using a pin-cell VENTURE model with the cross sections created at zero burnup. Once the cross sections were obtained as a function of burnup, another VENTURE pin-cell calculation was performed to obtain new nuclide concentrations that were, in turn, used to create new burnup-dependent cross sections. This process required two iterations (once with the zero burnup cross sections, and again with the first-iteration cross sections) to converge. Simply using the nuclide concentrations obtained using the zero burnup cross sections resulted in rather large errors in the ^{240}Pu concentrations. The cross sections for the VENTURE calculations were further collapsed in energy from 238 groups to 44 groups.

4.2.2.2 KENO model

KENO is a multigroup Monte Carlo code that is part of the SCALE system. It is widely used for criticality safety. For this analysis, version Va was used.

The KENO model consists of a full-assembly with an axial height of 365.76 cm. The fuel, gap, clad, and coolant regions were explicitly modeled as were all of the regions of the burnable absorber rods and guide tubes. Symmetric locations were assigned to the same unit number to improve the calculational statics for the fluxes and fission densities. The calculations were performed with 550 batches of 5000 particles with the 50 batches skipped. This results in k_{eff} uncertainties of less than 0.05% and fission density uncertainties of less than 0.5%. The KENO model was used only for the BOL cases.

4.2.2.3 VENTURE model

The VENTURE code system is a complete reactor core analysis system with modules to perform finite-difference diffusion theory neutronics calculations, fuel burnup, perturbation calculations, and fuel management. A dedicated production version created for the Fissile Materials Disposition Program (FMDP) was used for all of the calculations.

The VENTURE model consists of a 1/4-assembly with four meshes per pin cell. VENTURE does not have any facility for handling burnup-dependent cross sections. However, it does have the ability for handling temperature-dependent cross sections. Therefore, by using the burnup values as the temperature, VENTURE can be forced to interpolate on BURNUP. This procedure was used for all burnup calculations.

Detailed burnup chains were used in the VENTURE calculations. There are 20 actinides modeled and 106 fission products modeled. A list of the nuclides in the depletion model are given in Table 4.6.

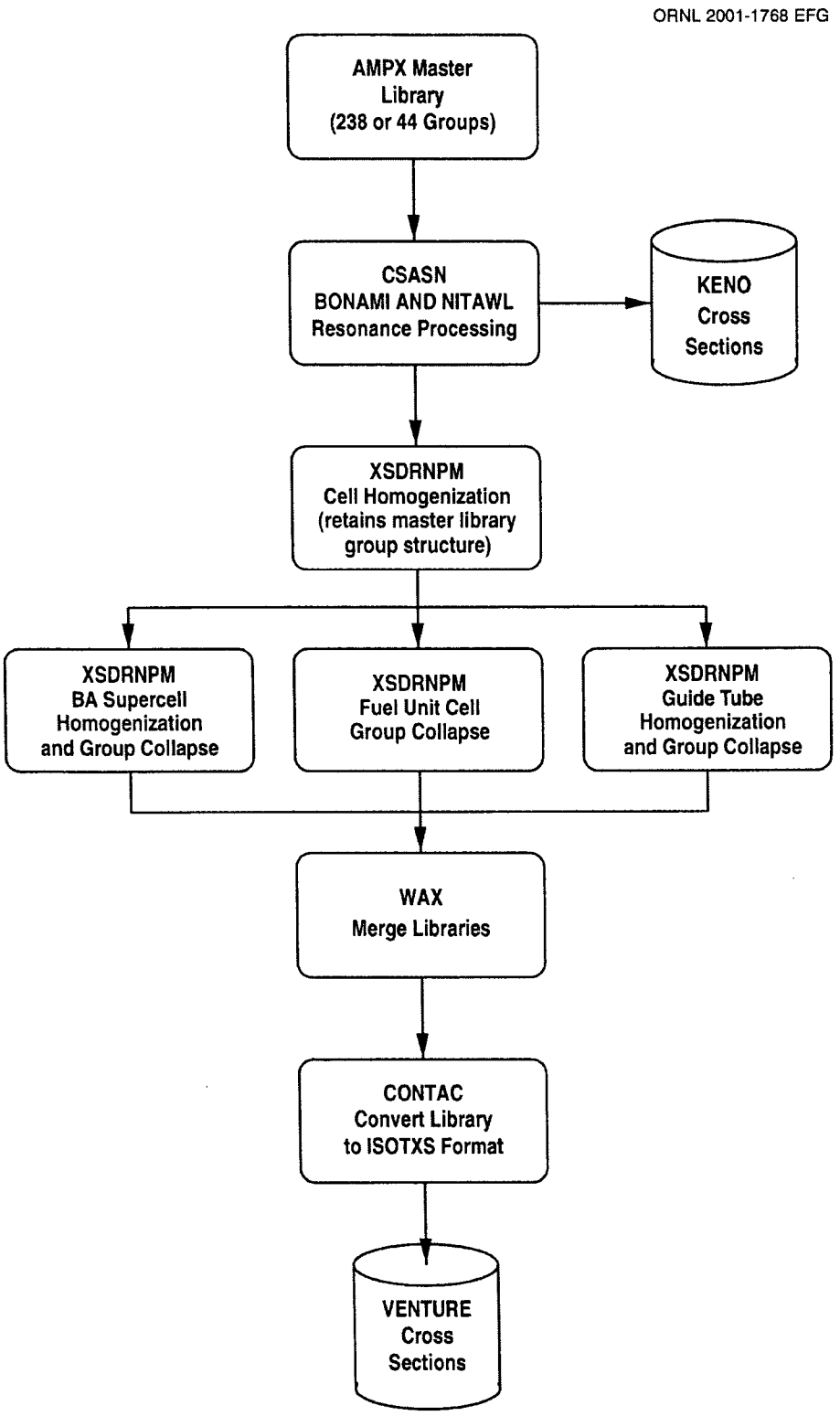


Fig. 4.2. Flow diagram of cross section processing.

Table 4.6. Nuclides included in the VENTURE depletion model

^{81}Br	^{103}Ru	^{128}Te	^{139}La	^{149}Sm	^{237}U
^{83}Kr	^{104}Ru	^{130}Te	^{140}Ce	^{150}Sm	^{238}U
^{84}Kr	^{106}Ru	^{127m}Te	^{141}Ce	^{151}Sm	^{237}Np
^{85}Rb	^{103}Rh	^{129m}Te	^{142}Ce	^{152}Sm	^{238}Np
^{87}Rb	^{105}Rh	^{127}I	^{144}Ce	^{153}Sm	^{238}Pu
^{90}Sr	^{104}Pd	^{129}I	^{141}Pr	^{154}Sm	^{239}Pu
^{89}Y	^{105}Pd	^{131}I	^{143}Pr	^{153}Eu	^{240}Pu
^{91}Zr	^{106}Pd	^{135}I	^{142}Nd	^{154}Eu	^{241}Pu
^{93}Zr	^{107}Pd	^{130}Xe	^{143}Nd	^{155}Eu	^{242}Pu
^{94}Zr	^{108}Pd	^{131}Xe	^{144}Nd	^{156}Eu	^{241}Am
^{95}Zr	^{110}Pd	^{132}Xe	^{145}Nd	^{155}Gd	^{242}Am
^{96}Zr	^{109}Ag	^{133}Xe	^{146}Nd	^{156}Gd	^{242m}Am
^{95}Nb	^{110}Cd	^{134}Xe	^{147}Nd	^{157}Gd	^{243}Am
^{95}Mo	^{111}Cd	^{135}Xe	^{148}Nd	^{158}Gd	^{242}Cm
^{97}Mo	^{112}Cd	^{136}Xe	^{150}Nd	^{159}Tb	^{243}Cm
^{98}Mo	^{113}Cd	^{133}Cs	^{147}Pm	^{161}Dy	^{244}Cm
^{100}Mo	^{114}Cd	^{134}Cs	^{148}Pm	^{162}Dy	^{245}Cm
^{99}Tc	^{115}In	^{135}Cs	^{149}Pm	^{164}Dy	
^{100}Ru	^{121}Sb	^{137}Cs	^{148m}Pm	^{234}U	
^{101}Ru	^{123}Sb	^{137}Ba	^{147}Sm	^{235}U	
^{102}Ru	^{125}Sb	^{138}Ba	^{148}Sm	^{236}U	

4.2.2.4 HELIOS model

HELIOS is a commercial lattice physics code that is used for the analysis of fuel assemblies and the generation of collapsed cross sections for full-core analysis codes. The code uses the collision probability method with current coupling for the transport solution. The subgroup method is used for resonance treatment. A detailed set of nuclides is used for the fuel depletion. Cross sections based on ENDF/B-VI are available in 34-, 89-, and 190-group libraries. The reference cross section library used in this work is the 190-group library.

The HELIOS model consists of a 1/8-assembly geometry. A diagram of the model is presented in Fig. 4.3. Note that fuel pins and burnable absorber rods were subdivided into multiple regions to ensure that the burnup distribution is accurately modeled.

4.2.3 Results

The results are presented in the many tables that follow. A summary of the k_{eff} values for the BOL cases are presented in Table 4.7, for the multicycle depletion calculations in Table 4.8, and for the EOL cases in Table 4.9. The output tables for all of the calculations are as follows:

- Multiplication factor summary for BOL cases — Table 4.7
- Multiplication factor summary for burnup case — Table 4.8
- Multiplication factor summary for EOL cases — Table 4.9
- KENO BOL cases — Tables 4.10–4.19
- VENTURE BOL cases — Tables 4.20–4.29
- VENTURE burnup case
  - — multiplication factors, and reaction rates — Tables 4.30–4.38
  - — actinide inventories — Tables 4.39–4.45
- HELIOS BOL cases — Tables 4.46–4.55
- HELIOS burnup case
  - — multiplication factors, and reaction rates — Tables 4.56–4.64
  - — actinide inventories — Tables 4.65–4.71

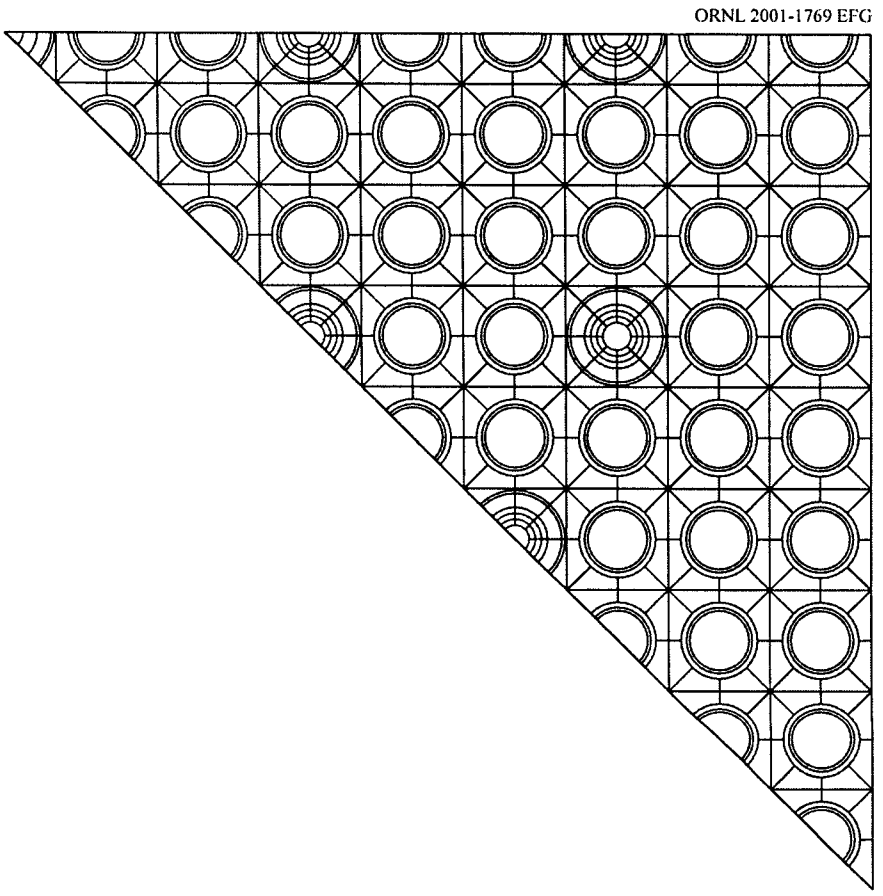


Fig. 4.3. Diagram of the HELIOS model.

Table 4.7. Multiplication factors for the MOX PWR benchmark BOL cases

Case	KENO	VENTURE	HELIOS
BOL-1	1.30257	1.30588	1.30240
BOL-2	1.23276	1.23523	1.23162
BOL-3	1.26166	1.26073	1.26137
BOL-4	1.19061	1.19092	1.18932
BOL-5	1.21987	1.21965	1.22065
BOL-6	1.15079	1.15333	1.15177
BOL-7	1.24725	1.24664	1.24851
BOL-8	1.17416	1.17576	1.17434
BOL-9	1.27825	1.27563	1.27811
BOL-10	1.19793	1.19940	1.19808

Table 4.8. Multiplication factors for the MOX PWR benchmark multicycle depletion

Burnup (MWd/kg)	VENTURE	HELIOS	Burnup (MWd/kg)	VENTURE	HELIOS
0.0	1.17601	1.17433	22.5	1.03704	1.04428
1.5	1.15383	1.15192	24.0	1.02727	1.03481
3.0	1.14117	1.13874	25.5	1.01776	1.02554
4.5	1.13043	1.12816	27.0	1.00853	1.01647
6.0	1.12048	1.11877	28.5	0.99953	1.00758
7.5	1.11101	1.11007	30.0	0.99077	0.99889
9.0	1.10181	1.10182	31.5	0.98225	0.99037
10.5	1.09281	1.09385	33.0	0.97395	0.98202
12.0	1.08397	1.08602	34.5	0.96587	0.97380
13.5	1.07521	1.07827	36.0	0.95800	0.96578
15.0	1.06654	1.07055	37.5	0.95035	0.95790
15.0	1.09013	1.09508	39.0	0.94291	0.95016
16.5	1.08055	1.08465	40.5	0.93567	0.94258
18.0	1.06811	1.07416	42.0	0.92831	0.93512
19.5	1.05745	1.06394	43.5	0.92161	0.92783
21.0	1.04709	1.05398	45.0	0.91510	0.92069

Table 4.9. Multiplication factors for the MOX PWR benchmark EOL cases

Case	VENTURE		HELIOS	
	k_{eff}	k_0[a]	k_{eff}	k_0[a]
EOL-1	0.88849	0.89280	0.89329	0.89765
EOL-2	1.06643	1.06994	1.07348	1.07690
EOL-3	0.93602	0.94053	0.94200	0.94638
EOL-4	0.94471	0.94925	0.95007	0.95441
EOL-5	0.90620	0.90921	0.91059	0.91354
EOL-6	0.95829	0.96126	0.96304	0.96591
EOL-7	1.00967	1.01231	1.01477	1.01735

[a]Ratio of total production to total absorption.

Table 4.10. KENO results for PWR MOX benchmark Case BOL-1

Total production/total absorption = 1.30603
Multiplication factor (k_{eff}) = 1.30257

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.074	2.3995e+15	0.00000	0.00603	0.32603	0.40651	0.08604	0.00378	0.00000	2.1171e+15	0.02732	0.05183	0.90824	0.00058	0.01202	0.0000e+00
2	1.076	2.4028e+15	0.00000	0.00606	0.32559	0.40607	0.08612	0.00381	0.00000	2.1214e+15	0.02744	0.05143	0.90848	0.00057	0.01209	0.0000e+00
3	1.067	2.3850e+15	0.00000	0.00604	0.32691	0.40582	0.08564	0.00379	0.00000	2.1034e+15	0.02735	0.05206	0.90795	0.00058	0.01206	0.0000e+00
4	1.064	2.3819e+15	0.00000	0.00605	0.32685	0.40508	0.08659	0.00379	0.00000	2.0969e+15	0.02742	0.05183	0.90810	0.00058	0.01208	0.0000e+00
5	1.036	2.3405e+15	0.00000	0.00604	0.33165	0.40262	0.08644	0.00375	0.00000	2.0424e+15	0.02732	0.05297	0.90706	0.00059	0.01205	0.0000e+00
6	0.933	2.1764e+15	0.00000	0.00599	0.34584	0.39193	0.09062	0.00360	0.00000	1.8396e+15	0.02703	0.05944	0.90091	0.00066	0.01196	0.0000e+00
7	1.006	2.2932e+15	0.00000	0.00602	0.33549	0.39895	0.08837	0.00370	0.00000	1.9834e+15	0.02725	0.05555	0.90457	0.00062	0.01201	0.0000e+00
8	1.007	2.2934e+15	0.00000	0.00602	0.33487	0.39919	0.08857	0.00371	0.00000	1.9849e+15	0.02726	0.05534	0.90476	0.00062	0.01203	0.0000e+00
9	1.075	2.4036e+15	0.00000	0.00604	0.32633	0.40563	0.08631	0.00379	0.00000	2.1184e+15	0.02740	0.05145	0.90851	0.00057	0.01207	0.0000e+00
10	1.002	2.2866e+15	0.00000	0.00601	0.33563	0.39847	0.08906	0.00370	0.00000	1.9744e+15	0.02724	0.05552	0.90458	0.00062	0.01203	0.0000e+00
11	0.999	2.2772e+15	0.00000	0.00601	0.33516	0.39919	0.08872	0.00370	0.00000	1.9693e+15	0.02720	0.05565	0.90452	0.00062	0.01201	0.0000e+00
12	1.059	2.3768e+15	0.00000	0.00603	0.32814	0.40518	0.08658	0.00377	0.00000	2.0865e+15	0.02728	0.05214	0.90795	0.00058	0.01205	0.0000e+00
13	0.975	2.2451e+15	0.00000	0.00601	0.34062	0.39569	0.08876	0.00367	0.00000	1.9219e+15	0.02722	0.05650	0.90363	0.00063	0.01202	0.0000e+00
14	0.925	2.1648e+15	0.00000	0.00597	0.34771	0.39050	0.09087	0.00359	0.00000	1.8230e+15	0.02700	0.05987	0.90051	0.00067	0.01195	0.0000e+00
15	1.009	2.2993e+15	0.00000	0.00602	0.33492	0.39881	0.08888	0.00371	0.00000	1.9887e+15	0.02728	0.05517	0.90490	0.00062	0.01203	0.0000e+00
16	1.079	2.4074e+15	0.00000	0.00605	0.32577	0.40637	0.08576	0.00380	0.00000	2.1263e+15	0.02740	0.05145	0.90851	0.00057	0.01206	0.0000e+00
17	1.007	2.2959e+15	0.00000	0.00602	0.33572	0.39882	0.08819	0.00371	0.00000	1.9846e+15	0.02727	0.05519	0.90489	0.00062	0.01203	0.0000e+00
18	1.002	2.2870e+15	0.00000	0.00602	0.33543	0.39858	0.08895	0.00371	0.00000	1.9757e+15	0.02727	0.05532	0.90476	0.00062	0.01203	0.0000e+00
19	1.064	2.3826e+15	0.00000	0.00605	0.32730	0.40538	0.08616	0.00378	0.00000	2.0970e+15	0.02737	0.05205	0.90795	0.00058	0.01205	0.0000e+00
20	0.979	2.2484e+15	0.00000	0.00601	0.33893	0.39659	0.08923	0.00367	0.00000	1.9288e+15	0.02719	0.05648	0.90368	0.00063	0.01201	0.0000e+00
21	0.922	2.1618e+15	0.00000	0.00598	0.34810	0.39060	0.09099	0.00358	0.00000	1.8181e+15	0.02697	0.05999	0.90042	0.00067	0.01195	0.0000e+00
22	1.088	2.4236e+15	0.00000	0.00605	0.32376	0.40694	0.08641	0.00381	0.00000	2.1449e+15	0.02746	0.05074	0.90915	0.00057	0.01209	0.0000e+00
23	1.089	2.4272e+15	0.00000	0.00606	0.32503	0.40657	0.08575	0.00381	0.00000	2.1460e+15	0.02746	0.05090	0.90899	0.00057	0.01208	0.0000e+00
24	1.042	2.3530e+15	0.00000	0.00604	0.33060	0.40247	0.08726	0.00376	0.00000	2.0544e+15	0.02736	0.05283	0.90716	0.00059	0.01206	0.0000e+00
25	0.928	2.1698e+15	0.00000	0.00598	0.34719	0.39100	0.09070	0.00359	0.00000	1.8291e+15	0.02704	0.05948	0.90087	0.00066	0.01195	0.0000e+00
26	1.063	2.3831e+15	0.00000	0.00604	0.32668	0.40485	0.08756	0.00379	0.00000	2.0950e+15	0.02738	0.05221	0.90775	0.00058	0.01208	0.0000e+00
27	1.117	2.4673e+15	0.00000	0.00608	0.32063	0.40920	0.08513	0.00385	0.00000	2.2009e+15	0.02757	0.04942	0.91034	0.00055	0.01211	0.0000e+00
28	1.098	2.4373e+15	0.00000	0.00607	0.32291	0.40822	0.08539	0.00383	0.00000	2.1642e+15	0.02747	0.05034	0.90954	0.00056	0.01209	0.0000e+00
29	0.976	2.2443e+15	0.00000	0.00602	0.33974	0.39569	0.08921	0.00367	0.00000	1.9229e+15	0.02725	0.05639	0.90371	0.00063	0.01202	0.0000e+00
30	0.921	2.1601e+15	0.00000	0.00597	0.34818	0.38979	0.09127	0.00358	0.00000	1.8157e+15	0.02704	0.05970	0.90064	0.00067	0.01195	0.0000e+00
31	1.058	2.3777e+15	0.00000	0.00604	0.32883	0.40419	0.08638	0.00378	0.00000	2.0856e+15	0.02737	0.05214	0.90784	0.00058	0.01207	0.0000e+00
32	0.941	2.1892e+15	0.00000	0.00599	0.34546	0.39274	0.08981	0.00362	0.00000	1.8539e+15	0.02705	0.05862	0.90170	0.00066	0.01197	0.0000e+00
33	0.904	2.1319e+15	0.00000	0.00598	0.35095	0.38781	0.09171	0.00357	0.00000	1.7817e+15	0.02704	0.06089	0.89943	0.00068	0.01196	0.0000e+00
34	0.965	2.2306e+15	0.00000	0.00602	0.34234	0.39375	0.08912	0.00366	0.00000	1.9020e+15	0.02729	0.05702	0.90302	0.00064	0.01203	0.0000e+00
35	0.913	2.1455e+15	0.00000	0.00598	0.34965	0.38960	0.09075	0.00358	0.00000	1.8001e+15	0.02700	0.06012	0.90025	0.00067	0.01195	0.0000e+00
36	0.896	2.1186e+15	0.00000	0.00598	0.35289	0.38752	0.09096	0.00356	0.00000	1.7663e+15	0.02698	0.06119	0.89918	0.00069	0.01196	0.0000e+00
37	0.894	2.1156e+15	0.00000	0.00597	0.35297	0.38703	0.09161	0.00355	0.00000	1.7614e+15	0.02698	0.06111	0.89928	0.00069	0.01195	0.0000e+00
38	0.895	2.1176e+15	0.00000	0.00597	0.35288	0.38777	0.09107	0.00355	0.00000	1.7648e+15	0.02692	0.06120	0.89927	0.00069	0.01192	0.0000e+00
39	0.893	2.1155e+15	0.00000	0.00596	0.35332	0.38764	0.09121	0.00354	0.00000	1.7605e+15	0.02686	0.06151	0.89901	0.00069	0.01193	0.0000e+00
Assembly total[c]		6.0284e+17	0.00000	0.00602	0.33627	0.39865	0.08836	0.00370	0.00000	5.2036e+17	0.02724	0.05526	0.90486	0.00062	0.01202	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.11. KENO results for PWR MOX benchmark Case BOL-2

Total production/total absorption = 1.23612
Multiplication factor (k_{eff}) = 1.23276

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.121	2.5396e+15	0.00000	0.00605	0.33165	0.40244	0.08681	0.00376	0.00000	2.2142e+15	0.02735	0.05264	0.90735	0.00059	0.01207	0.0000e+00
2	1.037	2.4110e+15	0.00000	0.00598	0.34288	0.39577	0.08940	0.00363	0.00000	2.0494e+15	0.02695	0.05683	0.90362	0.00064	0.01197	0.0000e+00
3	1.016	2.3793e+15	0.00000	0.00597	0.34646	0.39318	0.08995	0.00360	0.00000	2.0067e+15	0.02691	0.05785	0.90264	0.00065	0.01196	0.0000e+00
4	1.013	2.3749e+15	0.00000	0.00597	0.34650	0.39289	0.09022	0.00360	0.00000	2.0020e+15	0.02694	0.05773	0.90272	0.00065	0.01195	0.0000e+00
5	1.007	2.3727e+15	0.00000	0.00595	0.34855	0.39140	0.09074	0.00358	0.00000	1.9902e+15	0.02687	0.05853	0.90198	0.00066	0.01196	0.0000e+00
6	0.975	2.3130e+15	0.00000	0.00595	0.35211	0.38792	0.09179	0.00354	0.00000	1.9270e+15	0.02689	0.06111	0.89939	0.00069	0.01192	0.0000e+00
7	1.048	2.4242e+15	0.00000	0.00600	0.34053	0.39596	0.08953	0.00366	0.00000	2.0713e+15	0.02714	0.05644	0.90379	0.00063	0.01200	0.0000e+00
8	1.010	2.3638e+15	0.00000	0.00599	0.34625	0.39208	0.09047	0.00361	0.00000	1.9951e+15	0.02703	0.05860	0.90174	0.00066	0.01198	0.0000e+00
9	1.018	2.3807e+15	0.00000	0.00597	0.34491	0.39414	0.09028	0.00361	0.00000	2.0121e+15	0.02689	0.05745	0.90306	0.00064	0.01196	0.0000e+00
10	1.000	2.3495e+15	0.00000	0.00598	0.34810	0.39100	0.09077	0.00359	0.00000	1.9747e+15	0.02698	0.05891	0.90148	0.00066	0.01197	0.0000e+00
11	0.995	2.3416e+15	0.00000	0.00598	0.34902	0.39044	0.09060	0.00358	0.00000	1.9655e+15	0.02699	0.05916	0.90122	0.00066	0.01196	0.0000e+00
12	1.014	2.3777e+15	0.00000	0.00596	0.34671	0.39317	0.09017	0.00359	0.00000	2.0031e+15	0.02688	0.05796	0.90256	0.00065	0.01195	0.0000e+00
13	0.993	2.3454e+15	0.00000	0.00597	0.35029	0.38940	0.09103	0.00357	0.00000	1.9623e+15	0.02695	0.05968	0.90074	0.00067	0.01196	0.0000e+00
14	0.974	2.3109e+15	0.00000	0.00597	0.35335	0.38734	0.09106	0.00355	0.00000	1.9243e+15	0.02694	0.06107	0.89936	0.00068	0.01195	0.0000e+00
15	1.002	2.3541e+15	0.00000	0.00598	0.34829	0.39086	0.09051	0.00359	0.00000	1.9790e+15	0.02700	0.05899	0.90138	0.00066	0.01197	0.0000e+00
16	1.014	2.3751e+15	0.00000	0.00596	0.34634	0.39328	0.09024	0.00360	0.00000	2.0026e+15	0.02689	0.05789	0.90262	0.00065	0.01196	0.0000e+00
17	0.999	2.3498e+15	0.00000	0.00596	0.34843	0.39105	0.09068	0.00358	0.00000	1.9731e+15	0.02692	0.05896	0.90149	0.00066	0.01196	0.0000e+00
18	0.996	2.3450e+15	0.00000	0.00598	0.34922	0.39022	0.09058	0.00358	0.00000	1.9674e+15	0.02699	0.05911	0.90127	0.00066	0.01197	0.0000e+00
19	1.017	2.3845e+15	0.00000	0.00596	0.34660	0.39293	0.09045	0.00360	0.00000	2.0083e+15	0.02690	0.05775	0.90275	0.00065	0.01196	0.0000e+00
20	0.993	2.3443e+15	0.00000	0.00596	0.34957	0.38999	0.09142	0.00357	0.00000	1.9626e+15	0.02690	0.05960	0.90089	0.00067	0.01194	0.0000e+00
21	0.972	2.3066e+15	0.00000	0.00597	0.35291	0.38713	0.09151	0.00355	0.00000	1.9211e+15	0.02696	0.06131	0.89911	0.00069	0.01194	0.0000e+00
22	1.018	2.3863e+15	0.00000	0.00597	0.34651	0.39348	0.08980	0.00360	0.00000	2.0115e+15	0.02691	0.05734	0.90313	0.00064	0.01198	0.0000e+00
23	1.016	2.3841e+15	0.00000	0.00597	0.34706	0.39292	0.09013	0.00360	0.00000	2.0068e+15	0.02691	0.05754	0.90294	0.00064	0.01197	0.0000e+00
24	1.003	2.3635e+15	0.00000	0.00596	0.34900	0.39105	0.09057	0.00358	0.00000	1.9824e+15	0.02692	0.05858	0.90188	0.00066	0.01195	0.0000e+00
25	0.978	2.3187e+15	0.00000	0.00597	0.35265	0.38751	0.09119	0.00355	0.00000	1.9328e+15	0.02695	0.06100	0.89942	0.00068	0.01195	0.0000e+00
26	1.010	2.3732e+15	0.00000	0.00597	0.34671	0.39186	0.09129	0.00360	0.00000	1.9961e+15	0.02697	0.05787	0.90253	0.00065	0.01198	0.0000e+00
27	1.027	2.4031e+15	0.00000	0.00596	0.34543	0.39471	0.08967	0.00361	0.00000	2.0296e+15	0.02686	0.05666	0.90387	0.00064	0.01197	0.0000e+00
28	1.023	2.3974e+15	0.00000	0.00596	0.34664	0.39376	0.08973	0.00360	0.00000	2.0202e+15	0.02687	0.05705	0.90347	0.00064	0.01197	0.0000e+00
29	0.994	2.3473e+15	0.00000	0.00598	0.35079	0.38945	0.09059	0.00357	0.00000	1.9641e+15	0.02696	0.05974	0.90067	0.00067	0.01196	0.0000e+00
30	0.977	2.3231e+15	0.00000	0.00597	0.35392	0.38644	0.09155	0.00355	0.00000	1.9307e+15	0.02700	0.06105	0.89930	0.00069	0.01197	0.0000e+00
31	1.014	2.3798e+15	0.00000	0.00596	0.34724	0.39264	0.09034	0.00359	0.00000	2.0024e+15	0.02689	0.05795	0.90255	0.00065	0.01196	0.0000e+00
32	0.986	2.3325e+15	0.00000	0.00598	0.35176	0.38853	0.09065	0.00357	0.00000	1.9487e+15	0.02697	0.06030	0.90009	0.00068	0.01196	0.0000e+00
33	0.972	2.3128e+15	0.00000	0.00597	0.35472	0.38609	0.09142	0.00354	0.00000	1.9201e+15	0.02696	0.06167	0.89874	0.00069	0.01195	0.0000e+00
34	0.989	2.3435e+15	0.00000	0.00596	0.35077	0.38840	0.09256	0.00355	0.00000	1.9538e+15	0.02692	0.06001	0.90045	0.00067	0.01195	0.0000e+00
35	0.975	2.3191e+15	0.00000	0.00597	0.35445	0.38614	0.09157	0.00354	0.00000	1.9256e+15	0.02697	0.06136	0.89904	0.00069	0.01195	0.0000e+00
36	0.972	2.3118e+15	0.00000	0.00597	0.35447	0.38665	0.09125	0.00354	0.00000	1.9206e+15	0.02693	0.06166	0.89877	0.00069	0.01194	0.0000e+00
37	0.973	2.3111e+15	0.00000	0.00598	0.35373	0.38638	0.09149	0.00354	0.00000	1.9227e+15	0.02699	0.06185	0.89854	0.00069	0.01194	0.0000e+00
38	0.970	2.3107e+15	0.00000	0.00596	0.35506	0.38606	0.09142	0.00353	0.00000	1.9172e+15	0.02691	0.06192	0.89855	0.00069	0.01193	0.0000e+00
39	0.966	2.3030e+15	0.00000	0.00595	0.35525	0.38528	0.09224	0.00352	0.00000	1.9076e+15	0.02691	0.06242	0.89804	0.00070	0.01193	0.0000e+00
Assembly total[c]		6.2172e+17	0.00000	0.00597	0.34912	0.39062	0.09067	0.00358	0.00000	5.2156e+17	0.02694	0.05912	0.90131	0.00066	0.01196	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.12. KENO results for PWR MOX benchmark Case BOL-3

Total production/total absorption = 1.26642
Multiplication factor(k_{eff}) = 1.26166

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.071	2.5642e+15	0.00000	0.00578	0.38183	0.40707	0.09475	0.00344	0.00000	2.1117e+15	0.02443	0.06531	0.89786	0.00074	0.01166	0.0000e+00
2	1.068	2.5616e+15	0.00000	0.00579	0.38214	0.40571	0.09555	0.00344	0.00000	2.1058e+15	0.02452	0.06529	0.89777	0.00074	0.01168	0.0000e+00
3	1.064	2.5567e+15	0.00000	0.00579	0.38313	0.40567	0.09508	0.00344	0.00000	2.0978e+15	0.02448	0.06515	0.89794	0.00074	0.01169	0.0000e+00
4	1.058	2.5452e+15	0.00000	0.00579	0.38463	0.40489	0.09448	0.00343	0.00000	2.0853e+15	0.02451	0.06538	0.89768	0.00075	0.01168	0.0000e+00
5	1.021	2.4910e+15	0.00000	0.00577	0.38990	0.39955	0.09605	0.00337	0.00000	2.0137e+15	0.02448	0.06752	0.89558	0.00077	0.01165	0.0000e+00
6	0.934	2.3498e+15	0.00000	0.00579	0.40264	0.38558	0.09976	0.00326	0.00000	1.8422e+15	0.02470	0.07386	0.88895	0.00084	0.01164	0.0000e+00
7	1.017	2.4790e+15	0.00000	0.00579	0.38956	0.39901	0.09662	0.00339	0.00000	2.0053e+15	0.02454	0.06859	0.89440	0.00078	0.01169	0.0000e+00
8	1.017	2.4793e+15	0.00000	0.00579	0.38927	0.39852	0.09715	0.00339	0.00000	2.0054e+15	0.02458	0.06859	0.89436	0.00078	0.01169	0.0000e+00
9	1.071	2.5662e+15	0.00000	0.00578	0.38158	0.40672	0.09524	0.00344	0.00000	2.1124e+15	0.02446	0.06494	0.89819	0.00074	0.01166	0.0000e+00
10	1.017	2.4814e+15	0.00000	0.00579	0.38991	0.39824	0.09709	0.00338	0.00000	2.0041e+15	0.02456	0.06855	0.89444	0.00078	0.01167	0.0000e+00
11	1.007	2.4653e+15	0.00000	0.00580	0.39132	0.39707	0.09711	0.00337	0.00000	1.9854e+15	0.02459	0.06884	0.89411	0.00079	0.01168	0.0000e+00
12	1.051	2.5328e+15	0.00000	0.00578	0.38465	0.40418	0.09543	0.00342	0.00000	2.0713e+15	0.02449	0.06566	0.89743	0.00075	0.01167	0.0000e+00
13	0.981	2.4243e+15	0.00000	0.00579	0.39519	0.39330	0.09788	0.00333	0.00000	1.9348e+15	0.02459	0.07043	0.89252	0.00080	0.01165	0.0000e+00
14	0.931	2.3470e+15	0.00000	0.00579	0.40333	0.38440	0.10043	0.00325	0.00000	1.8354e+15	0.02471	0.07431	0.88851	0.00085	0.01162	0.0000e+00
15	1.016	2.4804e+15	0.00000	0.00580	0.39015	0.39807	0.09704	0.00338	0.00000	2.0030e+15	0.02459	0.06867	0.89428	0.00078	0.01167	0.0000e+00
16	1.070	2.5634e+15	0.00000	0.00580	0.38134	0.40643	0.09567	0.00344	0.00000	2.1097e+15	0.02452	0.06516	0.89789	0.00074	0.01168	0.0000e+00
17	1.017	2.4817e+15	0.00000	0.00580	0.39009	0.39832	0.09673	0.00338	0.00000	2.0049e+15	0.02460	0.06822	0.89472	0.00078	0.01168	0.0000e+00
18	1.015	2.4747e+15	0.00000	0.00580	0.38983	0.39861	0.09656	0.00338	0.00000	2.0015e+15	0.02459	0.06837	0.89458	0.00078	0.01168	0.0000e+00
19	1.054	2.5405e+15	0.00000	0.00578	0.38507	0.40417	0.09496	0.00342	0.00000	2.0773e+15	0.02451	0.06545	0.89761	0.00075	0.01169	0.0000e+00
20	0.980	2.4236e+15	0.00000	0.00579	0.39593	0.39316	0.09757	0.00333	0.00000	1.9317e+15	0.02460	0.07020	0.89274	0.00080	0.01165	0.0000e+00
21	0.927	2.3371e+15	0.00000	0.00580	0.40411	0.38446	0.09953	0.00326	0.00000	1.8279e+15	0.02473	0.07438	0.88840	0.00085	0.01164	0.0000e+00
22	1.077	2.5750e+15	0.00000	0.00579	0.38137	0.40734	0.09466	0.00345	0.00000	2.1226e+15	0.02450	0.06442	0.89866	0.00073	0.01168	0.0000e+00
23	1.078	2.5756e+15	0.00000	0.00580	0.38065	0.40787	0.09466	0.00346	0.00000	2.1261e+15	0.02451	0.06436	0.89870	0.00073	0.01169	0.0000e+00
24	1.030	2.5022e+15	0.00000	0.00578	0.38793	0.40137	0.09589	0.00339	0.00000	2.0307e+15	0.02450	0.06668	0.89641	0.00076	0.01165	0.0000e+00
25	0.935	2.3517e+15	0.00000	0.00580	0.40327	0.38543	0.09921	0.00327	0.00000	1.8439e+15	0.02472	0.07395	0.88884	0.00084	0.01164	0.0000e+00
26	1.062	2.5501e+15	0.00000	0.00579	0.38326	0.40570	0.09471	0.00344	0.00000	2.0947e+15	0.02450	0.06549	0.89759	0.00074	0.01168	0.0000e+00
27	1.107	2.6199e+15	0.00000	0.00579	0.37647	0.41207	0.09372	0.00349	0.00000	2.1828e+15	0.02448	0.06236	0.90076	0.00071	0.01169	0.0000e+00
28	1.083	2.5861e+15	0.00000	0.00578	0.38013	0.40894	0.09450	0.00345	0.00000	2.1350e+15	0.02442	0.06366	0.89953	0.00073	0.01167	0.0000e+00
29	0.979	2.4194e+15	0.00000	0.00579	0.39575	0.39332	0.09747	0.00333	0.00000	1.9300e+15	0.02460	0.07040	0.89254	0.00080	0.01166	0.0000e+00
30	0.928	2.3390e+15	0.00000	0.00579	0.40418	0.38463	0.09946	0.00326	0.00000	1.8290e+15	0.02469	0.07439	0.88843	0.00085	0.01164	0.0000e+00
31	1.047	2.5318e+15	0.00000	0.00578	0.38573	0.40310	0.09572	0.00341	0.00000	2.0642e+15	0.02451	0.06574	0.89732	0.00075	0.01168	0.0000e+00
32	0.943	2.3622e+15	0.00000	0.00579	0.40175	0.38705	0.09886	0.00328	0.00000	1.8588e+15	0.02467	0.07349	0.88936	0.00084	0.01164	0.0000e+00
33	0.914	2.3142e+15	0.00000	0.00580	0.40606	0.38304	0.09967	0.00324	0.00000	1.8018e+15	0.02470	0.07545	0.88738	0.00086	0.01162	0.0000e+00
34	0.963	2.3989e+15	0.00000	0.00578	0.39847	0.39027	0.09859	0.00329	0.00000	1.8985e+15	0.02461	0.07169	0.89124	0.00082	0.01164	0.0000e+00
35	0.915	2.3237e+15	0.00000	0.00579	0.40768	0.38201	0.09931	0.00323	0.00000	1.8040e+15	0.02470	0.07513	0.88768	0.00086	0.01163	0.0000e+00
36	0.902	2.2959e+15	0.00000	0.00580	0.40957	0.38060	0.09908	0.00322	0.00000	1.7775e+15	0.02473	0.07630	0.88647	0.00087	0.01163	0.0000e+00
37	0.897	2.2909e+15	0.00000	0.00581	0.41008	0.37931	0.09986	0.00322	0.00000	1.7688e+15	0.02481	0.07654	0.88613	0.00088	0.01165	0.0000e+00
38	0.892	2.2860e+15	0.00000	0.00579	0.41163	0.37804	0.10022	0.00320	0.00000	1.7577e+15	0.02476	0.07689	0.88584	0.00088	0.01163	0.0000e+00
39	0.894	2.2867e+15	0.00000	0.00578	0.41062	0.37910	0.09995	0.00320	0.00000	1.7622e+15	0.02471	0.07663	0.88618	0.00088	0.01161	0.0000e+00
Assembly total[c]		6.4782e+17	0.00000	0.00579	0.39252	0.39624	0.09704	0.00336	0.00000	5.2048e+17	0.02458	0.06916	0.89381	0.00079	0.01166	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.13. KENO results for PWR MOX benchmark Case BOL-4

Total production/total absorption = 1.19532
Multiplication factor (k_{eff}) = 1.19061

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.106	2.7060e+15	0.00000	0.00580	0.39019	0.39896	0.09638	0.00338	0.00000	2.1837e+15	0.02456	0.06721	0.89578	0.00077	0.01168	0.0000e+00
2	1.034	2.5959e+15	0.00000	0.00579	0.40185	0.38863	0.09765	0.00328	0.00000	2.0419e+15	0.02462	0.07155	0.89135	0.00082	0.01166	0.0000e+00
3	1.020	2.5781e+15	0.00000	0.00579	0.40517	0.38698	0.09723	0.00326	0.00000	2.0138e+15	0.02455	0.07202	0.89096	0.00083	0.01164	0.0000e+00
4	1.019	2.5724e+15	0.00000	0.00578	0.40446	0.38770	0.09727	0.00325	0.00000	2.0119e+15	0.02448	0.07215	0.89093	0.00083	0.01161	0.0000e+00
5	1.006	2.5541e+15	0.00000	0.00579	0.40674	0.38505	0.09788	0.00324	0.00000	1.9867e+15	0.02457	0.07326	0.88970	0.00084	0.01163	0.0000e+00
6	0.976	2.5015e+15	0.00000	0.00580	0.41161	0.37953	0.09899	0.00321	0.00000	1.9267e+15	0.02470	0.07638	0.88641	0.00088	0.01164	0.0000e+00
7	1.047	2.6122e+15	0.00000	0.00580	0.39900	0.39052	0.09777	0.00331	0.00000	2.0678e+15	0.02464	0.07117	0.89171	0.00081	0.01167	0.0000e+00
8	1.017	2.5658e+15	0.00000	0.00580	0.40390	0.38573	0.09860	0.00327	0.00000	2.0084e+15	0.02470	0.07308	0.88972	0.00084	0.01166	0.0000e+00
9	1.022	2.5758e+15	0.00000	0.00578	0.40373	0.38768	0.09750	0.00326	0.00000	2.0176e+15	0.02454	0.07216	0.89085	0.00083	0.01163	0.0000e+00
10	1.000	2.5431e+15	0.00000	0.00580	0.40722	0.38355	0.09866	0.00324	0.00000	1.9755e+15	0.02465	0.07417	0.88869	0.00085	0.01164	0.0000e+00
11	1.000	2.5451e+15	0.00000	0.00579	0.40654	0.38364	0.09946	0.00323	0.00000	1.9755e+15	0.02461	0.07383	0.88907	0.00085	0.01164	0.0000e+00
12	1.015	2.5689e+15	0.00000	0.00578	0.40522	0.38674	0.09763	0.00325	0.00000	2.0042e+15	0.02451	0.07244	0.89060	0.00083	0.01162	0.0000e+00
13	0.992	2.5272e+15	0.00000	0.00580	0.40875	0.38257	0.09834	0.00323	0.00000	1.9591e+15	0.02465	0.07478	0.88807	0.00086	0.01164	0.0000e+00
14	0.976	2.5030e+15	0.00000	0.00581	0.41184	0.37899	0.09911	0.00321	0.00000	1.9273e+15	0.02476	0.07635	0.88637	0.00088	0.01165	0.0000e+00
15	1.008	2.5552e+15	0.00000	0.00580	0.40551	0.38399	0.09915	0.00325	0.00000	1.9905e+15	0.02473	0.07340	0.88935	0.00084	0.01167	0.0000e+00
16	1.022	2.5753e+15	0.00000	0.00579	0.40301	0.38802	0.09789	0.00327	0.00000	2.0186e+15	0.02454	0.07223	0.89077	0.00083	0.01163	0.0000e+00
17	1.002	2.5452e+15	0.00000	0.00580	0.40659	0.38405	0.09863	0.00324	0.00000	1.9791e+15	0.02465	0.07380	0.88905	0.00085	0.01165	0.0000e+00
18	0.999	2.5440e+15	0.00000	0.00580	0.40747	0.38277	0.09922	0.00324	0.00000	1.9726e+15	0.02469	0.07409	0.88872	0.00085	0.01166	0.0000e+00
19	1.013	2.5665e+15	0.00000	0.00579	0.40536	0.38567	0.09835	0.00325	0.00000	2.0002e+15	0.02457	0.07275	0.89020	0.00083	0.01164	0.0000e+00
20	0.992	2.5279e+15	0.00000	0.00580	0.40860	0.38213	0.09892	0.00322	0.00000	1.9582e+15	0.02467	0.07484	0.88800	0.00086	0.01163	0.0000e+00
21	0.973	2.4979e+15	0.00000	0.00581	0.41149	0.37858	0.09992	0.00320	0.00000	1.9219e+15	0.02477	0.07656	0.88615	0.00088	0.01165	0.0000e+00
22	1.025	2.5836e+15	0.00000	0.00579	0.40377	0.38809	0.09726	0.00326	0.00000	2.0240e+15	0.02453	0.07198	0.89103	0.00083	0.01163	0.0000e+00
23	1.020	2.5788e+15	0.00000	0.00578	0.40496	0.38723	0.09718	0.00326	0.00000	2.0151e+15	0.02453	0.07203	0.89098	0.00083	0.01163	0.0000e+00
24	1.008	2.5557e+15	0.00000	0.00578	0.40610	0.38541	0.09813	0.00324	0.00000	1.9899e+15	0.02452	0.07339	0.88964	0.00084	0.01160	0.0000e+00
25	0.977	2.5018e+15	0.00000	0.00581	0.41086	0.37964	0.09926	0.00321	0.00000	1.9297e+15	0.02475	0.07624	0.88651	0.00087	0.01163	0.0000e+00
26	1.015	2.5697e+15	0.00000	0.00579	0.40582	0.38590	0.09762	0.00325	0.00000	2.0039e+15	0.02460	0.07235	0.89057	0.00083	0.01165	0.0000e+00
27	1.027	2.5938e+15	0.00000	0.00578	0.40421	0.38781	0.09731	0.00326	0.00000	2.0285e+15	0.02452	0.07140	0.89162	0.00082	0.01163	0.0000e+00
28	1.027	2.5926e+15	0.00000	0.00578	0.40382	0.38816	0.09729	0.00326	0.00000	2.0292e+15	0.02452	0.07132	0.89171	0.00082	0.01163	0.0000e+00
29	0.991	2.5297e+15	0.00000	0.00580	0.40892	0.38132	0.09933	0.00322	0.00000	1.9566e+15	0.02472	0.07472	0.88806	0.00086	0.01164	0.0000e+00
30	0.974	2.4975e+15	0.00000	0.00581	0.41138	0.37951	0.09901	0.00321	0.00000	1.9245e+15	0.02475	0.07628	0.88647	0.00088	0.01163	0.0000e+00
31	1.014	2.5645e+15	0.00000	0.00579	0.40542	0.38605	0.09774	0.00325	0.00000	2.0018e+15	0.02458	0.07279	0.89017	0.00084	0.01161	0.0000e+00
32	0.982	2.5139e+15	0.00000	0.00580	0.41048	0.37981	0.09953	0.00321	0.00000	1.9385e+15	0.02473	0.07574	0.88702	0.00087	0.01163	0.0000e+00
33	0.970	2.4943e+15	0.00000	0.00580	0.41231	0.37809	0.09975	0.00319	0.00000	1.9161e+15	0.02474	0.07680	0.88596	0.00088	0.01162	0.0000e+00
34	0.990	2.5287e+15	0.00000	0.00579	0.40860	0.38109	0.09994	0.00321	0.00000	1.9554e+15	0.02470	0.07510	0.88771	0.00086	0.01162	0.0000e+00
35	0.967	2.4864e+15	0.00000	0.00580	0.41262	0.37752	0.09985	0.00319	0.00000	1.9089e+15	0.02479	0.07699	0.88570	0.00089	0.01164	0.0000e+00
36	0.961	2.4814e+15	0.00000	0.00580	0.41424	0.37641	0.09977	0.00318	0.00000	1.8988e+15	0.02478	0.07731	0.88538	0.00089	0.01163	0.0000e+00
37	0.962	2.4788e+15	0.00000	0.00580	0.41371	0.37741	0.09935	0.00319	0.00000	1.9002e+15	0.02474	0.07734	0.88541	0.00089	0.01162	0.0000e+00
38	0.962	2.4722e+15	0.00000	0.00580	0.41296	0.37754	0.09948	0.00319	0.00000	1.8994e+15	0.02477	0.07757	0.88514	0.00089	0.01162	0.0000e+00
39	0.964	2.4852e+15	0.00000	0.00581	0.41362	0.37702	0.09974	0.00319	0.00000	1.9043e+15	0.02477	0.07724	0.88548	0.00089	0.01162	0.0000e+00
Assembly total[c]		6.7121e+17	0.00000	0.00580	0.40735	0.38353	0.09855	0.00324	0.00000	5.2138e+17	0.02465	0.07404	0.88882	0.00085	0.01164	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.14. KENO results for PWR MOX benchmark Case BOL-5

Total production/total absorption = 1.22450
Multiplication factor (k_{eff}) = 1.21987

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.070	2.7344e+15	0.02901	0.00543	0.38747	0.38436	0.09487	0.00323	0.02901	2.1174e+15	0.02428	0.06707	0.89628	0.00076	0.01161	2.0257e-08
2	1.066	2.7276e+15	0.02889	0.00544	0.38734	0.38408	0.09543	0.00323	0.02889	2.1099e+15	0.02430	0.06712	0.89620	0.00076	0.01162	2.0256e-08
3	1.064	2.7237e+15	0.02880	0.00543	0.38825	0.38422	0.09461	0.00322	0.02880	2.1063e+15	0.02427	0.06715	0.89622	0.00076	0.01160	2.0246e-08
4	1.060	2.7177e+15	0.02855	0.00544	0.38977	0.38369	0.09411	0.00322	0.02855	2.0984e+15	0.02426	0.06741	0.89596	0.00077	0.01161	2.0220e-08
5	1.026	2.6626e+15	0.02769	0.00544	0.39485	0.37873	0.09565	0.00318	0.02769	2.0318e+15	0.02435	0.06905	0.89420	0.00079	0.01161	2.0079e-08
6	0.934	2.4962e+15	0.02467	0.00546	0.40905	0.36598	0.09935	0.00308	0.02467	1.8492e+15	0.02450	0.07629	0.88675	0.00087	0.01158	1.9422e-08
7	1.011	2.6317e+15	0.02703	0.00545	0.39631	0.37687	0.09699	0.00317	0.02703	2.0010e+15	0.02435	0.07092	0.89231	0.00081	0.01161	1.9866e-08
8	1.012	2.6336e+15	0.02714	0.00545	0.39638	0.37677	0.09676	0.00316	0.02714	2.0033e+15	0.02437	0.07088	0.89235	0.00081	0.01159	1.9867e-08
9	1.064	2.7236e+15	0.02895	0.00544	0.38760	0.38369	0.09538	0.00322	0.02895	2.1068e+15	0.02430	0.06749	0.89584	0.00077	0.01161	2.0256e-08
10	1.011	2.6327e+15	0.02700	0.00544	0.39642	0.37689	0.09686	0.00316	0.02700	2.0019e+15	0.02435	0.07072	0.89254	0.00081	0.01159	1.9858e-08
11	1.010	2.6303e+15	0.02696	0.00545	0.39693	0.37650	0.09677	0.00317	0.02696	1.9986e+15	0.02437	0.07079	0.89242	0.00081	0.01161	1.9835e-08
12	1.051	2.7009e+15	0.02863	0.00544	0.39012	0.38234	0.09490	0.00321	0.02863	2.0814e+15	0.02434	0.06764	0.89563	0.00077	0.01162	2.0184e-08
13	0.980	2.5798e+15	0.02608	0.00545	0.40179	0.37269	0.09753	0.00313	0.02608	1.9408e+15	0.02440	0.07246	0.89072	0.00083	0.01159	1.9694e-08
14	0.936	2.5011e+15	0.02463	0.00547	0.40970	0.36625	0.09851	0.00308	0.02463	1.8535e+15	0.02451	0.07597	0.88707	0.00087	0.01159	1.9398e-08
15	1.018	2.6351e+15	0.02726	0.00544	0.39302	0.37903	0.09742	0.00318	0.02726	2.0144e+15	0.02429	0.07035	0.89298	0.00080	0.01157	1.9870e-08
16	1.067	2.7293e+15	0.02903	0.00543	0.38657	0.38401	0.09594	0.00323	0.02903	2.1131e+15	0.02431	0.06722	0.89609	0.00077	0.01162	2.0265e-08
17	1.016	2.6434e+15	0.02729	0.00545	0.39520	0.37677	0.09757	0.00317	0.02729	2.0119e+15	0.02441	0.07046	0.89272	0.00080	0.01162	1.9871e-08
18	1.019	2.6437e+15	0.02730	0.00545	0.39514	0.37803	0.09638	0.00318	0.02730	2.0165e+15	0.02436	0.07025	0.89299	0.00080	0.01160	1.9851e-08
19	1.056	2.7097e+15	0.02869	0.00544	0.38926	0.38316	0.09481	0.00322	0.02869	2.0911e+15	0.02433	0.06718	0.89612	0.00077	0.01161	2.0196e-08
20	0.984	2.5853e+15	0.02610	0.00545	0.40118	0.37319	0.09750	0.00313	0.02610	1.9474e+15	0.02438	0.07236	0.89085	0.00083	0.01158	1.9697e-08
21	0.935	2.5040e+15	0.02453	0.00546	0.41057	0.36535	0.09884	0.00307	0.02453	1.8512e+15	0.02451	0.07613	0.88690	0.00087	0.01159	1.9395e-08
22	1.079	2.7458e+15	0.02939	0.00544	0.38531	0.38592	0.09453	0.00325	0.02939	2.1354e+15	0.02431	0.06616	0.89716	0.00075	0.01162	2.0299e-08
23	1.081	2.7551e+15	0.02939	0.00544	0.38555	0.38581	0.09457	0.00325	0.02939	2.1404e+15	0.02431	0.06582	0.89748	0.00075	0.01164	2.0293e-08
24	1.033	2.6685e+15	0.02775	0.00544	0.39287	0.38070	0.09546	0.00319	0.02775	2.0446e+15	0.02427	0.06871	0.89465	0.00079	0.01158	2.0084e-08
25	0.935	2.5034e+15	0.02464	0.00546	0.41004	0.36530	0.09922	0.00307	0.02464	1.8506e+15	0.02454	0.07593	0.88707	0.00087	0.01159	1.9407e-08
26	1.060	2.7126e+15	0.02862	0.00544	0.38739	0.38398	0.09555	0.00323	0.02862	2.0991e+15	0.02431	0.06754	0.89577	0.00077	0.01161	2.0104e-08
27	1.102	2.7858e+15	0.03013	0.00543	0.38169	0.38944	0.09348	0.00327	0.03013	2.1823e+15	0.02424	0.06450	0.89891	0.00074	0.01162	2.0431e-08
28	1.087	2.7637e+15	0.02944	0.00542	0.38458	0.38742	0.09398	0.00325	0.02944	2.1518e+15	0.02422	0.06520	0.89821	0.00075	0.01163	2.0345e-08
29	0.979	2.5748e+15	0.02616	0.00546	0.40205	0.37225	0.09733	0.00313	0.02616	1.9375e+15	0.02447	0.07266	0.89044	0.00083	0.01161	1.9665e-08
30	0.927	2.4907e+15	0.02430	0.00546	0.41208	0.36432	0.09883	0.00306	0.02430	1.8356e+15	0.02452	0.07656	0.88647	0.00088	0.01158	1.9347e-08
31	1.046	2.6956e+15	0.02823	0.00544	0.39118	0.38166	0.09529	0.00321	0.02823	2.0706e+15	0.02433	0.06746	0.89581	0.00077	0.01162	2.0144e-08
32	0.941	2.5101e+15	0.02491	0.00547	0.40894	0.36668	0.09833	0.00308	0.02491	1.8628e+15	0.02454	0.07544	0.88756	0.00086	0.01160	1.9420e-08
33	0.912	2.4637e+15	0.02365	0.00547	0.41499	0.36245	0.09905	0.00304	0.02365	1.8061e+15	0.02452	0.07767	0.88536	0.00089	0.01156	1.9265e-08
34	0.966	2.5488e+15	0.02565	0.00546	0.40412	0.37184	0.09674	0.00312	0.02565	1.9121e+15	0.02440	0.07329	0.88988	0.00084	0.01159	1.9604e-08
35	0.919	2.4713e+15	0.02392	0.00546	0.41329	0.36405	0.09859	0.00305	0.02392	1.8193e+15	0.02448	0.07716	0.88593	0.00088	0.01155	1.9287e-08
36	0.899	2.4418e+15	0.02319	0.00547	0.41766	0.36041	0.09937	0.00302	0.02319	1.7799e+15	0.02452	0.07886	0.88416	0.00090	0.01155	1.9194e-08
37	0.900	2.4415e+15	0.02321	0.00547	0.41735	0.36087	0.09917	0.00302	0.02321	1.7808e+15	0.02452	0.07838	0.88466	0.00090	0.01155	1.9188e-08
38	0.891	2.4273e+15	0.02301	0.00547	0.41950	0.35875	0.09937	0.00301	0.02301	1.7632e+15	0.02459	0.07919	0.88375	0.00091	0.01156	1.9141e-08
39	0.881	2.4119e+15	0.02283	0.00547	0.42033	0.35662	0.10102	0.00300	0.02283	1.7435e+15	0.02468	0.07939	0.88342	0.00091	0.01160	1.9112e-08
Assembly total[c]		6.8990e+17	0.02680	0.00545	0.39845	0.37541	0.09676	0.00315	0.02680	5.2264e+17	0.02439	0.07117	0.89203	0.00081	0.01160	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.15. KENO results for PWR MOX benchmark Case BOL-6

Total production/total absorption = 1.15509
Multiplication factor (k_{eff}) = 1.15079

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.109	2.8896e+15	0.02854	0.00544	0.39451	0.37857	0.09576	0.00317	0.02854	2.2002e+15	0.02430	0.06878	0.89453	0.00079	0.01160	2.0916e-08
2	1.033	2.7731e+15	0.02621	0.00544	0.40906	0.36714	0.09739	0.00307	0.02621	2.0498e+15	0.02444	0.07337	0.88974	0.00084	0.01160	2.0674e-08
3	1.016	2.7364e+15	0.02554	0.00544	0.41132	0.36670	0.09696	0.00305	0.02554	2.0155e+15	0.02433	0.07423	0.88903	0.00085	0.01156	2.0616e-08
4	1.014	2.7382e+15	0.02554	0.00544	0.41230	0.36506	0.09750	0.00305	0.02554	2.0121e+15	0.02442	0.07470	0.88844	0.00086	0.01158	2.0597e-08
5	1.005	2.7205e+15	0.02499	0.00544	0.41388	0.36455	0.09752	0.00303	0.02499	1.9938e+15	0.02436	0.07552	0.88771	0.00087	0.01154	2.0528e-08
6	0.980	2.6750e+15	0.02432	0.00546	0.41795	0.35953	0.09905	0.00301	0.02432	1.9444e+15	0.02455	0.07816	0.88482	0.00090	0.01157	2.0128e-08
7	1.048	2.7909e+15	0.02643	0.00544	0.40507	0.37025	0.09737	0.00310	0.02643	2.0808e+15	0.02438	0.07268	0.89050	0.00083	0.01160	2.0508e-08
8	1.013	2.7313e+15	0.02535	0.00546	0.41140	0.36501	0.09828	0.00306	0.02535	2.0100e+15	0.02446	0.07521	0.88787	0.00086	0.01159	2.0403e-08
9	1.024	2.7512e+15	0.02575	0.00544	0.40923	0.36767	0.09753	0.00307	0.02575	2.0327e+15	0.02434	0.07382	0.88943	0.00085	0.01156	2.0630e-08
10	1.002	2.7127e+15	0.02505	0.00546	0.41352	0.36394	0.09796	0.00304	0.02505	1.9889e+15	0.02446	0.07561	0.88747	0.00087	0.01158	2.0355e-08
11	1.000	2.7066e+15	0.02504	0.00547	0.41312	0.36363	0.09854	0.00305	0.02504	1.9848e+15	0.02451	0.07592	0.88711	0.00087	0.01158	2.0340e-08
12	1.009	2.7289e+15	0.02519	0.00546	0.41329	0.36492	0.09742	0.00304	0.02519	2.0018e+15	0.02440	0.07504	0.88812	0.00086	0.01157	2.0580e-08
13	0.986	2.6882e+15	0.02452	0.00546	0.41738	0.36101	0.09806	0.00302	0.02452	1.9576e+15	0.02450	0.07723	0.88581	0.00089	0.01158	2.0277e-08
14	0.977	2.6671e+15	0.02434	0.00547	0.41835	0.35924	0.09890	0.00301	0.02434	1.9386e+15	0.02457	0.07850	0.88446	0.00090	0.01157	2.0116e-08
15	1.008	2.7248e+15	0.02514	0.00546	0.41285	0.36441	0.09799	0.00305	0.02514	2.0005e+15	0.02445	0.07554	0.88755	0.00087	0.01159	2.0380e-08
16	1.023	2.7510e+15	0.02566	0.00544	0.40981	0.36713	0.09771	0.00306	0.02566	2.0299e+15	0.02436	0.07399	0.88923	0.00085	0.01157	2.0626e-08
17	1.004	2.7161e+15	0.02516	0.00546	0.41326	0.36408	0.09784	0.00305	0.02516	1.9934e+15	0.02446	0.07566	0.88742	0.00087	0.01159	2.0359e-08
18	1.001	2.7121e+15	0.02491	0.00545	0.41364	0.36377	0.09825	0.00304	0.02491	1.9875e+15	0.02443	0.07588	0.88723	0.00087	0.01158	2.0348e-08
19	1.011	2.7364e+15	0.02522	0.00544	0.41303	0.36486	0.09772	0.00304	0.02522	2.0067e+15	0.02437	0.07489	0.88832	0.00086	0.01156	2.0588e-08
20	0.989	2.6925e+15	0.02454	0.00546	0.41666	0.36168	0.09807	0.00302	0.02454	1.9633e+15	0.02448	0.07696	0.88611	0.00088	0.01156	2.0280e-08
21	0.975	2.6637e+15	0.02414	0.00546	0.41864	0.35932	0.09888	0.00301	0.02414	1.9348e+15	0.02455	0.07849	0.88449	0.00090	0.01156	2.0117e-08
22	1.022	2.7520e+15	0.02564	0.00545	0.41081	0.36676	0.09719	0.00306	0.02564	2.0282e+15	0.02439	0.07395	0.88924	0.00085	0.01158	2.0638e-08
23	1.025	2.7567e+15	0.02564	0.00543	0.40997	0.36759	0.09722	0.00306	0.02564	2.0347e+15	0.02430	0.07379	0.88951	0.00085	0.01155	2.0638e-08
24	1.011	2.7271e+15	0.02526	0.00544	0.41208	0.36580	0.09747	0.00304	0.02526	2.0065e+15	0.02435	0.07529	0.88797	0.00087	0.01153	2.0536e-08
25	0.980	2.6709e+15	0.02426	0.00546	0.41734	0.36036	0.09897	0.00301	0.02426	1.9444e+15	0.02451	0.07815	0.88489	0.00090	0.01155	2.0128e-08
26	1.019	2.7491e+15	0.02538	0.00545	0.41080	0.36637	0.09796	0.00306	0.02538	2.0232e+15	0.02438	0.07402	0.88917	0.00085	0.01158	2.0499e-08
27	1.025	2.7567e+15	0.02567	0.00544	0.40964	0.36816	0.09709	0.00306	0.02567	2.0347e+15	0.02430	0.07318	0.89011	0.00084	0.01157	2.0733e-08
28	1.021	2.7509e+15	0.02552	0.00544	0.41132	0.36691	0.09696	0.00305	0.02552	2.0256e+15	0.02432	0.07398	0.88929	0.00085	0.01156	2.0692e-08
29	0.992	2.6962e+15	0.02469	0.00546	0.41568	0.36201	0.09839	0.00303	0.02469	1.9697e+15	0.02449	0.07699	0.88608	0.00088	0.01156	2.0272e-08
30	0.975	2.6651e+15	0.02415	0.00547	0.41858	0.35881	0.09941	0.00301	0.02415	1.9351e+15	0.02459	0.07887	0.88408	0.00091	0.01156	2.0104e-08
31	1.011	2.7349e+15	0.02527	0.00545	0.41290	0.36483	0.09771	0.00304	0.02527	2.0069e+15	0.02440	0.07515	0.88803	0.00086	0.01156	2.0573e-08
32	0.978	2.6718e+15	0.02419	0.00546	0.41794	0.35952	0.09932	0.00301	0.02419	1.9411e+15	0.02453	0.07841	0.88459	0.00090	0.01157	2.0142e-08
33	0.968	2.6514e+15	0.02385	0.00545	0.41944	0.35846	0.09945	0.00300	0.02385	1.9217e+15	0.02451	0.07935	0.88368	0.00091	0.01154	2.0072e-08
34	0.990	2.6859e+15	0.02467	0.00546	0.41475	0.36219	0.09895	0.00303	0.02467	1.9639e+15	0.02449	0.07715	0.88590	0.00089	0.01157	2.0249e-08
35	0.971	2.6547e+15	0.02398	0.00546	0.41912	0.35908	0.09899	0.00301	0.02398	1.9265e+15	0.02453	0.07887	0.88413	0.00091	0.01156	2.0085e-08
36	0.966	2.6478e+15	0.02380	0.00546	0.42020	0.35818	0.09920	0.00300	0.02380	1.9169e+15	0.02454	0.07935	0.88364	0.00091	0.01155	2.0047e-08
37	0.967	2.6494e+15	0.02375	0.00546	0.42033	0.35841	0.09899	0.00299	0.02375	1.9188e+15	0.02449	0.07954	0.88351	0.00091	0.01154	2.0046e-08
38	0.966	2.6443e+15	0.02377	0.00547	0.42080	0.35865	0.09816	0.00300	0.02377	1.9168e+15	0.02452	0.07952	0.88350	0.00092	0.01155	2.0029e-08
39	0.963	2.6382e+15	0.02373	0.00547	0.42074	0.35776	0.09900	0.00299	0.02373	1.9104e+15	0.02458	0.08009	0.88286	0.00092	0.01155	2.0019e-08
Assembly total[c]		7.1539e+17	0.02494	0.00545	0.41414	0.36345	0.09811	0.00304	0.02494	5.2396e+17	0.02445	0.07612	0.88699	0.00087	0.01157	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.16. KENO results for PWR MOX benchmark Case BOL-7

Total production/total absorption = 1.25239
Multiplication factor (k_{eff}) = 1.24725

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.065	2.6331e+15	0.03033	0.00559	0.39451	0.39764	0.09680	0.00335	0.03033	2.1103e+15	0.02434	0.06554	0.89773	0.00075	0.01164	2.0091e-08
2	1.067	2.6364e+15	0.03042	0.00560	0.39383	0.39746	0.09738	0.00335	0.03042	2.1147e+15	0.02438	0.06559	0.89763	0.00075	0.01165	2.0090e-08
3	1.064	2.6346e+15	0.03026	0.00559	0.39410	0.39727	0.09773	0.00335	0.03026	2.1090e+15	0.02434	0.06529	0.89797	0.00075	0.01165	2.0079e-08
4	1.060	2.6291e+15	0.03012	0.00559	0.39566	0.39623	0.09729	0.00334	0.03012	2.1006e+15	0.02439	0.06567	0.89754	0.00075	0.01165	2.0052e-08
5	1.030	2.5733e+15	0.02914	0.00559	0.39953	0.39382	0.09742	0.00331	0.02914	2.0416e+15	0.02433	0.06705	0.89623	0.00077	0.01161	1.9911e-08
6	0.941	2.4269e+15	0.02603	0.00559	0.41474	0.37997	0.10055	0.00319	0.02603	1.8651e+15	0.02448	0.07372	0.88939	0.00084	0.01158	1.9253e-08
7	1.011	2.5403e+15	0.02863	0.00560	0.40231	0.39010	0.09888	0.00329	0.02863	2.0036e+15	0.02442	0.06932	0.89385	0.00079	0.01162	1.9702e-08
8	1.012	2.5399e+15	0.02849	0.00560	0.40127	0.39066	0.09951	0.00329	0.02849	2.0052e+15	0.02438	0.06934	0.89388	0.00079	0.01161	1.9702e-08
9	1.066	2.6294e+15	0.03046	0.00560	0.39389	0.39822	0.09653	0.00335	0.03046	2.1121e+15	0.02434	0.06550	0.89778	0.00075	0.01163	2.0089e-08
10	1.011	2.5453e+15	0.02843	0.00559	0.40294	0.38964	0.09914	0.00328	0.02843	2.0026e+15	0.02441	0.06906	0.89411	0.00079	0.01163	1.9693e-08
11	1.009	2.5413e+15	0.02833	0.00560	0.40335	0.38969	0.09872	0.00328	0.02833	1.9997e+15	0.02441	0.06922	0.89396	0.00079	0.01162	1.9670e-08
12	1.054	2.6171e+15	0.02989	0.00559	0.39664	0.39595	0.09701	0.00334	0.02989	2.0887e+15	0.02434	0.06595	0.89732	0.00075	0.01164	2.0016e-08
13	0.983	2.4968e+15	0.02733	0.00560	0.40813	0.38662	0.09865	0.00325	0.02733	1.9472e+15	0.02440	0.07035	0.89284	0.00081	0.01161	1.9527e-08
14	0.933	2.4138e+15	0.02565	0.00560	0.41664	0.37881	0.10031	0.00318	0.02565	1.8495e+15	0.02449	0.07441	0.88865	0.00085	0.01159	1.9230e-08
15	1.015	2.5467e+15	0.02849	0.00560	0.40155	0.39113	0.09872	0.00329	0.02849	2.0117e+15	0.02437	0.06892	0.89430	0.00079	0.01163	1.9706e-08
16	1.070	2.6404e+15	0.03041	0.00558	0.39324	0.39839	0.09715	0.00335	0.03041	2.1200e+15	0.02430	0.06512	0.89821	0.00074	0.01162	2.0099e-08
17	1.019	2.5574e+15	0.02858	0.00559	0.40172	0.39110	0.09854	0.00329	0.02858	2.0194e+15	0.02439	0.06866	0.89456	0.00078	0.01161	1.9706e-08
18	1.014	2.5492e+15	0.02853	0.00561	0.40254	0.38995	0.09886	0.00329	0.02853	2.0092e+15	0.02446	0.06896	0.89415	0.00079	0.01164	1.9686e-08
19	1.059	2.6219e+15	0.03002	0.00559	0.39483	0.39716	0.09726	0.00334	0.03002	2.0991e+15	0.02434	0.06569	0.89759	0.00075	0.01163	2.0029e-08
20	0.983	2.4980e+15	0.02729	0.00560	0.40814	0.38612	0.09906	0.00324	0.02729	1.9478e+15	0.02441	0.07084	0.89235	0.00081	0.01159	1.9530e-08
21	0.929	2.4066e+15	0.02549	0.00561	0.41694	0.37816	0.10101	0.00318	0.02549	1.8403e+15	0.02447	0.07470	0.88840	0.00085	0.01158	1.9227e-08
22	1.077	2.6508e+15	0.03071	0.00559	0.39299	0.39924	0.09611	0.00337	0.03071	2.1333e+15	0.02430	0.06499	0.89833	0.00074	0.01165	2.0133e-08
23	1.081	2.6591e+15	0.03083	0.00560	0.39198	0.39947	0.09659	0.00337	0.03083	2.1417e+15	0.02436	0.06450	0.89876	0.00073	0.01165	2.0126e-08
24	1.034	2.5817e+15	0.02912	0.00559	0.40002	0.39388	0.09697	0.00330	0.02912	2.0480e+15	0.02433	0.06684	0.89645	0.00077	0.01161	1.9915e-08
25	0.934	2.4149e+15	0.02562	0.00561	0.41658	0.37879	0.10054	0.00319	0.02562	1.8499e+15	0.02450	0.07418	0.88888	0.00085	0.01159	1.9238e-08
26	1.064	2.6300e+15	0.03018	0.00560	0.39472	0.39698	0.09717	0.00335	0.03018	2.1077e+15	0.02439	0.06579	0.89742	0.00075	0.01165	1.9939e-08
27	1.108	2.7016e+15	0.03167	0.00559	0.38772	0.40370	0.09548	0.00340	0.03167	2.1950e+15	0.02430	0.06263	0.90069	0.00071	0.01166	2.0264e-08
28	1.087	2.6681e+15	0.03097	0.00559	0.39114	0.40117	0.09566	0.00338	0.03097	2.1544e+15	0.02430	0.06362	0.89971	0.00073	0.01165	2.0177e-08
29	0.979	2.4887e+15	0.02719	0.00559	0.40845	0.38637	0.09880	0.00324	0.02719	1.9394e+15	0.02437	0.07064	0.89258	0.00081	0.01160	1.9498e-08
30	0.925	2.4012e+15	0.02534	0.00560	0.41794	0.37740	0.10099	0.00317	0.02534	1.8330e+15	0.02450	0.07479	0.88827	0.00086	0.01158	1.9177e-08
31	1.045	2.6009e+15	0.02970	0.00559	0.39812	0.39495	0.09683	0.00333	0.02970	2.0707e+15	0.02438	0.06616	0.89706	0.00076	0.01164	1.9976e-08
32	0.938	2.4243e+15	0.02598	0.00561	0.41614	0.37901	0.10016	0.00319	0.02598	1.8589e+15	0.02455	0.07354	0.88944	0.00084	0.01162	1.9251e-08
33	0.913	2.3821e+15	0.02487	0.00562	0.42090	0.37537	0.10067	0.00316	0.02487	1.8092e+15	0.02457	0.07551	0.88745	0.00087	0.01160	1.9094e-08
34	0.965	2.4639e+15	0.02689	0.00561	0.41047	0.38430	0.09915	0.00323	0.02689	1.9127e+15	0.02446	0.07155	0.89157	0.00082	0.01160	1.9435e-08
35	0.915	2.3843e+15	0.02494	0.00560	0.41998	0.37617	0.10076	0.00315	0.02494	1.8138e+15	0.02448	0.07543	0.88765	0.00086	0.01157	1.9116e-08
36	0.900	2.3566e+15	0.02439	0.00560	0.42279	0.37404	0.10096	0.00314	0.02439	1.7824e+15	0.02450	0.07657	0.88649	0.00088	0.01157	1.9022e-08
37	0.900	2.3564e+15	0.02451	0.00561	0.42195	0.37377	0.10186	0.00314	0.02451	1.7825e+15	0.02454	0.07659	0.88643	0.00088	0.01156	1.9016e-08
38	0.890	2.3439e+15	0.02403	0.00560	0.42497	0.37191	0.10153	0.00312	0.02403	1.7634e+15	0.02453	0.07717	0.88586	0.00088	0.01156	1.8968e-08
39	0.882	2.3298e+15	0.02398	0.00560	0.42742	0.37021	0.10076	0.00310	0.02398	1.7481e+15	0.02459	0.07803	0.88493	0.00089	0.01157	1.8939e-08
Assembly total[c]		6.6652e+17	0.02809	0.00560	0.40485	0.38877	0.09858	0.00327	0.02809	5.2310e+17	0.02441	0.06944	0.89374	0.00079	0.01162	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.17. KENO results for PWR MOX benchmark Case BOL-8

Total production/total absorption = 1.17903
Multiplication factor (k_{eff}) = 1.17416

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.103	2.7828e+15	0.02986	0.00558	0.40220	0.39042	0.09796	0.00329	0.02986	2.1888e+15	0.02436	0.06787	0.89536	0.00078	0.01163	2.0761e-08
2	1.042	2.6873e+15	0.02756	0.00557	0.41256	0.38222	0.09943	0.00320	0.02756	2.0672e+15	0.02433	0.07170	0.89155	0.00082	0.01160	2.0517e-08
3	1.022	2.6614e+15	0.02675	0.00557	0.41713	0.37887	0.09977	0.00316	0.02675	2.0277e+15	0.02434	0.07286	0.89040	0.00084	0.01155	2.0458e-08
4	1.019	2.6533e+15	0.02668	0.00557	0.41681	0.37883	0.10015	0.00316	0.02668	2.0214e+15	0.02435	0.07285	0.89041	0.00084	0.01155	2.0439e-08
5	1.010	2.6400e+15	0.02622	0.00559	0.41913	0.37686	0.10028	0.00315	0.02622	2.0027e+15	0.02443	0.07369	0.88946	0.00085	0.01157	2.0370e-08
6	0.977	2.5788e+15	0.02538	0.00562	0.42368	0.37164	0.10171	0.00313	0.02538	1.9389e+15	0.02461	0.07671	0.88619	0.00088	0.01161	1.9972e-08
7	1.045	2.6858e+15	0.02772	0.00559	0.41188	0.38256	0.09926	0.00321	0.02772	2.0722e+15	0.02442	0.07165	0.89150	0.00082	0.01160	2.0354e-08
8	1.017	2.6390e+15	0.02681	0.00560	0.41661	0.37855	0.09982	0.00318	0.02681	2.0171e+15	0.02445	0.07373	0.88937	0.00084	0.01160	2.0248e-08
9	1.027	2.6647e+15	0.02703	0.00558	0.41543	0.38006	0.09960	0.00318	0.02703	2.0377e+15	0.02437	0.07233	0.89090	0.00083	0.01157	2.0473e-08
10	1.005	2.6283e+15	0.02633	0.00560	0.41979	0.37578	0.10039	0.00315	0.02633	1.9932e+15	0.02450	0.07425	0.88879	0.00085	0.01160	2.0199e-08
11	0.998	2.6184e+15	0.02601	0.00559	0.42058	0.37477	0.10116	0.00314	0.02601	1.9790e+15	0.02449	0.07456	0.88852	0.00086	0.01158	2.0185e-08
12	1.016	2.6505e+15	0.02652	0.00558	0.41855	0.37814	0.09941	0.00315	0.02652	2.0148e+15	0.02435	0.07322	0.89003	0.00084	0.01156	2.0422e-08
13	0.991	2.6074e+15	0.02570	0.00560	0.42256	0.37366	0.10072	0.00313	0.02570	1.9654e+15	0.02451	0.07529	0.88775	0.00087	0.01159	2.0121e-08
14	0.976	2.5738e+15	0.02526	0.00560	0.42384	0.37244	0.10101	0.00312	0.02526	1.9372e+15	0.02450	0.07691	0.88614	0.00088	0.01157	1.9960e-08
15	1.008	2.6303e+15	0.02655	0.00560	0.41867	0.37638	0.10047	0.00317	0.02655	1.9997e+15	0.02452	0.07405	0.88896	0.00085	0.01162	2.0225e-08
16	1.023	2.6622e+15	0.02693	0.00559	0.41681	0.37896	0.09958	0.00317	0.02693	2.0299e+15	0.02441	0.07250	0.89066	0.00083	0.01160	2.0469e-08
17	1.006	2.6273e+15	0.02622	0.00559	0.41841	0.37688	0.10080	0.00316	0.02622	1.9960e+15	0.02445	0.07413	0.88899	0.00085	0.01158	2.0203e-08
18	1.003	2.6262e+15	0.02605	0.00559	0.42057	0.37594	0.09998	0.00314	0.02605	1.9894e+15	0.02444	0.07427	0.88886	0.00085	0.01158	2.0192e-08
19	1.017	2.6514e+15	0.02643	0.00558	0.41830	0.37874	0.09915	0.00315	0.02643	2.0172e+15	0.02433	0.07294	0.89035	0.00084	0.01155	2.0430e-08
20	0.989	2.6022e+15	0.02558	0.00559	0.42263	0.37361	0.10083	0.00313	0.02558	1.9613e+15	0.02447	0.07576	0.88733	0.00087	0.01157	2.0124e-08
21	0.972	2.5675e+15	0.02517	0.00560	0.42506	0.37110	0.10123	0.00311	0.02517	1.9274e+15	0.02454	0.07756	0.88543	0.00089	0.01158	1.9961e-08
22	1.023	2.6652e+15	0.02668	0.00558	0.41707	0.37909	0.09966	0.00317	0.02668	2.0301e+15	0.02436	0.07243	0.89081	0.00083	0.01158	2.0481e-08
23	1.018	2.6533e+15	0.02662	0.00559	0.41841	0.37854	0.09892	0.00316	0.02662	2.0190e+15	0.02437	0.07283	0.89038	0.00084	0.01158	2.0480e-08
24	1.007	2.6371e+15	0.02622	0.00559	0.42046	0.37637	0.09959	0.00314	0.02622	1.9974e+15	0.02441	0.07402	0.88915	0.00085	0.01157	2.0377e-08
25	0.975	2.5722e+15	0.02534	0.00561	0.42469	0.37161	0.10079	0.00312	0.02534	1.9343e+15	0.02457	0.07733	0.88564	0.00089	0.01158	1.9971e-08
26	1.018	2.6572e+15	0.02644	0.00558	0.41840	0.37812	0.09961	0.00316	0.02644	2.0196e+15	0.02437	0.07294	0.89026	0.00084	0.01159	2.0343e-08
27	1.030	2.6783e+15	0.02700	0.00558	0.41667	0.37994	0.09881	0.00317	0.02700	2.0437e+15	0.02436	0.07176	0.89146	0.00082	0.01159	2.0574e-08
28	1.019	2.6600e+15	0.02667	0.00558	0.41894	0.37844	0.09861	0.00316	0.02667	2.0214e+15	0.02436	0.07260	0.89062	0.00083	0.01158	2.0533e-08
29	0.989	2.6004e+15	0.02557	0.00559	0.42281	0.37399	0.10027	0.00313	0.02557	1.9611e+15	0.02445	0.07559	0.88752	0.00087	0.01157	2.0116e-08
30	0.976	2.5776e+15	0.02523	0.00560	0.42449	0.37149	0.10133	0.00312	0.02523	1.9362e+15	0.02454	0.07712	0.88587	0.00088	0.01158	1.9947e-08
31	1.008	2.6365e+15	0.02623	0.00558	0.41944	0.37713	0.09982	0.00315	0.02623	2.0003e+15	0.02439	0.07377	0.88942	0.00085	0.01157	2.0414e-08
32	0.976	2.5790e+15	0.02522	0.00560	0.42569	0.37134	0.10043	0.00311	0.02522	1.9358e+15	0.02455	0.07697	0.88602	0.00088	0.01157	1.9985e-08
33	0.969	2.5641e+15	0.02498	0.00560	0.42619	0.37061	0.10087	0.00311	0.02498	1.9224e+15	0.02454	0.07781	0.88519	0.00089	0.01156	1.9915e-08
34	0.985	2.5936e+15	0.02560	0.00560	0.42355	0.37311	0.10028	0.00312	0.02560	1.9549e+15	0.02450	0.07617	0.88689	0.00087	0.01157	2.0092e-08
35	0.968	2.5631e+15	0.02503	0.00561	0.42646	0.36980	0.10130	0.00311	0.02503	1.9194e+15	0.02461	0.07792	0.88499	0.00089	0.01159	1.9928e-08
36	0.964	2.5625e+15	0.02473	0.00561	0.42768	0.36887	0.10159	0.00310	0.02473	1.9124e+15	0.02459	0.07822	0.88472	0.00090	0.01158	1.9890e-08
37	0.965	2.5613e+15	0.02484	0.00561	0.42748	0.36940	0.10109	0.00310	0.02484	1.9148e+15	0.02457	0.07814	0.88482	0.00090	0.01157	1.9889e-08
38	0.962	2.5557e+15	0.02462	0.00560	0.42822	0.36894	0.10116	0.00309	0.02462	1.9077e+15	0.02455	0.07857	0.88443	0.00090	0.01156	1.9871e-08
39	0.963	2.5589e+15	0.02461	0.00560	0.42772	0.36884	0.10173	0.00309	0.02461	1.9099e+15	0.02454	0.07854	0.88445	0.00090	0.01156	1.9862e-08
Assembly total[c]		6.9175e+17	0.02605	0.00559	0.42071	0.37548	0.10022	0.00314	0.02605	5.2373e+17	0.02446	0.07473	0.88838	0.00086	0.01158	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.18. KENO results for PWR MOX benchmark Case BOL-9

Total production/total absorption = 1.28305
Multiplication factor (k_{eff}) = 1.27825

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.070	2.5436e+15	0.03177	0.00576	0.39988	0.41316	0.10011	0.00348	0.03177	2.1188e+15	0.02433	0.06382	0.89948	0.00073	0.01164	1.9916e-08
2	1.070	2.5471e+15	0.03182	0.00576	0.40119	0.41230	0.09949	0.00349	0.03182	2.1198e+15	0.02438	0.06377	0.89945	0.00073	0.01167	1.9916e-08
3	1.069	2.5390e+15	0.03193	0.00576	0.40078	0.41359	0.09849	0.00349	0.03193	2.1184e+15	0.02436	0.06359	0.89967	0.00073	0.01166	1.9904e-08
4	1.063	2.5272e+15	0.03171	0.00576	0.40136	0.41269	0.09904	0.00348	0.03171	2.1047e+15	0.02437	0.06394	0.89932	0.00073	0.01164	1.9877e-08
5	1.027	2.4772e+15	0.03057	0.00577	0.40782	0.40699	0.09963	0.00344	0.03057	2.0353e+15	0.02446	0.06551	0.89761	0.00075	0.01167	1.9732e-08
6	0.930	2.3228e+15	0.02675	0.00577	0.42398	0.39183	0.10295	0.00330	0.02675	1.8414e+15	0.02453	0.07275	0.89029	0.00083	0.01161	1.9069e-08
7	1.015	2.4575e+15	0.02973	0.00576	0.40811	0.40509	0.10206	0.00342	0.02973	2.0109e+15	0.02440	0.06748	0.89571	0.00077	0.01164	1.9527e-08
8	1.018	2.4622e+15	0.02988	0.00575	0.40834	0.40559	0.10122	0.00342	0.02988	2.0171e+15	0.02439	0.06718	0.89603	0.00077	0.01164	1.9527e-08
9	1.066	2.5361e+15	0.03181	0.00576	0.40100	0.41259	0.09939	0.00348	0.03181	2.1118e+15	0.02438	0.06398	0.89925	0.00073	0.01166	1.9915e-08
10	1.012	2.4528e+15	0.02991	0.00577	0.41016	0.40403	0.10086	0.00342	0.02991	2.0050e+15	0.02448	0.06747	0.89562	0.00077	0.01166	1.9517e-08
11	1.011	2.4482e+15	0.02982	0.00576	0.40986	0.40443	0.10090	0.00342	0.02982	2.0021e+15	0.02445	0.06751	0.89562	0.00077	0.01164	1.9493e-08
12	1.056	2.5226e+15	0.03142	0.00576	0.40278	0.41099	0.09970	0.00347	0.03142	2.0914e+15	0.02439	0.06425	0.89898	0.00073	0.01166	1.9839e-08
13	0.979	2.4047e+15	0.02867	0.00576	0.41560	0.39896	0.10201	0.00337	0.02867	1.9399e+15	0.02450	0.06918	0.89389	0.00079	0.01164	1.9347e-08
14	0.930	2.3242e+15	0.02666	0.00576	0.42418	0.39162	0.10314	0.00329	0.02666	1.8412e+15	0.02450	0.07274	0.89033	0.00083	0.01160	1.9045e-08
15	1.017	2.4587e+15	0.02973	0.00575	0.40810	0.40608	0.10119	0.00342	0.02973	2.0149e+15	0.02433	0.06716	0.89612	0.00077	0.01162	1.9531e-08
16	1.068	2.5399e+15	0.03194	0.00576	0.40133	0.41262	0.09885	0.00349	0.03194	2.1162e+15	0.02440	0.06383	0.89938	0.00073	0.01166	1.9924e-08
17	1.019	2.4626e+15	0.03012	0.00577	0.40880	0.40544	0.10056	0.00343	0.03012	2.0194e+15	0.02445	0.06708	0.89605	0.00077	0.01165	1.9531e-08
18	1.015	2.4538e+15	0.02999	0.00576	0.40840	0.40550	0.10108	0.00342	0.02999	2.0114e+15	0.02443	0.06706	0.89611	0.00077	0.01164	1.9509e-08
19	1.063	2.5276e+15	0.03167	0.00576	0.40161	0.41279	0.09869	0.00348	0.03167	2.1047e+15	0.02438	0.06382	0.89941	0.00073	0.01166	1.9852e-08
20	0.983	2.4046e+15	0.02871	0.00576	0.41452	0.40112	0.10090	0.00338	0.02871	1.9480e+15	0.02443	0.06886	0.89430	0.00079	0.01162	1.9350e-08
21	0.928	2.3177e+15	0.02672	0.00576	0.42420	0.39184	0.10272	0.00330	0.02672	1.8388e+15	0.02451	0.07310	0.88996	0.00084	0.01159	1.9042e-08
22	1.082	2.5613e+15	0.03237	0.00576	0.39850	0.41457	0.09922	0.00350	0.03237	2.1435e+15	0.02439	0.06307	0.90015	0.00072	0.01167	1.9958e-08
23	1.083	2.5612e+15	0.03244	0.00577	0.39881	0.41481	0.09859	0.00351	0.03244	2.1446e+15	0.02441	0.06297	0.90023	0.00072	0.01167	1.9951e-08
24	1.032	2.4807e+15	0.03055	0.00575	0.40616	0.40843	0.09987	0.00344	0.03055	2.0440e+15	0.02436	0.06556	0.89770	0.00075	0.01163	1.9736e-08
25	0.931	2.3233e+15	0.02687	0.00576	0.42322	0.39188	0.10354	0.00330	0.02687	1.8436e+15	0.02453	0.07272	0.89032	0.00083	0.01160	1.9053e-08
26	1.071	2.5454e+15	0.03174	0.00576	0.40092	0.41292	0.09922	0.00349	0.03174	2.1214e+15	0.02440	0.06373	0.89948	0.00073	0.01166	1.9766e-08
27	1.113	2.6096e+15	0.03332	0.00576	0.39477	0.41942	0.09717	0.00354	0.03332	2.2044e+15	0.02433	0.06082	0.90248	0.00069	0.01168	2.0090e-08
28	1.087	2.5696e+15	0.03240	0.00576	0.39787	0.41622	0.09835	0.00351	0.03240	2.1533e+15	0.02432	0.06207	0.90124	0.00071	0.01167	2.0001e-08
29	0.979	2.3958e+15	0.02850	0.00576	0.41435	0.40079	0.10159	0.00337	0.02850	1.9399e+15	0.02441	0.06913	0.89407	0.00079	0.01161	1.9316e-08
30	0.922	2.3082e+15	0.02638	0.00576	0.42543	0.39097	0.10276	0.00329	0.02638	1.8263e+15	0.02449	0.07357	0.88950	0.00084	0.01160	1.8991e-08
31	1.046	2.5060e+15	0.03115	0.00576	0.40508	0.40998	0.09875	0.00346	0.03115	2.0728e+15	0.02441	0.06457	0.89863	0.00074	0.01166	1.9797e-08
32	0.938	2.3355e+15	0.02703	0.00576	0.42253	0.39307	0.10283	0.00331	0.02703	1.8580e+15	0.02452	0.07213	0.89091	0.00082	0.01161	1.9066e-08
33	0.906	2.2823e+15	0.02588	0.00576	0.42847	0.38835	0.10289	0.00327	0.02588	1.7952e+15	0.02454	0.07470	0.88833	0.00085	0.01159	1.8905e-08
34	0.968	2.3852e+15	0.02805	0.00575	0.41749	0.39830	0.10158	0.00335	0.02805	1.9179e+15	0.02444	0.06962	0.89354	0.00080	0.01161	1.9252e-08
35	0.916	2.3003e+15	0.02607	0.00576	0.42626	0.38990	0.10346	0.00327	0.02607	1.8136e+15	0.02449	0.07363	0.88945	0.00084	0.01158	1.8928e-08
36	0.894	2.2643e+15	0.02552	0.00576	0.43032	0.38583	0.10398	0.00325	0.02552	1.7706e+15	0.02458	0.07558	0.88738	0.00086	0.01160	1.8831e-08
37	0.893	2.2622e+15	0.02547	0.00576	0.43069	0.38633	0.10325	0.00325	0.02547	1.7694e+15	0.02454	0.07544	0.88756	0.00086	0.01160	1.8824e-08
38	0.887	2.2526e+15	0.02518	0.00575	0.43194	0.38504	0.10366	0.00324	0.02518	1.7561e+15	0.02455	0.07569	0.88731	0.00087	0.01159	1.8775e-08
39	0.878	2.2360e+15	0.02493	0.00576	0.43252	0.38421	0.10425	0.00323	0.02493	1.7390e+15	0.02459	0.07606	0.88688	0.00087	0.01159	1.8745e-08
Assembly total[c]		6.4207e+17	0.02944	0.00576	0.41166	0.40313	0.10090	0.00340	0.02944	5.2295e+17	0.02444	0.06784	0.89531	0.00078	0.01163	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.19. KENO results for PWR MOX benchmark Case BOL-10

Total production/total absorption = 1.20267
Multiplication factor (k_{eff}) = 1.19793

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.112	2.6804e+15	0.03154	0.00579	0.41185	0.40914	0.10030	0.00344	0.03154	2.2077e+15	0.02435	0.06586	0.89740	0.00076	0.01163	2.0610e-08
2	1.042	2.5805e+15	0.02884	0.00578	0.42387	0.39849	0.10262	0.00333	0.02884	2.0672e+15	0.02432	0.07004	0.89325	0.00081	0.01158	2.0359e-08
3	1.023	2.5543e+15	0.02816	0.00578	0.42735	0.39524	0.10324	0.00331	0.02816	2.0307e+15	0.02439	0.07103	0.89218	0.00082	0.01159	2.0298e-08
4	1.016	2.5400e+15	0.02806	0.00579	0.42907	0.39446	0.10237	0.00331	0.02806	2.0161e+15	0.02442	0.07140	0.89175	0.00082	0.01161	2.0278e-08
5	1.007	2.5258e+15	0.02754	0.00578	0.43070	0.39313	0.10272	0.00329	0.02754	1.9984e+15	0.02441	0.07243	0.89074	0.00083	0.01159	2.0208e-08
6	0.978	2.4753e+15	0.02667	0.00580	0.43526	0.38779	0.10439	0.00326	0.02667	1.9406e+15	0.02456	0.07486	0.88812	0.00086	0.01160	1.9813e-08
7	1.048	2.5829e+15	0.02925	0.00579	0.42205	0.39911	0.10299	0.00335	0.02925	2.0809e+15	0.02445	0.07027	0.89287	0.00081	0.01161	2.0201e-08
8	1.018	2.5364e+15	0.02808	0.00579	0.42779	0.39511	0.10279	0.00332	0.02808	2.0208e+15	0.02443	0.07214	0.89099	0.00083	0.01161	2.0092e-08
9	1.025	2.5551e+15	0.02836	0.00579	0.42747	0.39544	0.10263	0.00331	0.02836	2.0335e+15	0.02441	0.07103	0.89214	0.00082	0.01161	2.0313e-08
10	1.004	2.5182e+15	0.02756	0.00579	0.43052	0.39230	0.10357	0.00329	0.02756	1.9921e+15	0.02447	0.07270	0.89041	0.00084	0.01160	2.0041e-08
11	0.999	2.5116e+15	0.02745	0.00579	0.43105	0.39157	0.10389	0.00329	0.02745	1.9838e+15	0.02450	0.07285	0.89020	0.00084	0.01161	2.0026e-08
12	1.015	2.5413e+15	0.02786	0.00577	0.42880	0.39421	0.10320	0.00330	0.02786	2.0143e+15	0.02439	0.07144	0.89177	0.00082	0.01159	2.0261e-08
13	0.992	2.5004e+15	0.02705	0.00579	0.43296	0.39010	0.10397	0.00327	0.02705	1.9684e+15	0.02451	0.07368	0.88938	0.00085	0.01158	1.9961e-08
14	0.974	2.4664e+15	0.02669	0.00580	0.43569	0.38749	0.10418	0.00326	0.02669	1.9338e+15	0.02459	0.07524	0.88770	0.00086	0.01161	1.9801e-08
15	1.012	2.5285e+15	0.02785	0.00579	0.42921	0.39394	0.10287	0.00331	0.02785	2.0081e+15	0.02445	0.07239	0.89072	0.00083	0.01162	2.0067e-08
16	1.024	2.5536e+15	0.02831	0.00578	0.42779	0.39523	0.10258	0.00331	0.02831	2.0315e+15	0.02441	0.07115	0.89203	0.00082	0.01159	2.0308e-08
17	1.004	2.5243e+15	0.02747	0.00579	0.43113	0.39167	0.10379	0.00329	0.02747	1.9927e+15	0.02447	0.07257	0.89052	0.00083	0.01161	2.0045e-08
18	1.001	2.5180e+15	0.02749	0.00580	0.43172	0.39090	0.10384	0.00328	0.02749	1.9867e+15	0.02454	0.07269	0.89032	0.00084	0.01161	2.0033e-08
19	1.011	2.5352e+15	0.02773	0.00578	0.42945	0.39366	0.10323	0.00329	0.02773	2.0074e+15	0.02439	0.07181	0.89139	0.00083	0.01158	2.0268e-08
20	0.987	2.4918e+15	0.02700	0.00580	0.43353	0.38913	0.10442	0.00327	0.02700	1.9582e+15	0.02455	0.07418	0.88883	0.00085	0.01159	1.9964e-08
21	0.971	2.4593e+15	0.02654	0.00579	0.43553	0.38734	0.10473	0.00325	0.02654	1.9263e+15	0.02455	0.07553	0.88747	0.00087	0.01158	1.9801e-08
22	1.021	2.5531e+15	0.02805	0.00577	0.42822	0.39500	0.10281	0.00330	0.02805	2.0265e+15	0.02435	0.07110	0.89215	0.00082	0.01158	2.0320e-08
23	1.019	2.5474e+15	0.02798	0.00577	0.42815	0.39530	0.10263	0.00330	0.02798	2.0232e+15	0.02433	0.07123	0.89205	0.00082	0.01157	2.0319e-08
24	1.002	2.5187e+15	0.02755	0.00578	0.43109	0.39234	0.10313	0.00328	0.02755	1.9896e+15	0.02441	0.07273	0.89044	0.00084	0.01159	2.0215e-08
25	0.973	2.4665e+15	0.02654	0.00580	0.43594	0.38704	0.10465	0.00325	0.02654	1.9304e+15	0.02456	0.07552	0.88747	0.00087	0.01159	1.9812e-08
26	1.018	2.5486e+15	0.02790	0.00578	0.42893	0.39405	0.10318	0.00329	0.02790	2.0204e+15	0.02440	0.07151	0.89168	0.00082	0.01158	2.0183e-08
27	1.030	2.5736e+15	0.02827	0.00577	0.42757	0.39585	0.10236	0.00330	0.02827	2.0451e+15	0.02436	0.07014	0.89310	0.00081	0.01159	2.0412e-08
28	1.025	2.5594e+15	0.02814	0.00577	0.42751	0.39588	0.10248	0.00331	0.02814	2.0351e+15	0.02434	0.07070	0.89256	0.00081	0.01159	2.0371e-08
29	0.992	2.5007e+15	0.02700	0.00579	0.43317	0.39023	0.10370	0.00327	0.02700	1.9682e+15	0.02448	0.07379	0.88930	0.00085	0.01158	1.9956e-08
30	0.972	2.4661e+15	0.02644	0.00580	0.43563	0.38686	0.10521	0.00325	0.02644	1.9294e+15	0.02458	0.07559	0.88737	0.00087	0.01160	1.9787e-08
31	1.014	2.5426e+15	0.02781	0.00578	0.43013	0.39340	0.10271	0.00329	0.02781	2.0133e+15	0.02441	0.07189	0.89128	0.00083	0.01159	2.0252e-08
32	0.982	2.4801e+15	0.02674	0.00580	0.43454	0.38866	0.10412	0.00326	0.02674	1.9486e+15	0.02454	0.07483	0.88819	0.00086	0.01159	1.9825e-08
33	0.968	2.4575e+15	0.02632	0.00580	0.43704	0.38626	0.10453	0.00324	0.02632	1.9213e+15	0.02458	0.07610	0.88687	0.00087	0.01158	1.9755e-08
34	0.989	2.4974e+15	0.02703	0.00580	0.43363	0.38915	0.10423	0.00327	0.02703	1.9634e+15	0.02454	0.07420	0.88881	0.00085	0.01160	1.9931e-08
35	0.970	2.4604e+15	0.02635	0.00580	0.43597	0.38725	0.10459	0.00325	0.02635	1.9261e+15	0.02453	0.07580	0.88721	0.00087	0.01159	1.9768e-08
36	0.962	2.4511e+15	0.02611	0.00579	0.43808	0.38504	0.10502	0.00323	0.02611	1.9100e+15	0.02456	0.07654	0.88644	0.00088	0.01158	1.9729e-08
37	0.965	2.4488e+15	0.02616	0.00579	0.43808	0.38677	0.10318	0.00324	0.02616	1.9146e+15	0.02450	0.07625	0.88681	0.00088	0.01156	1.9728e-08
38	0.962	2.4455e+15	0.02599	0.00580	0.43828	0.38592	0.10402	0.00324	0.02599	1.9091e+15	0.02454	0.07663	0.88639	0.00088	0.01155	1.9711e-08
39	0.956	2.4283e+15	0.02623	0.00581	0.43634	0.38551	0.10597	0.00324	0.02623	1.8978e+15	0.02462	0.07692	0.88602	0.00089	0.01156	1.9701e-08
Assembly total[c]		6.6763e+17	0.02725	0.00575	0.42866	0.38921	0.10290	0.00326	0.02725	5.2399e+17	0.02447	0.07307	0.89003	0.00084	0.01159	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.20. VENTURE results for PWR MOX benchmark Case BOL-1

Total production/total absorption = 1.30946
Multiplication factor (k_{eff}) = 1.30588

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.066	2.4031e+15	0.00000	0.00602	0.32913	0.40470	0.08717	0.00375	0.00000	2.1016e+15	0.02720	0.05226	0.90793	0.00058	0.01203	0.0000e+00
2	1.066	2.4037e+15	0.00000	0.00602	0.32912	0.40471	0.08717	0.00375	0.00000	2.1021e+15	0.02720	0.05224	0.90795	0.00058	0.01203	0.0000e+00
3	1.066	2.4034e+15	0.00000	0.00602	0.32929	0.40461	0.08718	0.00375	0.00000	2.1011e+15	0.02720	0.05222	0.90797	0.00058	0.01203	0.0000e+00
4	1.063	2.3989e+15	0.00000	0.00601	0.32977	0.40430	0.08722	0.00375	0.00000	2.0951e+15	0.02719	0.05233	0.90786	0.00058	0.01203	0.0000e+00
5	1.031	2.3470e+15	0.00000	0.00600	0.33408	0.40152	0.08785	0.00371	0.00000	2.0321e+15	0.02710	0.05391	0.90638	0.00060	0.01200	0.0000e+00
6	0.932	2.1840e+15	0.00000	0.00599	0.34814	0.39007	0.09091	0.00359	0.00000	1.8368e+15	0.02706	0.05982	0.90048	0.00067	0.01197	0.0000e+00
7	1.010	2.3113e+15	0.00000	0.00602	0.33645	0.39824	0.08893	0.00370	0.00000	1.9914e+15	0.02724	0.05526	0.90485	0.00061	0.01203	0.0000e+00
8	1.011	2.3121e+15	0.00000	0.00602	0.33642	0.39826	0.08893	0.00370	0.00000	1.9922e+15	0.02724	0.05523	0.90488	0.00061	0.01203	0.0000e+00
9	1.067	2.4051e+15	0.00000	0.00602	0.32907	0.40474	0.08716	0.00375	0.00000	2.1035e+15	0.02720	0.05219	0.90801	0.00058	0.01203	0.0000e+00
10	1.011	2.3128e+15	0.00000	0.00602	0.33651	0.39821	0.08893	0.00370	0.00000	1.9923e+15	0.02724	0.05518	0.90493	0.00061	0.01203	0.0000e+00
11	1.008	2.3088e+15	0.00000	0.00602	0.33698	0.39792	0.08896	0.00369	0.00000	1.9871e+15	0.02724	0.05529	0.90483	0.00061	0.01203	0.0000e+00
12	1.056	2.3879e+15	0.00000	0.00601	0.33077	0.40369	0.08732	0.00374	0.00000	2.0814e+15	0.02718	0.05264	0.90758	0.00059	0.01202	0.0000e+00
13	0.980	2.2632e+15	0.00000	0.00601	0.34107	0.39528	0.08952	0.00366	0.00000	1.9318e+15	0.02715	0.05681	0.90339	0.00063	0.01201	0.0000e+00
14	0.928	2.1771e+15	0.00000	0.00599	0.34879	0.38959	0.09105	0.00359	0.00000	1.8284e+15	0.02705	0.06010	0.90021	0.00067	0.01197	0.0000e+00
15	1.012	2.3138e+15	0.00000	0.00602	0.33630	0.39834	0.08891	0.00370	0.00000	1.9941e+15	0.02724	0.05517	0.90495	0.00061	0.01203	0.0000e+00
16	1.069	2.4091e+15	0.00000	0.00602	0.32878	0.40492	0.08712	0.00376	0.00000	2.1081e+15	0.02721	0.05206	0.90813	0.00058	0.01203	0.0000e+00
17	1.015	2.3193e+15	0.00000	0.00602	0.33601	0.39853	0.08885	0.00370	0.00000	1.9999e+15	0.02725	0.05495	0.90514	0.00061	0.01204	0.0000e+00
18	1.013	2.3164e+15	0.00000	0.00602	0.33638	0.39830	0.08886	0.00370	0.00000	1.9960e+15	0.02725	0.05502	0.90508	0.00061	0.01204	0.0000e+00
19	1.059	2.3934e+15	0.00000	0.00601	0.33037	0.40395	0.08725	0.00374	0.00000	2.0879e+15	0.02719	0.05246	0.90775	0.00058	0.01203	0.0000e+00
20	0.981	2.2652e+15	0.00000	0.00601	0.34094	0.39537	0.08949	0.00366	0.00000	1.9339e+15	0.02716	0.05673	0.90347	0.00063	0.01201	0.0000e+00
21	0.928	2.1774e+15	0.00000	0.00599	0.34881	0.38958	0.09104	0.00359	0.00000	1.8286e+15	0.02705	0.06008	0.90023	0.00067	0.01197	0.0000e+00
22	1.083	2.4322e+15	0.00000	0.00602	0.32720	0.40597	0.08680	0.00377	0.00000	2.1352e+15	0.02725	0.05133	0.90880	0.00057	0.01204	0.0000e+00
23	1.086	2.4366e+15	0.00000	0.00603	0.32701	0.40614	0.08669	0.00378	0.00000	2.1401e+15	0.02726	0.05117	0.90895	0.00057	0.01205	0.0000e+00
24	1.034	2.3524e+15	0.00000	0.00600	0.33377	0.40173	0.08777	0.00371	0.00000	2.0381e+15	0.02712	0.05370	0.90658	0.00060	0.01200	0.0000e+00
25	0.931	2.1832e+15	0.00000	0.00599	0.34837	0.38993	0.09091	0.00359	0.00000	1.8353e+15	0.02706	0.05982	0.90048	0.00067	0.01197	0.0000e+00
26	1.066	2.4044e+15	0.00000	0.00604	0.32944	0.40341	0.08743	0.00376	0.00000	2.1016e+15	0.02735	0.05215	0.90784	0.00058	0.01207	0.0000e+00
27	1.116	2.4859e+15	0.00000	0.00603	0.32349	0.40887	0.08587	0.00381	0.00000	2.1992e+15	0.02730	0.04970	0.91038	0.00055	0.01206	0.0000e+00
28	1.093	2.4496e+15	0.00000	0.00602	0.32629	0.40709	0.08629	0.00378	0.00000	2.1550e+15	0.02724	0.05070	0.90945	0.00056	0.01205	0.0000e+00
29	0.978	2.2610e+15	0.00000	0.00601	0.34149	0.39503	0.08951	0.00365	0.00000	1.9283e+15	0.02716	0.05683	0.90337	0.00063	0.01201	0.0000e+00
30	0.922	2.1680e+15	0.00000	0.00599	0.34991	0.38888	0.09115	0.00358	0.00000	1.8166e+15	0.02703	0.06041	0.89992	0.00067	0.01197	0.0000e+00
31	1.052	2.3829e+15	0.00000	0.00601	0.33148	0.40327	0.08730	0.00373	0.00000	2.0743e+15	0.02718	0.05269	0.90752	0.00059	0.01202	0.0000e+00
32	0.938	2.1953e+15	0.00000	0.00599	0.34746	0.39057	0.09066	0.00360	0.00000	1.8491e+15	0.02709	0.05928	0.90098	0.00066	0.01199	0.0000e+00
33	0.908	2.1460e+15	0.00000	0.00598	0.35215	0.38742	0.09146	0.00356	0.00000	1.7898e+15	0.02699	0.06127	0.89910	0.00068	0.01195	0.0000e+00
34	0.968	2.2439e+15	0.00000	0.00600	0.34315	0.39393	0.08974	0.00364	0.00000	1.9072e+15	0.02713	0.05741	0.90282	0.00064	0.01200	0.0000e+00
35	0.914	2.1564e+15	0.00000	0.00598	0.35125	0.38805	0.09125	0.00356	0.00000	1.8021e+15	0.02701	0.06081	0.89954	0.00068	0.01196	0.0000e+00
36	0.897	2.1289e+15	0.00000	0.00597	0.35397	0.38626	0.09167	0.00354	0.00000	1.7690e+15	0.02695	0.06194	0.89847	0.00069	0.01194	0.0000e+00
37	0.898	2.1292e+15	0.00000	0.00597	0.35401	0.38624	0.09164	0.00354	0.00000	1.7692e+15	0.02696	0.06192	0.89849	0.00069	0.01194	0.0000e+00
38	0.890	2.1172e+15	0.00000	0.00597	0.35526	0.38544	0.09179	0.00353	0.00000	1.7547e+15	0.02693	0.06240	0.89803	0.00070	0.01194	0.0000e+00
39	0.887	2.1114e+15	0.00000	0.00597	0.35592	0.38503	0.09184	0.00352	0.00000	1.7476e+15	0.02692	0.06263	0.89781	0.00070	0.01193	0.0000e+00
Assembly total[c]		6.0616e+17	0.00000	0.00601	0.33826	0.39763	0.08890	0.00368	0.00000	5.2038e+17	0.02715	0.05564	0.90458	0.00062	0.01201	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.21. VENTURE results for PWR MOX benchmark Case BOL-2

Total production/total absorption = 1.23872
Multiplication factor (k_{eff}) = 1.23523

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.111	2.5340e+15	0.00000	0.00600	0.33512	0.40107	0.08805	0.00370	0.00000	2.1877e+15	0.02708	0.05361	0.90671	0.00060	0.01200	0.0000e+00
2	1.036	2.4176e+15	0.00000	0.00596	0.34538	0.39427	0.09006	0.00360	0.00000	2.0414e+15	0.02685	0.05738	0.90317	0.00064	0.01195	0.0000e+00
3	1.017	2.3886e+15	0.00000	0.00595	0.34838	0.39241	0.09055	0.00357	0.00000	2.0037e+15	0.02678	0.05838	0.90226	0.00065	0.01193	0.0000e+00
4	1.016	2.3866e+15	0.00000	0.00595	0.34880	0.39214	0.09056	0.00357	0.00000	2.0005e+15	0.02678	0.05851	0.90213	0.00065	0.01193	0.0000e+00
5	1.006	2.3707e+15	0.00000	0.00594	0.35035	0.39103	0.09071	0.00356	0.00000	1.9816e+15	0.02676	0.05930	0.90136	0.00066	0.01192	0.0000e+00
6	0.975	2.3143e+15	0.00000	0.00597	0.35424	0.38629	0.09176	0.00354	0.00000	1.9206e+15	0.02694	0.06148	0.89894	0.00069	0.01195	0.0000e+00
7	1.047	2.4294e+15	0.00000	0.00600	0.34333	0.39402	0.08995	0.00363	0.00000	2.0621e+15	0.02711	0.05696	0.90329	0.00064	0.01201	0.0000e+00
8	1.013	2.3763e+15	0.00000	0.00598	0.34829	0.39079	0.09089	0.00359	0.00000	1.9952e+15	0.02699	0.05880	0.90158	0.00066	0.01198	0.0000e+00
9	1.020	2.3930e+15	0.00000	0.00595	0.34781	0.39276	0.09049	0.00358	0.00000	2.0098e+15	0.02679	0.05821	0.90241	0.00065	0.01194	0.0000e+00
10	1.000	2.3567e+15	0.00000	0.00597	0.35048	0.38943	0.09123	0.00357	0.00000	1.9692e+15	0.02694	0.05951	0.90092	0.00066	0.01196	0.0000e+00
11	0.998	2.3552e+15	0.00000	0.00597	0.35088	0.38918	0.09124	0.00356	0.00000	1.9665e+15	0.02693	0.05963	0.90081	0.00067	0.01196	0.0000e+00
12	1.014	2.3839e+15	0.00000	0.00595	0.34929	0.39183	0.09058	0.00357	0.00000	1.9965e+15	0.02677	0.05871	0.90193	0.00066	0.01193	0.0000e+00
13	0.990	2.3411e+15	0.00000	0.00597	0.35235	0.38816	0.09135	0.00355	0.00000	1.9497e+15	0.02691	0.06038	0.90008	0.00067	0.01195	0.0000e+00
14	0.974	2.3124e+15	0.00000	0.00597	0.35441	0.38613	0.09180	0.00354	0.00000	1.9184e+15	0.02695	0.06157	0.89885	0.00069	0.01195	0.0000e+00
15	1.005	2.3645e+15	0.00000	0.00597	0.34950	0.39004	0.09110	0.00358	0.00000	1.9799e+15	0.02696	0.05921	0.90120	0.00066	0.01197	0.0000e+00
16	1.019	2.3919e+15	0.00000	0.00595	0.34803	0.39263	0.09053	0.00358	0.00000	2.0078e+15	0.02679	0.05824	0.90239	0.00065	0.01194	0.0000e+00
17	1.001	2.3589e+15	0.00000	0.00597	0.35043	0.38947	0.09122	0.00357	0.00000	1.9712e+15	0.02694	0.05943	0.90100	0.00066	0.01197	0.0000e+00
18	1.000	2.3585e+15	0.00000	0.00597	0.35075	0.38927	0.09122	0.00357	0.00000	1.9696e+15	0.02694	0.05953	0.90091	0.00067	0.01197	0.0000e+00
19	1.015	2.3867e+15	0.00000	0.00595	0.34921	0.39189	0.09057	0.00357	0.00000	1.9991e+15	0.02677	0.05864	0.90200	0.00066	0.01193	0.0000e+00
20	0.990	2.3428e+15	0.00000	0.00597	0.35234	0.38817	0.09135	0.00355	0.00000	1.9511e+15	0.02692	0.06035	0.90010	0.00067	0.01195	0.0000e+00
21	0.974	2.3135e+15	0.00000	0.00597	0.35444	0.38611	0.09179	0.00354	0.00000	1.9193e+15	0.02695	0.06157	0.89884	0.00069	0.01195	0.0000e+00
22	1.022	2.3984e+15	0.00000	0.00595	0.34803	0.39271	0.09048	0.00358	0.00000	2.0131e+15	0.02679	0.05805	0.90257	0.00065	0.01194	0.0000e+00
23	1.023	2.4008e+15	0.00000	0.00595	0.34817	0.39267	0.09043	0.00358	0.00000	2.0147e+15	0.02679	0.05805	0.90257	0.00065	0.01194	0.0000e+00
24	1.008	2.3753e+15	0.00000	0.00594	0.35038	0.39103	0.09069	0.00356	0.00000	1.9854e+15	0.02676	0.05925	0.90140	0.00066	0.01192	0.0000e+00
25	0.976	2.3170e+15	0.00000	0.00597	0.35442	0.38618	0.09175	0.00354	0.00000	1.9223e+15	0.02694	0.06152	0.89890	0.00069	0.01195	0.0000e+00
26	1.016	2.3887e+15	0.00000	0.00597	0.34891	0.39115	0.09078	0.00358	0.00000	2.0018e+15	0.02691	0.05842	0.90205	0.00065	0.01197	0.0000e+00
27	1.032	2.4185e+15	0.00000	0.00595	0.34730	0.39374	0.09014	0.00358	0.00000	2.0329e+15	0.02675	0.05751	0.90316	0.00064	0.01194	0.0000e+00
28	1.026	2.4079e+15	0.00000	0.00594	0.34828	0.39305	0.09024	0.00357	0.00000	2.0205e+15	0.02674	0.05803	0.90265	0.00065	0.01193	0.0000e+00
29	0.991	2.3445e+15	0.00000	0.00597	0.35269	0.38795	0.09134	0.00355	0.00000	1.9514e+15	0.02691	0.06048	0.89998	0.00068	0.01195	0.0000e+00
30	0.974	2.3137e+15	0.00000	0.00597	0.35493	0.38579	0.09180	0.00353	0.00000	1.9178e+15	0.02694	0.06178	0.89864	0.00069	0.01195	0.0000e+00
31	1.014	2.3877e+15	0.00000	0.00595	0.34989	0.39147	0.09056	0.00356	0.00000	1.9977e+15	0.02677	0.05890	0.90175	0.00066	0.01193	0.0000e+00
32	0.979	2.3241e+15	0.00000	0.00597	0.35439	0.38627	0.09167	0.00354	0.00000	1.9285e+15	0.02695	0.06142	0.89900	0.00069	0.01195	0.0000e+00
33	0.970	2.3081e+15	0.00000	0.00597	0.35566	0.38527	0.09186	0.00353	0.00000	1.9107e+15	0.02693	0.06216	0.89827	0.00069	0.01194	0.0000e+00
34	0.988	2.3412e+15	0.00000	0.00597	0.35330	0.38751	0.09138	0.00354	0.00000	1.9466e+15	0.02691	0.06077	0.89969	0.00068	0.01195	0.0000e+00
35	0.972	2.3127e+15	0.00000	0.00597	0.35552	0.38541	0.09179	0.00353	0.00000	1.9151e+15	0.02694	0.06204	0.89838	0.00069	0.01194	0.0000e+00
36	0.967	2.3039e+15	0.00000	0.00597	0.35631	0.38483	0.09188	0.00352	0.00000	1.9051e+15	0.02693	0.06249	0.89794	0.00070	0.01194	0.0000e+00
37	0.967	2.3046e+15	0.00000	0.00597	0.35639	0.38479	0.09186	0.00352	0.00000	1.9055e+15	0.02693	0.06251	0.89792	0.00070	0.01194	0.0000e+00
38	0.965	2.3010e+15	0.00000	0.00597	0.35681	0.38450	0.09188	0.00352	0.00000	1.9013e+15	0.02692	0.06274	0.89770	0.00070	0.01193	0.0000e+00
39	0.964	2.2997e+15	0.00000	0.00597	0.35708	0.38433	0.09188	0.00351	0.00000	1.8993e+15	0.02692	0.06287	0.89758	0.00070	0.01193	0.0000e+00
Assembly total[c]		6.2284e+17	0.00000	0.00596	0.35105	0.38949	0.09105	0.00356	0.00000	5.2004e+17	0.02688	0.05976	0.90074	0.00067	0.01195	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.22. VENTURE results for PWR MOX benchmark Case BOL-3

Total production/total absorption = 1.26589
Multiplication factor (k_{eff}) = 1.26073

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.065	2.5714e+15	0.00000	0.00577	0.38555	0.40337	0.09611	0.00340	0.00000	2.0936e+15	0.02441	0.06586	0.89733	0.00075	0.01165	0.0000e+00
2	1.065	2.5716e+15	0.00000	0.00577	0.38557	0.40335	0.09611	0.00340	0.00000	2.0935e+15	0.02442	0.06584	0.89735	0.00075	0.01165	0.0000e+00
3	1.063	2.5687e+15	0.00000	0.00577	0.38595	0.40307	0.09610	0.00340	0.00000	2.0896e+15	0.02442	0.06589	0.89730	0.00075	0.01165	0.0000e+00
4	1.058	2.5609e+15	0.00000	0.00577	0.38672	0.40242	0.09612	0.00339	0.00000	2.0800e+15	0.02443	0.06614	0.89704	0.00075	0.01165	0.0000e+00
5	1.025	2.5063e+15	0.00000	0.00577	0.39156	0.39820	0.09662	0.00335	0.00000	2.0150e+15	0.02442	0.06820	0.89498	0.00078	0.01162	0.0000e+00
6	0.939	2.3628e+15	0.00000	0.00581	0.40521	0.38379	0.09916	0.00326	0.00000	1.8447e+15	0.02477	0.07464	0.88808	0.00085	0.01166	0.0000e+00
7	1.018	2.4936e+15	0.00000	0.00581	0.39250	0.39553	0.09761	0.00336	0.00000	2.0007e+15	0.02466	0.06900	0.89387	0.00078	0.01169	0.0000e+00
8	1.018	2.4941e+15	0.00000	0.00581	0.39250	0.39554	0.09760	0.00336	0.00000	2.0011e+15	0.02466	0.06897	0.89390	0.00078	0.01169	0.0000e+00
9	1.066	2.5721e+15	0.00000	0.00577	0.38559	0.40335	0.09609	0.00340	0.00000	2.0939e+15	0.02442	0.06579	0.89740	0.00075	0.01165	0.0000e+00
10	1.017	2.4922e+15	0.00000	0.00581	0.39280	0.39532	0.09758	0.00336	0.00000	1.9984e+15	0.02467	0.06898	0.89388	0.00079	0.01169	0.0000e+00
11	1.013	2.4853e+15	0.00000	0.00581	0.39352	0.39474	0.09759	0.00335	0.00000	1.9900e+15	0.02467	0.06922	0.89364	0.00079	0.01169	0.0000e+00
12	1.050	2.5470e+15	0.00000	0.00577	0.38799	0.40138	0.09619	0.00338	0.00000	2.0633e+15	0.02442	0.06661	0.89656	0.00076	0.01164	0.0000e+00
13	0.982	2.4353e+15	0.00000	0.00580	0.39820	0.39068	0.09803	0.00331	0.00000	1.9306e+15	0.02467	0.07126	0.89159	0.00081	0.01167	0.0000e+00
14	0.935	2.3567e+15	0.00000	0.00582	0.40584	0.38317	0.09926	0.00325	0.00000	1.8373e+15	0.02477	0.07494	0.88777	0.00085	0.01166	0.0000e+00
15	1.019	2.4956e+15	0.00000	0.00581	0.39239	0.39564	0.09758	0.00336	0.00000	2.0028e+15	0.02466	0.06889	0.89397	0.00078	0.01169	0.0000e+00
16	1.068	2.5760e+15	0.00000	0.00577	0.38530	0.40362	0.09605	0.00340	0.00000	2.0983e+15	0.02442	0.06563	0.89756	0.00075	0.01165	0.0000e+00
17	1.021	2.4983e+15	0.00000	0.00581	0.39229	0.39579	0.09750	0.00336	0.00000	2.0055e+15	0.02467	0.06871	0.89414	0.00078	0.01169	0.0000e+00
18	1.017	2.4924e+15	0.00000	0.00581	0.39292	0.39529	0.09750	0.00336	0.00000	1.9982e+15	0.02467	0.06890	0.89395	0.00078	0.01169	0.0000e+00
19	1.053	2.5521e+15	0.00000	0.00577	0.38759	0.40178	0.09612	0.00338	0.00000	2.0693e+15	0.02443	0.06639	0.89678	0.00076	0.01164	0.0000e+00
20	0.983	2.4368e+15	0.00000	0.00580	0.39810	0.39079	0.09800	0.00331	0.00000	1.9323e+15	0.02467	0.07117	0.89168	0.00081	0.01167	0.0000e+00
21	0.935	2.3563e+15	0.00000	0.00582	0.40592	0.38312	0.09925	0.00325	0.00000	1.8368e+15	0.02478	0.07493	0.88778	0.00085	0.01166	0.0000e+00
22	1.079	2.5942e+15	0.00000	0.00577	0.38390	0.40496	0.09576	0.00342	0.00000	2.1198e+15	0.02443	0.06487	0.89831	0.00074	0.01166	0.0000e+00
23	1.078	2.5935e+15	0.00000	0.00577	0.38405	0.40494	0.09565	0.00342	0.00000	2.1189e+15	0.02443	0.06483	0.89835	0.00074	0.01166	0.0000e+00
24	1.027	2.5095e+15	0.00000	0.00577	0.39137	0.39845	0.09652	0.00335	0.00000	2.0185e+15	0.02443	0.06800	0.89517	0.00078	0.01163	0.0000e+00
25	0.937	2.3596e+15	0.00000	0.00582	0.40564	0.38347	0.09913	0.00325	0.00000	1.8406e+15	0.02477	0.07472	0.88800	0.00085	0.01166	0.0000e+00
26	1.064	2.5700e+15	0.00000	0.00580	0.38615	0.40203	0.09630	0.00341	0.00000	2.0908e+15	0.02459	0.06574	0.89722	0.00075	0.01170	0.0000e+00
27	1.103	2.6335e+15	0.00000	0.00577	0.38080	0.40840	0.09495	0.00344	0.00000	2.1667e+15	0.02437	0.06330	0.89995	0.00072	0.01166	0.0000e+00
28	1.080	2.5959e+15	0.00000	0.00576	0.38394	0.40566	0.09529	0.00341	0.00000	2.1217e+15	0.02436	0.06460	0.89866	0.00074	0.01164	0.0000e+00
29	0.978	2.4285e+15	0.00000	0.00581	0.39899	0.39010	0.09797	0.00331	0.00000	1.9223e+15	0.02468	0.07143	0.89140	0.00081	0.01167	0.0000e+00
30	0.926	2.3429e+15	0.00000	0.00582	0.40739	0.38191	0.09929	0.00324	0.00000	1.8207e+15	0.02478	0.07548	0.88722	0.00086	0.01166	0.0000e+00
31	1.042	2.5347e+15	0.00000	0.00577	0.38924	0.40051	0.09610	0.00337	0.00000	2.0486e+15	0.02443	0.06690	0.89627	0.00076	0.01164	0.0000e+00
32	0.941	2.3666e+15	0.00000	0.00582	0.40508	0.38414	0.09889	0.00326	0.00000	1.8488e+15	0.02477	0.07426	0.88845	0.00085	0.01167	0.0000e+00
33	0.912	2.3186e+15	0.00000	0.00582	0.40995	0.37968	0.09952	0.00322	0.00000	1.7918e+15	0.02479	0.07664	0.88605	0.00087	0.01165	0.0000e+00
34	0.966	2.4091e+15	0.00000	0.00581	0.40093	0.38844	0.09812	0.00329	0.00000	1.8991e+15	0.02469	0.07223	0.89060	0.00082	0.01166	0.0000e+00
35	0.917	2.3264e+15	0.00000	0.00582	0.40920	0.38045	0.09934	0.00323	0.00000	1.8011e+15	0.02479	0.07619	0.88650	0.00087	0.01165	0.0000e+00
36	0.899	2.2980e+15	0.00000	0.00581	0.41216	0.37781	0.09967	0.00320	0.00000	1.7675e+15	0.02480	0.07762	0.88506	0.00089	0.01164	0.0000e+00
37	0.899	2.2968e+15	0.00000	0.00581	0.41232	0.37772	0.09963	0.00320	0.00000	1.7661e+15	0.02480	0.07765	0.88503	0.00089	0.01164	0.0000e+00
38	0.890	2.2829e+15	0.00000	0.00581	0.41381	0.37645	0.09975	0.00319	0.00000	1.7498e+15	0.02480	0.07834	0.88433	0.00089	0.01163	0.0000e+00
39	0.886	2.2752e+15	0.00000	0.00581	0.41466	0.37575	0.09978	0.00318	0.00000	1.7407e+15	0.02480	0.07871	0.88396	0.00090	0.01163	0.0000e+00
Assembly total[c]		6.5057e+17	0.00000	0.00579	0.39546	0.39363	0.09749	0.00333	0.00000	5.1880e+17	0.02460	0.06996	0.89298	0.00080	0.01166	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.23. VENTURE results for PWR MOX benchmark Case BOL-4

Total production/total absorption = 1.19589
Multiplication factor (k_{eff}) = 1.19092

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.100	2.7041e+15	0.00000	0.00577	0.39414	0.39631	0.09674	0.00333	0.00000	2.1600e+15	0.02445	0.06805	0.89509	0.00078	0.01163	0.0000e+00
2	1.042	2.6138e+15	0.00000	0.00578	0.40324	0.38790	0.09801	0.00326	0.00000	2.0456e+15	0.02451	0.07180	0.89125	0.00082	0.01163	0.0000e+00
3	1.023	2.5843e+15	0.00000	0.00578	0.40646	0.38518	0.09831	0.00323	0.00000	2.0079e+15	0.02451	0.07305	0.88999	0.00084	0.01161	0.0000e+00
4	1.019	2.5791e+15	0.00000	0.00578	0.40708	0.38467	0.09831	0.00323	0.00000	2.0015e+15	0.02451	0.07330	0.88973	0.00084	0.01161	0.0000e+00
5	1.007	2.5577e+15	0.00000	0.00578	0.40885	0.38305	0.09846	0.00321	0.00000	1.9780e+15	0.02452	0.07433	0.88869	0.00085	0.01160	0.0000e+00
6	0.974	2.4965e+15	0.00000	0.00582	0.41347	0.37703	0.09968	0.00319	0.00000	1.9129e+15	0.02481	0.07710	0.88556	0.00088	0.01165	0.0000e+00
7	1.046	2.6153e+15	0.00000	0.00581	0.40199	0.38772	0.09831	0.00328	0.00000	2.0542e+15	0.02470	0.07163	0.89118	0.00082	0.01168	0.0000e+00
8	1.018	2.5717e+15	0.00000	0.00581	0.40659	0.38359	0.09890	0.00324	0.00000	1.9988e+15	0.02472	0.07355	0.88922	0.00084	0.01167	0.0000e+00
9	1.027	2.5906e+15	0.00000	0.00578	0.40575	0.38576	0.09828	0.00324	0.00000	2.0159e+15	0.02451	0.07278	0.89026	0.00083	0.01162	0.0000e+00
10	1.004	2.5500e+15	0.00000	0.00581	0.40908	0.38149	0.09910	0.00322	0.00000	1.9709e+15	0.02472	0.07451	0.88826	0.00085	0.01166	0.0000e+00
11	1.001	2.5456e+15	0.00000	0.00581	0.40963	0.38105	0.09909	0.00322	0.00000	1.9654e+15	0.02472	0.07474	0.88803	0.00086	0.01166	0.0000e+00
12	1.016	2.5733e+15	0.00000	0.00578	0.40769	0.38418	0.09831	0.00322	0.00000	1.9947e+15	0.02451	0.07360	0.88944	0.00084	0.01161	0.0000e+00
13	0.990	2.5259e+15	0.00000	0.00581	0.41131	0.37955	0.09921	0.00321	0.00000	1.9439e+15	0.02473	0.07572	0.88703	0.00087	0.01165	0.0000e+00
14	0.973	2.4943e+15	0.00000	0.00582	0.41366	0.37681	0.09972	0.00319	0.00000	1.9104e+15	0.02482	0.07722	0.88543	0.00088	0.01165	0.0000e+00
15	1.010	2.5604e+15	0.00000	0.00581	0.40787	0.38249	0.09903	0.00323	0.00000	1.9842e+15	0.02472	0.07405	0.88872	0.00085	0.01166	0.0000e+00
16	1.025	2.5887e+15	0.00000	0.00578	0.40608	0.38549	0.09830	0.00323	0.00000	2.0128e+15	0.02451	0.07286	0.89018	0.00083	0.01162	0.0000e+00
17	1.004	2.5514e+15	0.00000	0.00581	0.40910	0.38150	0.09908	0.00322	0.00000	1.9719e+15	0.02472	0.07445	0.88832	0.00085	0.01166	0.0000e+00
18	1.002	2.5481e+15	0.00000	0.00581	0.40955	0.38116	0.09906	0.00322	0.00000	1.9677e+15	0.02472	0.07463	0.88813	0.00085	0.01166	0.0000e+00
19	1.017	2.5754e+15	0.00000	0.00578	0.40763	0.38426	0.09829	0.00322	0.00000	1.9966e+15	0.02451	0.07353	0.88951	0.00084	0.01161	0.0000e+00
20	0.990	2.5268e+15	0.00000	0.00581	0.41134	0.37955	0.09919	0.00321	0.00000	1.9445e+15	0.02473	0.07571	0.88705	0.00087	0.01165	0.0000e+00
21	0.973	2.4945e+15	0.00000	0.00582	0.41373	0.37676	0.09971	0.00319	0.00000	1.9104e+15	0.02482	0.07724	0.88541	0.00088	0.01165	0.0000e+00
22	1.026	2.5917e+15	0.00000	0.00578	0.40628	0.38546	0.09820	0.00323	0.00000	2.0144e+15	0.02451	0.07275	0.89029	0.00083	0.01162	0.0000e+00
23	1.025	2.5910e+15	0.00000	0.00578	0.40653	0.38535	0.09813	0.00323	0.00000	2.0132e+15	0.02451	0.07282	0.89022	0.00083	0.01162	0.0000e+00
24	1.008	2.5597e+15	0.00000	0.00578	0.40896	0.38302	0.09841	0.00321	0.00000	1.9793e+15	0.02452	0.07431	0.88871	0.00085	0.01160	0.0000e+00
25	0.974	2.4963e+15	0.00000	0.00582	0.41373	0.37684	0.09965	0.00319	0.00000	1.9119e+15	0.02481	0.07720	0.88546	0.00088	0.01165	0.0000e+00
26	1.018	2.5788e+15	0.00000	0.00580	0.40752	0.38364	0.09854	0.00323	0.00000	1.9998e+15	0.02464	0.07330	0.88956	0.00084	0.01165	0.0000e+00
27	1.034	2.6073e+15	0.00000	0.00577	0.40556	0.38671	0.09777	0.00324	0.00000	2.0300e+15	0.02445	0.07218	0.89094	0.00083	0.01161	0.0000e+00
28	1.026	2.5937e+15	0.00000	0.00577	0.40664	0.38571	0.09788	0.00323	0.00000	2.0151e+15	0.02445	0.07283	0.89028	0.00083	0.01160	0.0000e+00
29	0.989	2.5244e+15	0.00000	0.00581	0.41180	0.37920	0.09916	0.00320	0.00000	1.9412e+15	0.02473	0.07592	0.88683	0.00087	0.01164	0.0000e+00
30	0.970	2.4904e+15	0.00000	0.00582	0.41433	0.37627	0.09969	0.00319	0.00000	1.9052e+15	0.02482	0.07755	0.88510	0.00089	0.01165	0.0000e+00
31	1.013	2.5698e+15	0.00000	0.00578	0.40849	0.38360	0.09824	0.00322	0.00000	1.9893e+15	0.02452	0.07393	0.88910	0.00085	0.01161	0.0000e+00
32	0.975	2.4999e+15	0.00000	0.00582	0.41378	0.37693	0.09953	0.00319	0.00000	1.9148e+15	0.02481	0.07713	0.88552	0.00088	0.01165	0.0000e+00
33	0.965	2.4816e+15	0.00000	0.00582	0.41516	0.37551	0.09975	0.00318	0.00000	1.8954e+15	0.02483	0.07806	0.88458	0.00089	0.01164	0.0000e+00
34	0.985	2.5177e+15	0.00000	0.00581	0.41251	0.37856	0.09918	0.00320	0.00000	1.9334e+15	0.02474	0.07632	0.88642	0.00087	0.01164	0.0000e+00
35	0.967	2.4848e+15	0.00000	0.00582	0.41505	0.37571	0.09966	0.00318	0.00000	1.8986e+15	0.02482	0.07794	0.88470	0.00089	0.01164	0.0000e+00
36	0.961	2.4740e+15	0.00000	0.00582	0.41591	0.37488	0.09976	0.00317	0.00000	1.8871e+15	0.02483	0.07851	0.88413	0.00090	0.01164	0.0000e+00
37	0.961	2.4737e+15	0.00000	0.00582	0.41600	0.37483	0.09974	0.00317	0.00000	1.8866e+15	0.02483	0.07855	0.88408	0.00090	0.01164	0.0000e+00
38	0.958	2.4685e+15	0.00000	0.00582	0.41647	0.37442	0.09975	0.00317	0.00000	1.8810e+15	0.02483	0.07885	0.88378	0.00090	0.01163	0.0000e+00
39	0.956	2.4656e+15	0.00000	0.00582	0.41677	0.37418	0.09975	0.00317	0.00000	1.8778e+15	0.02483	0.07903	0.88360	0.00091	0.01163	0.0000e+00
Assembly total[c]		6.7154e+17	0.00000	0.00580	0.40985	0.38125	0.09889	0.00321	0.00000	5.1841e+17	0.02466	0.07496	0.88788	0.00086	0.01164	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.24. VENTURE results for PWR MOX benchmark Case BOL-5

Total production/total absorption = 1.22461
Multiplication factor (k_{eff}) = 1.21965

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.066	2.7315e+15	0.02796	0.00543	0.39188	0.38113	0.09594	0.00319	0.02796	2.0922e+15	0.02424	0.06805	0.89535	0.00077	0.01158	2.0257e-08
2	1.066	2.7316e+15	0.02795	0.00543	0.39191	0.38111	0.09593	0.00319	0.02795	2.0922e+15	0.02424	0.06803	0.89537	0.00077	0.01158	2.0256e-08
3	1.064	2.7285e+15	0.02789	0.00543	0.39231	0.38086	0.09592	0.00318	0.02789	2.0883e+15	0.02425	0.06808	0.89532	0.00078	0.01158	2.0246e-08
4	1.059	2.7200e+15	0.02775	0.00543	0.39313	0.38028	0.09594	0.00318	0.02775	2.0787e+15	0.02425	0.06834	0.89505	0.00078	0.01158	2.0220e-08
5	1.026	2.6606e+15	0.02674	0.00543	0.39829	0.37652	0.09644	0.00314	0.02674	2.0140e+15	0.02425	0.07046	0.89293	0.00080	0.01156	2.0079e-08
6	0.938	2.5029e+15	0.02427	0.00548	0.41277	0.36324	0.09912	0.00306	0.02427	1.8416e+15	0.02459	0.07720	0.88574	0.00088	0.01159	1.9422e-08
7	1.018	2.6457e+15	0.02676	0.00546	0.39923	0.37387	0.09752	0.00315	0.02676	1.9978e+15	0.02448	0.07136	0.89173	0.00081	0.01162	1.9866e-08
8	1.018	2.6462e+15	0.02676	0.00546	0.39922	0.37388	0.09752	0.00315	0.02676	1.9982e+15	0.02448	0.07132	0.89176	0.00081	0.01162	1.9867e-08
9	1.066	2.7322e+15	0.02796	0.00543	0.39193	0.38111	0.09592	0.00319	0.02796	2.0926e+15	0.02424	0.06798	0.89542	0.00077	0.01158	2.0256e-08
10	1.017	2.6442e+15	0.02672	0.00547	0.39954	0.37369	0.09749	0.00315	0.02672	1.9955e+15	0.02449	0.07133	0.89174	0.00081	0.01162	1.9858e-08
11	1.012	2.6368e+15	0.02659	0.00547	0.40030	0.37317	0.09750	0.00314	0.02659	1.9872e+15	0.02449	0.07157	0.89150	0.00081	0.01162	1.9835e-08
12	1.051	2.7050e+15	0.02750	0.00543	0.39449	0.37936	0.09601	0.00317	0.02750	2.0622e+15	0.02425	0.06882	0.89457	0.00078	0.01158	2.0184e-08
13	0.982	2.5824e+15	0.02564	0.00547	0.40529	0.36954	0.09794	0.00311	0.02564	1.9282e+15	0.02450	0.07367	0.88939	0.00084	0.01160	1.9694e-08
14	0.934	2.4962e+15	0.02415	0.00548	0.41345	0.36268	0.09923	0.00305	0.02415	1.8342e+15	0.02460	0.07751	0.88542	0.00088	0.01159	1.9398e-08
15	1.019	2.6479e+15	0.02679	0.00546	0.39911	0.37397	0.09750	0.00315	0.02679	1.9999e+15	0.02448	0.07124	0.89184	0.00081	0.01162	1.9870e-08
16	1.068	2.7365e+15	0.02802	0.00543	0.39161	0.38135	0.09587	0.00319	0.02802	2.0970e+15	0.02425	0.06781	0.89558	0.00077	0.01159	2.0265e-08
17	1.020	2.6509e+15	0.02683	0.00547	0.39899	0.37410	0.09741	0.00315	0.02683	2.0026e+15	0.02449	0.07106	0.89202	0.00081	0.01163	1.9871e-08
18	1.016	2.6445e+15	0.02672	0.00547	0.39966	0.37366	0.09740	0.00315	0.02672	1.9954e+15	0.02449	0.07125	0.89182	0.00081	0.01163	1.9851e-08
19	1.054	2.7107e+15	0.02759	0.00543	0.39405	0.37971	0.09593	0.00317	0.02759	2.0683e+15	0.02425	0.06859	0.89480	0.00078	0.01158	2.0196e-08
20	0.983	2.5841e+15	0.02566	0.00547	0.40518	0.36964	0.09790	0.00311	0.02566	1.9298e+15	0.02450	0.07358	0.88948	0.00084	0.01160	1.9697e-08
21	0.934	2.4958e+15	0.02414	0.00548	0.41353	0.36263	0.09921	0.00305	0.02414	1.8337e+15	0.02460	0.07750	0.88543	0.00088	0.01159	1.9395e-08
22	1.079	2.7565e+15	0.02836	0.00543	0.39011	0.38254	0.09557	0.00320	0.02836	2.1185e+15	0.02425	0.06702	0.89636	0.00076	0.01160	2.0299e-08
23	1.079	2.7559e+15	0.02836	0.00543	0.39027	0.38253	0.09545	0.00320	0.02836	2.1177e+15	0.02426	0.06698	0.89640	0.00076	0.01160	2.0293e-08
24	1.028	2.6643e+15	0.02680	0.00543	0.39809	0.37674	0.09633	0.00314	0.02680	2.0177e+15	0.02426	0.07024	0.89314	0.00080	0.01156	2.0084e-08
25	0.936	2.4996e+15	0.02421	0.00548	0.41323	0.36296	0.09908	0.00305	0.02421	1.8376e+15	0.02459	0.07728	0.88566	0.00088	0.01159	1.9407e-08
26	1.064	2.7297e+15	0.02810	0.00545	0.39243	0.37978	0.09615	0.00320	0.02810	2.0886e+15	0.02441	0.06795	0.89522	0.00077	0.01164	2.0104e-08
27	1.103	2.8000e+15	0.02902	0.00542	0.38679	0.38568	0.09471	0.00322	0.02902	2.1662e+15	0.02420	0.06538	0.89808	0.00075	0.01160	2.0431e-08
28	1.081	2.7591e+15	0.02835	0.00542	0.39015	0.38325	0.09505	0.00320	0.02835	2.1214e+15	0.02419	0.06672	0.89675	0.00076	0.01158	2.0345e-08
29	0.978	2.5752e+15	0.02551	0.00547	0.40613	0.36902	0.09787	0.00310	0.02551	1.9200e+15	0.02451	0.07385	0.88920	0.00084	0.01160	1.9665e-08
30	0.926	2.4814e+15	0.02387	0.00548	0.41510	0.36155	0.09925	0.00304	0.02387	1.8177e+15	0.02461	0.07807	0.88485	0.00089	0.01159	1.9347e-08
31	1.043	2.6920e+15	0.02728	0.00543	0.39580	0.37859	0.09590	0.00316	0.02728	2.0478e+15	0.02426	0.06911	0.89427	0.00079	0.01158	2.0144e-08
32	0.940	2.5074e+15	0.02436	0.00548	0.41262	0.36356	0.09882	0.00306	0.02436	1.8459e+15	0.02460	0.07680	0.88613	0.00088	0.01160	1.9420e-08
33	0.911	2.4549e+15	0.02338	0.00548	0.41783	0.35953	0.09948	0.00302	0.02338	1.7889e+15	0.02462	0.07926	0.88365	0.00090	0.01157	1.9265e-08
34	0.966	2.5541e+15	0.02514	0.00547	0.40820	0.36752	0.09802	0.00309	0.02514	1.8969e+15	0.02451	0.07467	0.88837	0.00085	0.01160	1.9604e-08
35	0.916	2.4635e+15	0.02355	0.00548	0.41703	0.36023	0.09929	0.00303	0.02355	1.7983e+15	0.02461	0.07879	0.88412	0.00090	0.01158	1.9287e-08
36	0.899	2.4325e+15	0.02296	0.00548	0.42019	0.35785	0.09962	0.00300	0.02296	1.7647e+15	0.02462	0.08027	0.88263	0.00092	0.01156	1.9194e-08
37	0.898	2.4313e+15	0.02294	0.00548	0.42035	0.35776	0.09958	0.00300	0.02294	1.7634e+15	0.02462	0.08030	0.88260	0.00092	0.01157	1.9188e-08
38	0.890	2.4162e+15	0.02265	0.00548	0.42194	0.35662	0.09969	0.00299	0.02265	1.7472e+15	0.02462	0.08101	0.88188	0.00092	0.01156	1.9141e-08
39	0.885	2.4078e+15	0.02250	0.00548	0.42285	0.35599	0.09972	0.00299	0.02250	1.7382e+15	0.02463	0.08139	0.88150	0.00093	0.01155	1.9112e-08
Assembly total[c]		6.9016e+17	0.02615	0.00546	0.40238	0.37224	0.09737	0.00312	0.02615	5.1824e+17	0.02442	0.07232	0.89084	0.00082	0.01159	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.25. VENTURE results for PWR MOX benchmark Case BOL-6

Total production/total absorption = 1.15811
Multiplication factor (k_{eff}) = 1.15333

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.100	2.8720e+15	0.02739	0.00543	0.40052	0.37444	0.09647	0.00312	0.02739	2.1581e+15	0.02427	0.07026	0.89309	0.00080	0.01157	2.0916e-08
2	1.042	2.7742e+15	0.02561	0.00544	0.41013	0.36687	0.09780	0.00306	0.02561	2.0446e+15	0.02434	0.07410	0.88915	0.00085	0.01156	2.0674e-08
3	1.024	2.7428e+15	0.02497	0.00544	0.41351	0.36448	0.09810	0.00303	0.02497	2.0078e+15	0.02434	0.07537	0.88789	0.00086	0.01155	2.0616e-08
4	1.020	2.7370e+15	0.02487	0.00544	0.41417	0.36401	0.09810	0.00303	0.02487	2.0012e+15	0.02434	0.07562	0.88762	0.00087	0.01154	2.0597e-08
5	1.008	2.7128e+15	0.02452	0.00544	0.41612	0.36251	0.09825	0.00301	0.02452	1.9769e+15	0.02435	0.07671	0.88653	0.00088	0.01153	2.0528e-08
6	0.973	2.6439e+15	0.02382	0.00548	0.42105	0.35679	0.09954	0.00299	0.02382	1.9089e+15	0.02463	0.07969	0.88319	0.00091	0.01158	2.0128e-08
7	1.046	2.7743e+15	0.02603	0.00546	0.40879	0.36653	0.09812	0.00308	0.02603	2.0509e+15	0.02452	0.07401	0.88901	0.00085	0.01161	2.0508e-08
8	1.018	2.7273e+15	0.02511	0.00547	0.41364	0.36283	0.09874	0.00304	0.02511	1.9963e+15	0.02454	0.07597	0.88702	0.00087	0.01160	2.0403e-08
9	1.028	2.7495e+15	0.02511	0.00544	0.41277	0.36499	0.09807	0.00304	0.02511	2.0156e+15	0.02434	0.07509	0.88816	0.00086	0.01155	2.0630e-08
10	1.004	2.7043e+15	0.02464	0.00547	0.41626	0.36098	0.09894	0.00302	0.02464	1.9691e+15	0.02454	0.07693	0.88605	0.00088	0.01159	2.0355e-08
11	1.001	2.6994e+15	0.02455	0.00547	0.41685	0.36058	0.09892	0.00302	0.02455	1.9636e+15	0.02455	0.07716	0.88582	0.00088	0.01159	2.0340e-08
12	1.017	2.7305e+15	0.02477	0.00544	0.41483	0.36356	0.09809	0.00302	0.02477	1.9943e+15	0.02434	0.07593	0.88731	0.00087	0.01154	2.0580e-08
13	0.990	2.6771e+15	0.02422	0.00547	0.41870	0.35918	0.09904	0.00301	0.02422	1.9413e+15	0.02455	0.07821	0.88477	0.00090	0.01157	2.0277e-08
14	0.972	2.6413e+15	0.02379	0.00548	0.42127	0.35658	0.09958	0.00299	0.02379	1.9062e+15	0.02464	0.07982	0.88305	0.00091	0.01158	2.0116e-08
15	1.011	2.7153e+15	0.02486	0.00547	0.41498	0.36186	0.09887	0.00303	0.02486	1.9821e+15	0.02454	0.07647	0.88652	0.00088	0.01159	2.0380e-08
16	1.026	2.7475e+15	0.02505	0.00544	0.41310	0.36475	0.09809	0.00303	0.02505	2.0127e+15	0.02434	0.07517	0.88808	0.00086	0.01155	2.0626e-08
17	1.004	2.7059e+15	0.02465	0.00547	0.41626	0.36099	0.09892	0.00302	0.02465	1.9702e+15	0.02455	0.07687	0.88612	0.00088	0.01159	2.0359e-08
18	1.002	2.7022e+15	0.02458	0.00547	0.41674	0.36067	0.09889	0.00302	0.02458	1.9660e+15	0.02455	0.07705	0.88593	0.00088	0.01159	2.0348e-08
19	1.018	2.7329e+15	0.02479	0.00544	0.41477	0.36363	0.09807	0.00302	0.02479	1.9963e+15	0.02434	0.07585	0.88739	0.00087	0.01154	2.0588e-08
20	0.990	2.6781e+15	0.02422	0.00547	0.41872	0.35917	0.09902	0.00301	0.02422	1.9419e+15	0.02455	0.07819	0.88478	0.00090	0.01158	2.0280e-08
21	0.972	2.6415e+15	0.02378	0.00548	0.42134	0.35654	0.09957	0.00299	0.02378	1.9062e+15	0.02464	0.07983	0.88303	0.00091	0.01158	2.0117e-08
22	1.027	2.7512e+15	0.02506	0.00544	0.41327	0.36475	0.09798	0.00303	0.02506	2.0148e+15	0.02434	0.07503	0.88822	0.00086	0.01155	2.0638e-08
23	1.027	2.7505e+15	0.02503	0.00544	0.41353	0.36464	0.09790	0.00303	0.02503	2.0135e+15	0.02434	0.07510	0.88815	0.00086	0.01155	2.0638e-08
24	1.009	2.7151e+15	0.02452	0.00544	0.41623	0.36247	0.09820	0.00301	0.02452	1.9783e+15	0.02435	0.07669	0.88655	0.00088	0.01153	2.0536e-08
25	0.973	2.6436e+15	0.02379	0.00548	0.42134	0.35661	0.09951	0.00299	0.02379	1.9078e+15	0.02464	0.07979	0.88308	0.00091	0.01158	2.0128e-08
26	1.019	2.7370e+15	0.02497	0.00546	0.41451	0.36302	0.09833	0.00303	0.02497	1.9996e+15	0.02447	0.07562	0.88745	0.00087	0.01158	2.0499e-08
27	1.036	2.7690e+15	0.02521	0.00543	0.41249	0.36593	0.09752	0.00304	0.02521	2.0312e+15	0.02428	0.07441	0.88892	0.00085	0.01154	2.0733e-08
28	1.028	2.7534e+15	0.02498	0.00543	0.41368	0.36500	0.09763	0.00303	0.02498	2.0157e+15	0.02428	0.07510	0.88822	0.00086	0.01153	2.0692e-08
29	0.988	2.6754e+15	0.02416	0.00547	0.41922	0.35884	0.09898	0.00300	0.02416	1.9384e+15	0.02456	0.07841	0.88456	0.00090	0.01157	2.0272e-08
30	0.969	2.6368e+15	0.02369	0.00548	0.42200	0.35608	0.09955	0.00299	0.02369	1.9007e+15	0.02464	0.08016	0.88270	0.00092	0.01157	2.0104e-08
31	1.014	2.7265e+15	0.02466	0.00544	0.41569	0.36302	0.09801	0.00302	0.02466	1.9887e+15	0.02435	0.07627	0.88697	0.00087	0.01154	2.0573e-08
32	0.974	2.6475e+15	0.02382	0.00548	0.42137	0.35669	0.09938	0.00299	0.02382	1.9107e+15	0.02463	0.07971	0.88316	0.00091	0.01158	2.0142e-08
33	0.964	2.6267e+15	0.02353	0.00548	0.42292	0.35536	0.09960	0.00298	0.02353	1.8905e+15	0.02465	0.08070	0.88215	0.00092	0.01157	2.0072e-08
34	0.984	2.6677e+15	0.02403	0.00547	0.42000	0.35824	0.09901	0.00300	0.02403	1.9303e+15	0.02456	0.07884	0.88412	0.00090	0.01157	2.0249e-08
35	0.966	2.6304e+15	0.02357	0.00548	0.42278	0.35554	0.09952	0.00298	0.02357	1.8938e+15	0.02465	0.08057	0.88229	0.00092	0.01157	2.0085e-08
36	0.959	2.6181e+15	0.02340	0.00548	0.42374	0.35477	0.09961	0.00298	0.02340	1.8818e+15	0.02465	0.08118	0.88167	0.00093	0.01156	2.0047e-08
37	0.959	2.6177e+15	0.02339	0.00548	0.42384	0.35471	0.09959	0.00297	0.02339	1.8813e+15	0.02465	0.08122	0.88163	0.00093	0.01156	2.0046e-08
38	0.956	2.6118e+15	0.02330	0.00548	0.42436	0.35433	0.09961	0.00297	0.02330	1.8755e+15	0.02465	0.08154	0.88131	0.00093	0.01156	2.0029e-08
39	0.954	2.6085e+15	0.02325	0.00548	0.42469	0.35410	0.09960	0.00297	0.02325	1.8721e+15	0.02465	0.08173	0.88112	0.00094	0.01156	2.0019e-08
Assembly total[c]		7.1196e+17	0.02446	0.00546	0.41715	0.36076	0.09871	0.00301	0.02446	5.1782e+17	0.02449	0.07740	0.88565	0.00089	0.01156	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.26. VENTURE results for PWR MOX benchmark Case BOL-7

Total production/total absorption = 1.25172
Multiplication factor (k_{eff}) = 1.24664

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.067	2.6406e+15	0.02926	0.00558	0.39822	0.39459	0.09799	0.00331	0.02926	2.0954e+15	0.02427	0.06650	0.89688	0.00076	0.01160	2.0091e-08
2	1.067	2.6407e+15	0.02926	0.00558	0.39825	0.39457	0.09799	0.00331	0.02926	2.0954e+15	0.02427	0.06648	0.89690	0.00076	0.01160	2.0090e-08
3	1.065	2.6376e+15	0.02920	0.00558	0.39865	0.39429	0.09797	0.00330	0.02920	2.0912e+15	0.02427	0.06653	0.89685	0.00076	0.01160	2.0079e-08
4	1.060	2.6291e+15	0.02904	0.00558	0.39950	0.39366	0.09800	0.00330	0.02904	2.0813e+15	0.02428	0.06678	0.89658	0.00076	0.01160	2.0052e-08
5	1.026	2.5711e+15	0.02796	0.00558	0.40474	0.38955	0.09852	0.00326	0.02796	2.0147e+15	0.02427	0.06890	0.89446	0.00079	0.01157	1.9911e-08
6	0.937	2.4180e+15	0.02535	0.00562	0.41943	0.37549	0.10125	0.00316	0.02535	1.8398e+15	0.02460	0.07559	0.88734	0.00086	0.01160	1.9253e-08
7	1.019	2.5575e+15	0.02800	0.00561	0.40566	0.38698	0.09961	0.00326	0.02800	2.0000e+15	0.02450	0.06976	0.89331	0.00079	0.01164	1.9702e-08
8	1.019	2.5579e+15	0.02801	0.00561	0.40566	0.38699	0.09960	0.00327	0.02801	2.0003e+15	0.02450	0.06972	0.89334	0.00079	0.01164	1.9702e-08
9	1.067	2.6413e+15	0.02927	0.00558	0.39827	0.39457	0.09797	0.00331	0.02927	2.0957e+15	0.02427	0.06643	0.89695	0.00076	0.01160	2.0089e-08
10	1.017	2.5559e+15	0.02796	0.00561	0.40598	0.38678	0.09958	0.00326	0.02796	1.9975e+15	0.02451	0.06973	0.89332	0.00079	0.01164	1.9693e-08
11	1.013	2.5485e+15	0.02782	0.00561	0.40676	0.38621	0.09959	0.00326	0.02782	1.9888e+15	0.02451	0.06997	0.89308	0.00080	0.01164	1.9670e-08
12	1.051	2.6144e+15	0.02877	0.00558	0.40087	0.39265	0.09807	0.00329	0.02877	2.0642e+15	0.02428	0.06727	0.89610	0.00077	0.01159	2.0016e-08
13	0.982	2.4953e+15	0.02680	0.00561	0.41184	0.38224	0.10004	0.00322	0.02680	1.9280e+15	0.02451	0.07208	0.89097	0.00082	0.01162	1.9527e-08
14	0.933	2.4115e+15	0.02522	0.00562	0.42011	0.37488	0.10136	0.00316	0.02522	1.8322e+15	0.02461	0.07590	0.88702	0.00086	0.01160	1.9230e-08
15	1.020	2.5596e+15	0.02804	0.00561	0.40554	0.38709	0.09958	0.00327	0.02804	2.0021e+15	0.02450	0.06964	0.89342	0.00079	0.01164	1.9706e-08
16	1.070	2.6455e+15	0.02934	0.00558	0.39794	0.39484	0.09792	0.00331	0.02934	2.1003e+15	0.02427	0.06626	0.89712	0.00075	0.01160	2.0099e-08
17	1.021	2.5624e+15	0.02808	0.00561	0.40542	0.38723	0.09950	0.00327	0.02808	2.0048e+15	0.02451	0.06945	0.89360	0.00079	0.01164	1.9706e-08
18	1.017	2.5560e+15	0.02797	0.00561	0.40610	0.38674	0.09949	0.00326	0.02797	1.9973e+15	0.02452	0.06965	0.89340	0.00079	0.01164	1.9686e-08
19	1.054	2.6199e+15	0.02887	0.00558	0.40042	0.39303	0.09799	0.00329	0.02887	2.0704e+15	0.02428	0.06704	0.89633	0.00076	0.01160	2.0029e-08
20	0.983	2.4969e+15	0.02683	0.00561	0.41173	0.38235	0.10001	0.00322	0.02683	1.9297e+15	0.02452	0.07199	0.89106	0.00082	0.01162	1.9530e-08
21	0.933	2.4111e+15	0.02521	0.00562	0.42019	0.37483	0.10134	0.00316	0.02521	1.8316e+15	0.02461	0.07590	0.88702	0.00086	0.01160	1.9227e-08
22	1.081	2.6648e+15	0.02970	0.00558	0.39642	0.39614	0.09761	0.00332	0.02970	2.1222e+15	0.02428	0.06547	0.89789	0.00075	0.01161	2.0133e-08
23	1.080	2.6640e+15	0.02969	0.00558	0.39658	0.39611	0.09750	0.00332	0.02969	2.1212e+15	0.02428	0.06542	0.89793	0.00075	0.01162	2.0126e-08
24	1.028	2.5746e+15	0.02802	0.00558	0.40453	0.38980	0.09840	0.00326	0.02802	2.0184e+15	0.02428	0.06869	0.89467	0.00078	0.01158	1.9915e-08
25	0.935	2.4147e+15	0.02528	0.00562	0.41990	0.37518	0.10122	0.00316	0.02528	1.8356e+15	0.02461	0.07567	0.88725	0.00086	0.01160	1.9238e-08
26	1.066	2.6388e+15	0.02943	0.00561	0.39877	0.39331	0.09820	0.00332	0.02943	2.0924e+15	0.02444	0.06637	0.89678	0.00076	0.01166	1.9939e-08
27	1.105	2.7067e+15	0.03039	0.00557	0.39306	0.39947	0.09674	0.00335	0.03039	2.1704e+15	0.02423	0.06384	0.89959	0.00073	0.01162	2.0264e-08
28	1.082	2.6667e+15	0.02967	0.00557	0.39647	0.39681	0.09709	0.00332	0.02967	2.1243e+15	0.02422	0.06518	0.89826	0.00074	0.01160	2.0177e-08
29	0.978	2.4881e+15	0.02667	0.00561	0.41269	0.38168	0.09998	0.00321	0.02667	1.9195e+15	0.02452	0.07225	0.89078	0.00082	0.01162	1.9498e-08
30	0.924	2.3969e+15	0.02492	0.00562	0.42179	0.37365	0.10139	0.00315	0.02492	1.8151e+15	0.02462	0.07646	0.88645	0.00087	0.01160	1.9177e-08
31	1.044	2.6015e+15	0.02854	0.00558	0.40220	0.39181	0.09796	0.00328	0.02854	2.0493e+15	0.02428	0.06755	0.89581	0.00077	0.01159	1.9976e-08
32	0.939	2.4221e+15	0.02544	0.00562	0.41928	0.37583	0.10095	0.00317	0.02544	1.8440e+15	0.02461	0.07519	0.88773	0.00086	0.01161	1.9251e-08
33	0.909	2.3710e+15	0.02439	0.00562	0.42457	0.37145	0.10163	0.00313	0.02439	1.7855e+15	0.02463	0.07766	0.88524	0.00089	0.01159	1.9094e-08
34	0.966	2.4675e+15	0.02626	0.00561	0.41479	0.38004	0.10013	0.00320	0.02626	1.8958e+15	0.02453	0.07307	0.88996	0.00083	0.01161	1.9435e-08
35	0.914	2.3793e+15	0.02457	0.00562	0.42376	0.37220	0.10142	0.00313	0.02457	1.7950e+15	0.02463	0.07719	0.88571	0.00088	0.01159	1.9116e-08
36	0.897	2.3491e+15	0.02394	0.00562	0.42698	0.36960	0.10177	0.00311	0.02394	1.7606e+15	0.02463	0.07868	0.88422	0.00090	0.01158	1.9022e-08
37	0.896	2.3478e+15	0.02392	0.00562	0.42714	0.36951	0.10173	0.00311	0.02392	1.7592e+15	0.02463	0.07870	0.88419	0.00090	0.01158	1.9016e-08
38	0.887	2.3331e+15	0.02361	0.00562	0.42876	0.36826	0.10185	0.00309	0.02361	1.7425e+15	0.02463	0.07942	0.88347	0.00091	0.01157	1.8968e-08
39	0.883	2.3249e+15	0.02344	0.00562	0.42969	0.36756	0.10188	0.00309	0.02344	1.7332e+15	0.02464	0.07981	0.88308	0.00091	0.01157	1.8939e-08
Assembly total[c]		6.6692e+17	0.02735	0.00560	0.40888	0.38510	0.09946	0.00324	0.02735	5.1835e+17	0.02444	0.07073	0.89241	0.00081	0.01161	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.27. VENTURE results for PWR MOX benchmark Case BOL-8

Total production/total absorption = 1.18064
Multiplication factor (k_{eff}) = 1.17576

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.102	2.7821e+15	0.02864	0.00557	0.40705	0.38719	0.09855	0.00323	0.02864	2.1629e+15	0.02429	0.06878	0.89456	0.00079	0.01158	2.0761e-08
2	1.043	2.6871e+15	0.02674	0.00558	0.41676	0.37904	0.09990	0.00316	0.02674	2.0468e+15	0.02435	0.07262	0.89063	0.00083	0.01157	2.0517e-08
3	1.024	2.6562e+15	0.02606	0.00558	0.42020	0.37641	0.10021	0.00314	0.02606	2.0087e+15	0.02435	0.07390	0.88935	0.00085	0.01156	2.0458e-08
4	1.020	2.6504e+15	0.02595	0.00558	0.42088	0.37590	0.10020	0.00313	0.02595	2.0020e+15	0.02435	0.07415	0.88909	0.00085	0.01156	2.0439e-08
5	1.008	2.6269e+15	0.02557	0.00558	0.42285	0.37428	0.10036	0.00312	0.02557	1.9771e+15	0.02436	0.07523	0.88800	0.00086	0.01154	2.0370e-08
6	0.973	2.5599e+15	0.02484	0.00562	0.42788	0.36837	0.10169	0.00309	0.02484	1.9086e+15	0.02464	0.07817	0.88470	0.00090	0.01159	1.9972e-08
7	1.047	2.6872e+15	0.02720	0.00561	0.41544	0.37886	0.10023	0.00319	0.02720	2.0542e+15	0.02454	0.07249	0.89052	0.00083	0.01162	2.0354e-08
8	1.019	2.6414e+15	0.02622	0.00561	0.42035	0.37485	0.10086	0.00315	0.02622	1.9982e+15	0.02455	0.07446	0.88853	0.00085	0.01161	2.0248e-08
9	1.028	2.6628e+15	0.02620	0.00558	0.41944	0.37697	0.10018	0.00314	0.02620	2.0168e+15	0.02435	0.07362	0.88963	0.00084	0.01156	2.0473e-08
10	1.004	2.6187e+15	0.02571	0.00561	0.42302	0.37282	0.10107	0.00313	0.02571	1.9700e+15	0.02455	0.07544	0.88755	0.00086	0.01160	2.0199e-08
11	1.001	2.6138e+15	0.02561	0.00561	0.42362	0.37238	0.10106	0.00312	0.02561	1.9642e+15	0.02456	0.07567	0.88731	0.00087	0.01160	2.0185e-08
12	1.017	2.6441e+15	0.02583	0.00558	0.42154	0.37541	0.10020	0.00313	0.02583	1.9948e+15	0.02435	0.07446	0.88878	0.00085	0.01155	2.0422e-08
13	0.990	2.5921e+15	0.02526	0.00561	0.42549	0.37087	0.10117	0.00311	0.02526	1.9414e+15	0.02456	0.07671	0.88626	0.00088	0.01159	2.0121e-08
14	0.972	2.5574e+15	0.02481	0.00562	0.42810	0.36814	0.10173	0.00309	0.02481	1.9060e+15	0.02465	0.07830	0.88457	0.00090	0.01159	1.9960e-08
15	1.011	2.6296e+15	0.02595	0.00561	0.42171	0.37379	0.10100	0.00314	0.02595	1.9835e+15	0.02455	0.07497	0.88802	0.00086	0.01160	2.0225e-08
16	1.026	2.6609e+15	0.02614	0.00558	0.41979	0.37671	0.10020	0.00314	0.02614	2.0138e+15	0.02435	0.07370	0.88955	0.00084	0.01156	2.0469e-08
17	1.005	2.6203e+15	0.02572	0.00561	0.42302	0.37283	0.10105	0.00313	0.02572	1.9711e+15	0.02456	0.07537	0.88761	0.00086	0.01160	2.0203e-08
18	1.002	2.6166e+15	0.02564	0.00561	0.42351	0.37248	0.10102	0.00312	0.02564	1.9666e+15	0.02456	0.07556	0.88742	0.00087	0.01160	2.0192e-08
19	1.018	2.6464e+15	0.02585	0.00558	0.42148	0.37548	0.10018	0.00313	0.02585	1.9968e+15	0.02435	0.07438	0.88886	0.00085	0.01155	2.0430e-08
20	0.990	2.5931e+15	0.02526	0.00561	0.42551	0.37086	0.10116	0.00311	0.02526	1.9420e+15	0.02456	0.07669	0.88628	0.00088	0.01159	2.0124e-08
21	0.971	2.5576e+15	0.02480	0.00562	0.42817	0.36809	0.10172	0.00309	0.02480	1.9059e+15	0.02465	0.07831	0.88455	0.00090	0.01159	1.9961e-08
22	1.027	2.6643e+15	0.02614	0.00558	0.41996	0.37670	0.10008	0.00314	0.02614	2.0157e+15	0.02435	0.07357	0.88968	0.00084	0.01156	2.0481e-08
23	1.027	2.6636e+15	0.02611	0.00558	0.42023	0.37657	0.10000	0.00314	0.02611	2.0143e+15	0.02435	0.07363	0.88961	0.00084	0.01156	2.0480e-08
24	1.008	2.6291e+15	0.02558	0.00558	0.42295	0.37424	0.10031	0.00312	0.02558	1.9784e+15	0.02436	0.07521	0.88802	0.00086	0.01155	2.0377e-08
25	0.972	2.5595e+15	0.02481	0.00562	0.42817	0.36817	0.10165	0.00309	0.02481	1.9074e+15	0.02464	0.07827	0.88460	0.00090	0.01159	1.9971e-08
26	1.020	2.6503e+15	0.02606	0.00560	0.42124	0.37494	0.10045	0.00314	0.02606	2.0005e+15	0.02448	0.07414	0.88893	0.00085	0.01160	2.0343e-08
27	1.036	2.6815e+15	0.02629	0.00557	0.41916	0.37790	0.09962	0.00314	0.02629	2.0321e+15	0.02429	0.07295	0.89037	0.00084	0.01155	2.0574e-08
28	1.028	2.6663e+15	0.02606	0.00557	0.42037	0.37691	0.09973	0.00313	0.02606	2.0162e+15	0.02429	0.07364	0.88968	0.00084	0.01155	2.0533e-08
29	0.988	2.5904e+15	0.02520	0.00561	0.42602	0.37051	0.10112	0.00311	0.02520	1.9384e+15	0.02457	0.07691	0.88606	0.00088	0.01159	2.0116e-08
30	0.969	2.5529e+15	0.02470	0.00562	0.42884	0.36760	0.10170	0.00309	0.02470	1.9002e+15	0.02465	0.07864	0.88422	0.00090	0.01159	1.9947e-08
31	1.014	2.6401e+15	0.02571	0.00558	0.42241	0.37482	0.10012	0.00312	0.02571	1.9889e+15	0.02436	0.07480	0.88844	0.00086	0.01155	2.0414e-08
32	0.974	2.5633e+15	0.02484	0.00562	0.42820	0.36825	0.10152	0.00309	0.02484	1.9104e+15	0.02464	0.07819	0.88468	0.00090	0.01159	1.9985e-08
33	0.963	2.5431e+15	0.02454	0.00562	0.42977	0.36683	0.10175	0.00308	0.02454	1.8898e+15	0.02466	0.07918	0.88368	0.00091	0.01158	1.9915e-08
34	0.984	2.5829e+15	0.02506	0.00561	0.42681	0.36986	0.10114	0.00310	0.02506	1.9301e+15	0.02457	0.07733	0.88563	0.00089	0.01158	2.0092e-08
35	0.965	2.5467e+15	0.02458	0.00562	0.42963	0.36702	0.10166	0.00308	0.02458	1.8931e+15	0.02465	0.07905	0.88381	0.00091	0.01158	1.9928e-08
36	0.959	2.5347e+15	0.02439	0.00562	0.43060	0.36619	0.10176	0.00308	0.02439	1.8810e+15	0.02466	0.07965	0.88320	0.00091	0.01158	1.9890e-08
37	0.958	2.5343e+15	0.02438	0.00562	0.43070	0.36613	0.10174	0.00307	0.02438	1.8804e+15	0.02466	0.07970	0.88315	0.00091	0.01158	1.9889e-08
38	0.955	2.5285e+15	0.02429	0.00562	0.43123	0.36571	0.10176	0.00307	0.02429	1.8744e+15	0.02466	0.08001	0.88284	0.00092	0.01157	1.9871e-08
39	0.954	2.5253e+15	0.02423	0.00562	0.43157	0.36547	0.10174	0.00307	0.02423	1.8710e+15	0.02466	0.08020	0.88265	0.00092	0.01157	1.9862e-08
Assembly total[c]		6.8940e+17	0.02552	0.00560	0.42391	0.37253	0.10083	0.00312	0.02552	5.1793e+17	0.02450	0.07591	0.88715	0.00087	0.01158	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.28. VENTURE results for PWR MOX benchmark Case BOL-9

Total production/total absorption = 1.28080
Multiplication factor (k_{eff}) = 1.27563

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.069	2.5481e+15	0.03075	0.00574	0.40475	0.40957	0.10016	0.00344	0.03075	2.1002e+15	0.02429	0.06477	0.89858	0.00074	0.01162	1.9916e-08
2	1.069	2.5482e+15	0.03074	0.00574	0.40478	0.40955	0.10015	0.00344	0.03074	2.1001e+15	0.02429	0.06476	0.89860	0.00074	0.01162	1.9916e-08
3	1.067	2.5449e+15	0.03067	0.00574	0.40519	0.40925	0.10014	0.00344	0.03067	2.0957e+15	0.02430	0.06480	0.89854	0.00074	0.01162	1.9904e-08
4	1.062	2.5365e+15	0.03050	0.00574	0.40606	0.40854	0.10017	0.00343	0.03050	2.0852e+15	0.02430	0.06506	0.89827	0.00074	0.01162	1.9877e-08
5	1.026	2.4792e+15	0.02932	0.00574	0.41145	0.40399	0.10071	0.00338	0.02932	2.0158e+15	0.02430	0.06721	0.89614	0.00077	0.01159	1.9732e-08
6	0.935	2.3296e+15	0.02653	0.00578	0.42649	0.38889	0.10353	0.00328	0.02653	1.8365e+15	0.02462	0.07390	0.88902	0.00084	0.01162	1.9069e-08
7	1.020	2.4668e+15	0.02940	0.00578	0.41237	0.40149	0.10183	0.00340	0.02940	2.0027e+15	0.02453	0.06801	0.89503	0.00077	0.01166	1.9527e-08
8	1.020	2.4672e+15	0.02941	0.00578	0.41236	0.40151	0.10182	0.00340	0.02941	2.0030e+15	0.02453	0.06798	0.89506	0.00077	0.01166	1.9527e-08
9	1.069	2.5486e+15	0.03075	0.00574	0.40480	0.40955	0.10014	0.00344	0.03075	2.1004e+15	0.02430	0.06470	0.89864	0.00074	0.01162	1.9915e-08
10	1.018	2.4651e+15	0.02936	0.00578	0.41269	0.40128	0.10179	0.00339	0.02936	2.0000e+15	0.02453	0.06799	0.89504	0.00077	0.01166	1.9517e-08
11	1.014	2.4577e+15	0.02920	0.00578	0.41349	0.40064	0.10181	0.00339	0.02920	1.9908e+15	0.02454	0.06823	0.89480	0.00078	0.01166	1.9493e-08
12	1.053	2.5218e+15	0.03020	0.00574	0.40748	0.40741	0.10024	0.00342	0.03020	2.0673e+15	0.02430	0.06555	0.89779	0.00075	0.01161	1.9839e-08
13	0.981	2.4052e+15	0.02809	0.00577	0.41872	0.39624	0.10228	0.00334	0.02809	1.9275e+15	0.02454	0.07036	0.89266	0.00080	0.01163	1.9347e-08
14	0.931	2.3232e+15	0.02639	0.00578	0.42718	0.38824	0.10364	0.00328	0.02639	1.8287e+15	0.02463	0.07421	0.88869	0.00085	0.01162	1.9045e-08
15	1.021	2.4689e+15	0.02944	0.00578	0.41224	0.40162	0.10180	0.00340	0.02944	2.0048e+15	0.02453	0.06790	0.89514	0.00077	0.01166	1.9531e-08
16	1.072	2.5527e+15	0.03083	0.00574	0.40446	0.40986	0.10009	0.00344	0.03083	2.1052e+15	0.02430	0.06453	0.89881	0.00073	0.01162	1.9924e-08
17	1.022	2.4715e+15	0.02949	0.00578	0.41211	0.40179	0.10171	0.00340	0.02949	2.0076e+15	0.02454	0.06770	0.89533	0.00077	0.01166	1.9531e-08
18	1.018	2.4651e+15	0.02936	0.00578	0.41281	0.40125	0.10170	0.00339	0.02936	1.9997e+15	0.02454	0.06790	0.89512	0.00077	0.01166	1.9509e-08
19	1.056	2.5272e+15	0.03031	0.00574	0.40702	0.40785	0.10016	0.00342	0.03031	2.0737e+15	0.02430	0.06532	0.89802	0.00074	0.01161	1.9852e-08
20	0.982	2.4067e+15	0.02812	0.00577	0.41860	0.39636	0.10224	0.00334	0.02812	1.9292e+15	0.02454	0.07027	0.89276	0.00080	0.01164	1.9350e-08
21	0.931	2.3228e+15	0.02638	0.00578	0.42727	0.38819	0.10362	0.00328	0.02638	1.8281e+15	0.02463	0.07420	0.88870	0.00085	0.01162	1.9042e-08
22	1.083	2.5716e+15	0.03122	0.00575	0.40289	0.41130	0.09977	0.00346	0.03122	2.1279e+15	0.02431	0.06373	0.89960	0.00073	0.01163	1.9958e-08
23	1.083	2.5706e+15	0.03120	0.00575	0.40307	0.41126	0.09965	0.00346	0.03120	2.1267e+15	0.02431	0.06369	0.89964	0.00073	0.01163	1.9951e-08
24	1.028	2.4825e+15	0.02939	0.00574	0.41123	0.40427	0.10059	0.00339	0.02939	2.0196e+15	0.02430	0.06699	0.89635	0.00076	0.01160	1.9736e-08
25	0.933	2.3261e+15	0.02645	0.00578	0.42696	0.38856	0.10349	0.00328	0.02645	1.8321e+15	0.02463	0.07398	0.88893	0.00084	0.01162	1.9053e-08
26	1.068	2.5461e+15	0.03094	0.00577	0.40530	0.40839	0.10038	0.00345	0.03094	2.0978e+15	0.02447	0.06461	0.89851	0.00074	0.01168	1.9766e-08
27	1.109	2.6123e+15	0.03195	0.00574	0.39947	0.41488	0.09887	0.00348	0.03195	2.1771e+15	0.02426	0.06211	0.90129	0.00071	0.01164	2.0090e-08
28	1.084	2.5728e+15	0.03117	0.00574	0.40298	0.41193	0.09924	0.00345	0.03117	2.1290e+15	0.02425	0.06346	0.89995	0.00072	0.01162	2.0001e-08
29	0.977	2.3979e+15	0.02794	0.00577	0.41958	0.39563	0.10221	0.00334	0.02794	1.9185e+15	0.02454	0.07053	0.89248	0.00080	0.01163	1.9316e-08
30	0.922	2.3086e+15	0.02606	0.00578	0.42891	0.38687	0.10367	0.00326	0.02606	1.8108e+15	0.02464	0.07478	0.88812	0.00085	0.01161	1.8991e-08
31	1.045	2.5088e+15	0.02995	0.00574	0.40883	0.40649	0.10013	0.00341	0.02995	2.0515e+15	0.02430	0.06583	0.89750	0.00075	0.01161	1.9797e-08
32	0.937	2.3333e+15	0.02662	0.00578	0.42632	0.38928	0.10322	0.00329	0.02662	1.8406e+15	0.02463	0.07349	0.88941	0.00084	0.01163	1.9066e-08
33	0.906	2.2832e+15	0.02548	0.00578	0.43176	0.38444	0.10392	0.00324	0.02548	1.7801e+15	0.02464	0.07599	0.88690	0.00087	0.01160	1.8905e-08
34	0.964	2.3776e+15	0.02750	0.00577	0.42173	0.39382	0.10237	0.00332	0.02750	1.8938e+15	0.02455	0.07136	0.89165	0.00081	0.01163	1.9252e-08
35	0.911	2.2912e+15	0.02568	0.00578	0.43092	0.38527	0.10371	0.00325	0.02568	1.7898e+15	0.02464	0.07551	0.88737	0.00086	0.01161	1.8928e-08
36	0.893	2.2615e+15	0.02499	0.00577	0.43424	0.38239	0.10407	0.00322	0.02499	1.7540e+15	0.02465	0.07703	0.88585	0.00088	0.01159	1.8831e-08
37	0.892	2.2602e+15	0.02496	0.00577	0.43441	0.38229	0.10403	0.00322	0.02496	1.7526e+15	0.02465	0.07706	0.88582	0.00088	0.01159	1.8824e-08
38	0.884	2.2457e+15	0.02463	0.00577	0.43608	0.38089	0.10416	0.00321	0.02463	1.7351e+15	0.02465	0.07779	0.88509	0.00089	0.01158	1.8775e-08
39	0.879	2.2375e+15	0.02444	0.00577	0.43704	0.38012	0.10419	0.00320	0.02444	1.7254e+15	0.02465	0.07819	0.88469	0.00089	0.01158	1.8745e-08
Assembly total[c]		6.4298e+17	0.02868	0.00576	0.41566	0.39932	0.10168	0.00336	0.02868	5.1848e+17	0.02447	0.06901	0.89411	0.00079	0.01163	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.29. VENTURE results for PWR MOX benchmark Case BOL-10

Total production/total absorption = 1.20437
Multiplication factor (k_{eff}) = 1.19940

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.106	2.6718e+15	0.03027	0.00577	0.41720	0.40440	0.10154	0.00338	0.03027	2.1706e+15	0.02431	0.06719	0.89613	0.00077	0.01160	2.0610e-08
2	1.045	2.5780e+15	0.02821	0.00578	0.42735	0.39547	0.10298	0.00330	0.02821	2.0498e+15	0.02437	0.07109	0.89214	0.00081	0.01158	2.0359e-08
3	1.024	2.5472e+15	0.02746	0.00578	0.43096	0.39254	0.10332	0.00327	0.02746	2.0097e+15	0.02436	0.07241	0.89083	0.00083	0.01157	2.0298e-08
4	1.021	2.5415e+15	0.02734	0.00578	0.43167	0.39198	0.10331	0.00327	0.02734	2.0026e+15	0.02437	0.07266	0.89057	0.00083	0.01157	2.0278e-08
5	1.008	2.5185e+15	0.02693	0.00577	0.43372	0.39025	0.10349	0.00325	0.02693	1.9772e+15	0.02437	0.07374	0.88948	0.00085	0.01156	2.0208e-08
6	0.972	2.4534e+15	0.02617	0.00582	0.43902	0.38416	0.10488	0.00323	0.02617	1.9083e+15	0.02465	0.07664	0.88623	0.00088	0.01160	1.9813e-08
7	1.049	2.5787e+15	0.02873	0.00581	0.42598	0.39555	0.10332	0.00333	0.02873	2.0591e+15	0.02455	0.07091	0.89210	0.00081	0.01164	2.0201e-08
8	1.020	2.5334e+15	0.02766	0.00581	0.43113	0.39113	0.10399	0.00329	0.02766	2.0006e+15	0.02457	0.07292	0.89006	0.00084	0.01162	2.0092e-08
9	1.029	2.5539e+15	0.02761	0.00578	0.43016	0.39316	0.10328	0.00328	0.02761	2.0183e+15	0.02436	0.07212	0.89112	0.00083	0.01157	2.0313e-08
10	1.004	2.5107e+15	0.02710	0.00581	0.43393	0.38887	0.10422	0.00327	0.02710	1.9709e+15	0.02457	0.07392	0.88906	0.00085	0.01161	2.0041e-08
11	1.001	2.5059e+15	0.02699	0.00581	0.43456	0.38838	0.10421	0.00326	0.02699	1.9648e+15	0.02457	0.07415	0.88882	0.00085	0.01161	2.0026e-08
12	1.017	2.5353e+15	0.02721	0.00577	0.43236	0.39145	0.10332	0.00326	0.02721	1.9952e+15	0.02437	0.07297	0.89026	0.00084	0.01156	2.0261e-08
13	0.989	2.4847e+15	0.02661	0.00581	0.43651	0.38677	0.10434	0.00325	0.02661	1.9414e+15	0.02457	0.07519	0.88778	0.00086	0.01160	1.9961e-08
14	0.971	2.4509e+15	0.02614	0.00582	0.43924	0.38393	0.10493	0.00323	0.02614	1.9056e+15	0.02466	0.07676	0.88610	0.00088	0.01160	1.9801e-08
15	1.012	2.5216e+15	0.02737	0.00581	0.43256	0.38995	0.10415	0.00328	0.02737	1.9851e+15	0.02456	0.07344	0.88954	0.00084	0.01162	2.0067e-08
16	1.027	2.5518e+15	0.02755	0.00578	0.43053	0.39287	0.10330	0.00328	0.02755	2.0150e+15	0.02436	0.07221	0.89103	0.00083	0.01157	2.0308e-08
17	1.005	2.5122e+15	0.02711	0.00581	0.43394	0.38887	0.10420	0.00327	0.02711	1.9719e+15	0.02457	0.07386	0.88912	0.00085	0.01161	2.0045e-08
18	1.003	2.5086e+15	0.02702	0.00581	0.43445	0.38849	0.10418	0.00326	0.02702	1.9672e+15	0.02457	0.07404	0.88893	0.00085	0.01161	2.0033e-08
19	1.018	2.5375e+15	0.02723	0.00577	0.43229	0.39153	0.10329	0.00327	0.02723	1.9972e+15	0.02437	0.07290	0.89034	0.00084	0.01157	2.0268e-08
20	0.990	2.4856e+15	0.02662	0.00581	0.43653	0.38676	0.10432	0.00325	0.02662	1.9420e+15	0.02457	0.07517	0.88779	0.00086	0.01160	1.9964e-08
21	0.971	2.4511e+15	0.02613	0.00582	0.43932	0.38387	0.10492	0.00323	0.02613	1.9055e+15	0.02466	0.07678	0.88608	0.00088	0.01160	1.9801e-08
22	1.028	2.5550e+15	0.02754	0.00578	0.43071	0.39283	0.10319	0.00328	0.02754	2.0166e+15	0.02436	0.07208	0.89115	0.00083	0.01158	2.0320e-08
23	1.027	2.5542e+15	0.02751	0.00578	0.43099	0.39268	0.10310	0.00328	0.02751	2.0151e+15	0.02436	0.07215	0.89108	0.00083	0.01157	2.0319e-08
24	1.008	2.5206e+15	0.02694	0.00577	0.43383	0.39020	0.10343	0.00325	0.02694	1.9784e+15	0.02438	0.07372	0.88950	0.00085	0.01156	2.0215e-08
25	0.972	2.4530e+15	0.02614	0.00582	0.43931	0.38395	0.10485	0.00323	0.02614	1.9070e+15	0.02465	0.07673	0.88613	0.00088	0.01160	1.9812e-08
26	1.020	2.5413e+15	0.02746	0.00580	0.43207	0.39104	0.10357	0.00328	0.02746	2.0014e+15	0.02449	0.07265	0.89042	0.00083	0.01161	2.0183e-08
27	1.036	2.5715e+15	0.02770	0.00577	0.42987	0.39405	0.10270	0.00328	0.02770	2.0328e+15	0.02430	0.07148	0.89183	0.00082	0.01157	2.0412e-08
28	1.028	2.5567e+15	0.02744	0.00577	0.43112	0.39299	0.10282	0.00327	0.02744	2.0167e+15	0.02430	0.07216	0.89115	0.00083	0.01156	2.0371e-08
29	0.988	2.4829e+15	0.02654	0.00581	0.43705	0.38638	0.10428	0.00324	0.02654	1.9382e+15	0.02458	0.07539	0.88757	0.00086	0.01160	1.9956e-08
30	0.968	2.4465e+15	0.02602	0.00582	0.44000	0.38334	0.10490	0.00323	0.02602	1.8996e+15	0.02466	0.07710	0.88575	0.00088	0.01160	1.9787e-08
31	1.014	2.5312e+15	0.02708	0.00577	0.43326	0.39081	0.10323	0.00326	0.02708	1.9890e+15	0.02437	0.07331	0.88992	0.00084	0.01156	2.0252e-08
32	0.973	2.4566e+15	0.02617	0.00582	0.43934	0.38403	0.10471	0.00323	0.02617	1.9099e+15	0.02465	0.07666	0.88621	0.00088	0.01160	1.9825e-08
33	0.963	2.4370e+15	0.02585	0.00582	0.44097	0.38253	0.10496	0.00322	0.02585	1.8890e+15	0.02467	0.07763	0.88521	0.00089	0.01159	1.9755e-08
34	0.983	2.4756e+15	0.02640	0.00581	0.43787	0.38569	0.10431	0.00324	0.02640	1.9297e+15	0.02458	0.07581	0.88715	0.00087	0.01159	1.9931e-08
35	0.964	2.4404e+15	0.02589	0.00582	0.44082	0.38272	0.10486	0.00322	0.02589	1.8923e+15	0.02466	0.07751	0.88535	0.00089	0.01159	1.9768e-08
36	0.958	2.4288e+15	0.02569	0.00582	0.44184	0.38184	0.10497	0.00321	0.02569	1.8799e+15	0.02467	0.07811	0.88474	0.00090	0.01159	1.9729e-08
37	0.958	2.4284e+15	0.02568	0.00582	0.44195	0.38177	0.10495	0.00321	0.02568	1.8793e+15	0.02467	0.07815	0.88469	0.00090	0.01159	1.9728e-08
38	0.955	2.4228e+15	0.02558	0.00581	0.44249	0.38133	0.10497	0.00321	0.02558	1.8732e+15	0.02467	0.07847	0.88438	0.00090	0.01158	1.9711e-08
39	0.953	2.4196e+15	0.02552	0.00581	0.44284	0.38106	0.10496	0.00320	0.02552	1.8696e+15	0.02467	0.07866	0.88419	0.00090	0.01158	1.9701e-08
Assembly total[c]		6.6479e+17	0.02673	0.00576	0.43232	0.38626	0.10338	0.00324	0.02673	5.1803e+17	0.02451	0.07439	0.88866	0.00085	0.01159	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.30. VENTURE multiplication factors and total fuel pin reaction rate results for PWR MOX benchmark multicycle case

Burnup			Total capture	Fraction of total capture rate							Total fission	Fraction of total fission rate				
(MWd/kg)	k_{eff}	k_0[a]	rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
0.0	1.17601	1.18088	6.8325e+17	0.02544	0.00563	0.42737	0.37670	0.09248	0.00314	0.02544	5.1783e+17	0.02436	0.07591	0.88733	0.00087	0.01154
1.5	1.15383	1.15861	7.1639e+17	0.02456	0.00534	0.41452	0.35525	0.11139	0.00461	0.04116	5.1669e+17	0.02432	0.07726	0.87949	0.00111	0.01782
3.0	1.14117	1.14589	7.3522e+17	0.02447	0.00515	0.40831	0.34307	0.12025	0.00622	0.04955	5.1634e+17	0.02415	0.07802	0.87176	0.00134	0.02469
4.5	1.13043	1.13510	7.5169e+17	0.02433	0.00498	0.40320	0.33237	0.12771	0.00790	0.05635	5.1605e+17	0.02398	0.07867	0.86368	0.00155	0.03206
6.0	1.12048	1.12512	7.6716e+17	0.02422	0.00482	0.39867	0.32243	0.13410	0.00961	0.06264	5.1579e+17	0.02380	0.07927	0.85526	0.00176	0.03983
7.5	1.11101	1.11560	7.8196e+17	0.02413	0.00467	0.39456	0.31304	0.13966	0.01135	0.06859	5.1554e+17	0.02360	0.07986	0.84653	0.00195	0.04793
9.0	1.10181	1.10637	7.9631e+17	0.02405	0.00453	0.39082	0.30408	0.14455	0.01309	0.07426	5.1530e+17	0.02340	0.08042	0.83755	0.00214	0.05632
10.5	1.09281	1.09733	8.1032e+17	0.02399	0.00439	0.38738	0.29549	0.14889	0.01483	0.07968	5.1507e+17	0.02318	0.08098	0.82835	0.00232	0.06494
12.0	1.08397	1.08845	8.2402e+17	0.02392	0.00426	0.38419	0.28723	0.15275	0.01656	0.08488	5.1485e+17	0.02296	0.08154	0.81896	0.00249	0.07375
13.5	1.07521	1.07966	8.3752e+17	0.02387	0.00413	0.38123	0.27927	0.15620	0.01827	0.08987	5.1463e+17	0.02272	0.08210	0.80944	0.00265	0.08272
15.0	1.06654	1.07095	8.5085e+17	0.02381	0.00400	0.37847	0.27158	0.15928	0.01995	0.09468	5.1443e+17	0.02248	0.08267	0.79981	0.00280	0.09179
15.0	1.09013	1.09455	8.3456e+17	0.02468	0.00401	0.37104	0.27694	0.15868	0.02042	0.09579	5.1468e+17	0.02246	0.07992	0.80241	0.00269	0.09207
16.5	1.08055	1.08493	8.4735e+17	0.02475	0.00389	0.36882	0.26883	0.16199	0.02203	0.10022	5.1341e+17	0.02225	0.08070	0.79258	0.00285	0.10107
18.0	1.06811	1.07244	8.6241e+17	0.02451	0.00377	0.36678	0.26140	0.16445	0.02365	0.10451	5.1428e+17	0.02202	0.08137	0.78278	0.00299	0.11021
19.5	1.05745	1.06173	8.7631e+17	0.02442	0.00366	0.36477	0.25397	0.16684	0.02522	0.10886	5.1407e+17	0.02178	0.08209	0.77287	0.00312	0.11939
21.0	1.04709	1.05133	8.9009e+17	0.02433	0.00355	0.36285	0.24681	0.16894	0.02674	0.11310	5.1388e+17	0.02152	0.08279	0.76296	0.00325	0.12860
22.5	1.03704	1.04124	9.0375e+17	0.02425	0.00344	0.36103	0.23991	0.17077	0.02822	0.11723	5.1369e+17	0.02125	0.08349	0.75307	0.00337	0.13780
24.0	1.02727	1.03143	9.1728e+17	0.02417	0.00333	0.35928	0.23326	0.17234	0.02965	0.12127	5.1351e+17	0.02097	0.08417	0.74325	0.00348	0.14696
25.5	1.01776	1.02189	9.3070e+17	0.02409	0.00322	0.35762	0.22687	0.17368	0.03103	0.12521	5.1335e+17	0.02068	0.08485	0.73353	0.00359	0.15604
27.0	1.00853	1.01262	9.4401e+17	0.02401	0.00312	0.35602	0.22072	0.17479	0.03235	0.12907	5.1319e+17	0.02038	0.08552	0.72394	0.00368	0.16500
28.5	0.99953	1.00358	9.5722e+17	0.02393	0.00302	0.35449	0.21482	0.17569	0.03360	0.13286	5.1304e+17	0.02006	0.08617	0.71452	0.00377	0.17381
30.0	0.99077	0.99479	9.7032e+17	0.02385	0.00292	0.35302	0.20916	0.17639	0.03480	0.13656	5.1290e+17	0.01974	0.08682	0.70530	0.00385	0.18244
31.5	0.98225	0.98623	9.8331e+17	0.02377	0.00282	0.35160	0.20373	0.17691	0.03593	0.14019	5.1277e+17	0.01940	0.08746	0.69630	0.00392	0.19086
33.0	0.97395	0.97789	9.9619e+17	0.02369	0.00272	0.35024	0.19855	0.17724	0.03699	0.14375	5.1264e+17	0.01905	0.08809	0.68756	0.00399	0.19905
34.5	0.96587	0.96978	1.0090e+18	0.02362	0.00263	0.34894	0.19360	0.17740	0.03798	0.14724	5.1253e+17	0.01869	0.08871	0.67909	0.00404	0.20697
36.0	0.95800	0.96188	1.0216e+18	0.02354	0.00254	0.34768	0.18888	0.17740	0.03889	0.15066	5.1243e+17	0.01832	0.08932	0.67092	0.00410	0.21460
37.5	0.95035	0.95420	1.0341e+18	0.02346	0.00245	0.34647	0.18439	0.17725	0.03974	0.15402	5.1234e+17	0.01795	0.08992	0.66308	0.00414	0.22192
39.0	0.94291	0.94672	1.0465e+18	0.02339	0.00236	0.34530	0.18012	0.17696	0.04051	0.15732	5.1226e+17	0.01756	0.09051	0.65558	0.00418	0.22891
40.5	0.93567	0.93946	1.0588e+18	0.02332	0.00227	0.34417	0.17608	0.17654	0.04121	0.16055	5.1220e+17	0.01717	0.09109	0.64844	0.00421	0.23555
42.0	0.92831	0.93207	1.0717e+18	0.02300	0.00219	0.34303	0.17240	0.17600	0.04188	0.16352	5.1294e+17	0.01677	0.09155	0.64174	0.00423	0.24187
43.5	0.92161	0.92534	1.0830e+18	0.02292	0.00210	0.34208	0.16871	0.17536	0.04241	0.16662	5.1240e+17	0.01636	0.09218	0.63532	0.00425	0.24773
45.0	0.91510	0.91880	1.0949e+18	0.02313	0.00202	0.34091	0.16507	0.17423	0.04288	0.17010	5.1204e+17	0.01597	0.09277	0.62912	0.00426	0.25339

[a]Ratio of total production to total absorption.

Table 4.31. VENTURE results for PWR MOX benchmark multicycle depletion at BOC 1 (0.0 MWd/kg)

Total production/total absorption = 1.18088
Multiplication factor (k_{eff}) = 1.17601

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.102	2.7577e+15	0.02854	0.00560	0.41028	0.39138	0.09041	0.00325	0.02854	2.1619e+15	0.02415	0.06880	0.89472	0.00079	0.01154	2.0759e-08
2	1.043	2.6635e+15	0.02666	0.00561	0.42010	0.38325	0.09163	0.00318	0.02666	2.0465e+15	0.02421	0.07262	0.89081	0.00083	0.01153	2.0516e-08
3	1.024	2.6329e+15	0.02598	0.00561	0.42357	0.38063	0.09190	0.00315	0.02598	2.0087e+15	0.02421	0.07388	0.88955	0.00084	0.01152	2.0457e-08
4	1.021	2.6272e+15	0.02587	0.00561	0.42425	0.38012	0.09189	0.00315	0.02587	2.0019e+15	0.02421	0.07414	0.88928	0.00085	0.01152	2.0437e-08
5	1.008	2.6038e+15	0.02549	0.00561	0.42626	0.37849	0.09203	0.00313	0.02549	1.9770e+15	0.02422	0.07522	0.88819	0.00086	0.01151	2.0368e-08
6	0.973	2.5366e+15	0.02476	0.00565	0.43145	0.37250	0.09326	0.00311	0.02476	1.9080e+15	0.02450	0.07818	0.88487	0.00089	0.01155	1.9970e-08
7	1.047	2.6630e+15	0.02711	0.00564	0.41883	0.38301	0.09196	0.00320	0.02711	2.0532e+15	0.02440	0.07251	0.89068	0.00083	0.01158	2.0352e-08
8	1.018	2.6177e+15	0.02614	0.00564	0.42380	0.37901	0.09252	0.00317	0.02614	1.9976e+15	0.02441	0.07447	0.88870	0.00085	0.01157	2.0246e-08
9	1.028	2.6395e+15	0.02612	0.00561	0.42281	0.38119	0.09187	0.00316	0.02612	2.0167e+15	0.02421	0.07361	0.88982	0.00084	0.01152	2.0471e-08
10	1.004	2.5953e+15	0.02563	0.00564	0.42648	0.37699	0.09270	0.00315	0.02563	1.9696e+15	0.02442	0.07544	0.88772	0.00086	0.01156	2.0198e-08
11	1.001	2.5905e+15	0.02553	0.00564	0.42709	0.37655	0.09269	0.00314	0.02553	1.9638e+15	0.02442	0.07567	0.88749	0.00086	0.01156	2.0183e-08
12	1.017	2.6209e+15	0.02575	0.00561	0.42493	0.37963	0.09189	0.00314	0.02575	1.9948e+15	0.02421	0.07445	0.88897	0.00085	0.01151	2.0421e-08
13	0.990	2.5689e+15	0.02518	0.00564	0.42899	0.37503	0.09279	0.00313	0.02518	1.9409e+15	0.02442	0.07671	0.88644	0.00088	0.01155	2.0119e-08
14	0.971	2.5341e+15	0.02473	0.00565	0.43167	0.37228	0.09331	0.00311	0.02473	1.9054e+15	0.02451	0.07831	0.88474	0.00089	0.01155	1.9958e-08
15	1.011	2.6060e+15	0.02587	0.00564	0.42517	0.37796	0.09264	0.00316	0.02587	1.9829e+15	0.02441	0.07498	0.88819	0.00086	0.01156	2.0223e-08
16	1.027	2.6375e+15	0.02606	0.00561	0.42315	0.38094	0.09189	0.00316	0.02606	2.0138e+15	0.02421	0.07369	0.88974	0.00084	0.01152	2.0467e-08
17	1.005	2.5968e+15	0.02564	0.00564	0.42649	0.37700	0.09268	0.00315	0.02564	1.9707e+15	0.02442	0.07537	0.88779	0.00086	0.01156	2.0202e-08
18	1.002	2.5932e+15	0.02557	0.00564	0.42698	0.37665	0.09266	0.00314	0.02557	1.9662e+15	0.02442	0.07556	0.88760	0.00086	0.01156	2.0190e-08
19	1.018	2.6232e+15	0.02577	0.00561	0.42486	0.37970	0.09186	0.00315	0.02577	1.9967e+15	0.02421	0.07437	0.88905	0.00085	0.01151	2.0428e-08
20	0.990	2.5698e+15	0.02518	0.00564	0.42901	0.37502	0.09277	0.00313	0.02518	1.9416e+15	0.02443	0.07669	0.88646	0.00088	0.01155	2.0122e-08
21	0.971	2.5343e+15	0.02472	0.00565	0.43174	0.37223	0.09329	0.00311	0.02472	1.9053e+15	0.02451	0.07832	0.88472	0.00089	0.01155	1.9959e-08
22	1.028	2.6410e+15	0.02606	0.00561	0.42332	0.38092	0.09178	0.00316	0.02606	2.0157e+15	0.02421	0.07355	0.88987	0.00084	0.01152	2.0479e-08
23	1.027	2.6403e+15	0.02603	0.00561	0.42358	0.38080	0.09171	0.00315	0.02603	2.0143e+15	0.02421	0.07362	0.88981	0.00084	0.01152	2.0479e-08
24	1.009	2.6059e+15	0.02550	0.00561	0.42636	0.37845	0.09198	0.00313	0.02550	1.9783e+15	0.02422	0.07520	0.88821	0.00086	0.01151	2.0375e-08
25	0.972	2.5363e+15	0.02473	0.00565	0.43173	0.37230	0.09323	0.00311	0.02473	1.9068e+15	0.02451	0.07828	0.88477	0.00089	0.01155	1.9969e-08
26	1.020	2.6269e+15	0.02598	0.00563	0.42465	0.37913	0.09213	0.00316	0.02598	2.0003e+15	0.02434	0.07414	0.88912	0.00085	0.01156	2.0341e-08
27	1.036	2.6582e+15	0.02621	0.00560	0.42248	0.38214	0.09135	0.00316	0.02621	2.0322e+15	0.02415	0.07293	0.89057	0.00083	0.01151	2.0573e-08
28	1.028	2.6432e+15	0.02598	0.00560	0.42371	0.38114	0.09145	0.00315	0.02598	2.0163e+15	0.02415	0.07362	0.88988	0.00084	0.01151	2.0531e-08
29	0.988	2.5671e+15	0.02512	0.00564	0.42952	0.37466	0.09273	0.00312	0.02512	1.9379e+15	0.02443	0.07691	0.88624	0.00088	0.01155	2.0114e-08
30	0.968	2.5297e+15	0.02462	0.00565	0.43241	0.37173	0.09327	0.00311	0.02462	1.8996e+15	0.02451	0.07865	0.88439	0.00090	0.01155	1.9945e-08
31	1.014	2.6169e+15	0.02563	0.00561	0.42580	0.37903	0.09181	0.00314	0.02563	1.9888e+15	0.02422	0.07478	0.88863	0.00086	0.01151	2.0413e-08
32	0.974	2.5401e+15	0.02476	0.00565	0.43176	0.37238	0.09311	0.00311	0.02476	1.9098e+15	0.02450	0.07820	0.88485	0.00089	0.01155	1.9983e-08
33	0.963	2.5199e+15	0.02446	0.00565	0.43336	0.37095	0.09332	0.00310	0.02446	1.8892e+15	0.02452	0.07918	0.88385	0.00091	0.01154	1.9913e-08
34	0.984	2.5597e+15	0.02498	0.00564	0.43032	0.37401	0.09276	0.00312	0.02498	1.9296e+15	0.02443	0.07733	0.88581	0.00088	0.01154	2.0090e-08
35	0.965	2.5235e+15	0.02450	0.00565	0.43321	0.37114	0.09324	0.00310	0.02450	1.8925e+15	0.02452	0.07905	0.88398	0.00090	0.01154	1.9926e-08
36	0.959	2.5116e+15	0.02431	0.00565	0.43420	0.37030	0.09333	0.00309	0.02431	1.8803e+15	0.02452	0.07966	0.88337	0.00091	0.01154	1.9888e-08
37	0.958	2.5112e+15	0.02430	0.00565	0.43430	0.37024	0.09330	0.00309	0.02430	1.8797e+15	0.02452	0.07971	0.88332	0.00091	0.01154	1.9886e-08
38	0.955	2.5055e+15	0.02421	0.00565	0.43484	0.36982	0.09332	0.00309	0.02421	1.8737e+15	0.02452	0.08002	0.88301	0.00091	0.01153	1.9869e-08
39	0.954	2.5023e+15	0.02415	0.00565	0.43518	0.36957	0.09331	0.00309	0.02415	1.8703e+15	0.02452	0.08021	0.88282	0.00092	0.01153	1.9859e-08
Assembly total[c]		6.8325e+17	0.02544	0.00563	0.42737	0.37670	0.09248	0.00314	0.02544	5.1783e+17	0.02436	0.07591	0.88733	0.00087	0.01154	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.32. VENTURE results for PWR MOX benchmark multicycle depletion at MOC 1 (7.5 MWd/kg)

Total production/total absorption = 1.11560
Multiplication factor (k_{eff}) = 1.11101

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.075	3.1509e+15	0.02627	0.00460	0.37951	0.31627	0.14475	0.01223	0.07318	2.0997e+15	0.02368	0.07420	0.84905	0.00191	0.05102	1.9187e-08
2	1.044	3.0703e+15	0.02533	0.00463	0.38604	0.31573	0.14209	0.01180	0.07098	2.0392e+15	0.02359	0.07639	0.84854	0.00192	0.04943	1.9230e-08
3	1.031	3.0397e+15	0.02489	0.00464	0.38876	0.31530	0.14125	0.01163	0.07007	2.0141e+15	0.02355	0.07727	0.84827	0.00192	0.04886	1.9257e-08
4	1.027	3.0301e+15	0.02476	0.00464	0.38963	0.31504	0.14101	0.01159	0.06983	2.0059e+15	0.02354	0.07758	0.84812	0.00193	0.04871	1.9253e-08
5	1.009	2.9875e+15	0.02424	0.00465	0.39288	0.31404	0.14024	0.01140	0.06884	1.9712e+15	0.02351	0.07904	0.84727	0.00195	0.04811	1.9228e-08
6	0.968	2.8806e+15	0.02329	0.00470	0.40062	0.31085	0.13800	0.01103	0.06693	1.8897e+15	0.02365	0.08268	0.84469	0.00198	0.04688	1.8967e-08
7	1.036	3.0467e+15	0.02536	0.00466	0.38695	0.31452	0.14186	0.01180	0.07108	2.0232e+15	0.02373	0.07711	0.84764	0.00193	0.04946	1.9051e-08
8	1.020	3.0064e+15	0.02483	0.00467	0.39043	0.31407	0.14061	0.01158	0.06991	1.9917e+15	0.02368	0.07830	0.84728	0.00193	0.04868	1.9076e-08
9	1.035	3.0478e+15	0.02501	0.00464	0.38803	0.31546	0.14145	0.01168	0.07030	2.0210e+15	0.02356	0.07703	0.84836	0.00192	0.04900	1.9253e-08
10	1.010	2.9835e+15	0.02449	0.00468	0.39260	0.31366	0.13997	0.01145	0.06921	1.9725e+15	0.02365	0.07900	0.84704	0.00194	0.04825	1.9092e-08
11	1.007	2.9754e+15	0.02438	0.00468	0.39337	0.31343	0.13977	0.01141	0.06899	1.9655e+15	0.02365	0.07927	0.84690	0.00194	0.04812	1.9089e-08
12	1.022	3.0185e+15	0.02461	0.00465	0.39061	0.31475	0.14078	0.01153	0.06953	1.9961e+15	0.02353	0.07798	0.84791	0.00193	0.04853	1.9250e-08
13	0.990	2.9354e+15	0.02387	0.00468	0.39653	0.31241	0.13904	0.01124	0.06804	1.9327e+15	0.02362	0.08071	0.84603	0.00196	0.04756	1.9061e-08
14	0.966	2.8761e+15	0.02324	0.00471	0.40097	0.31070	0.13791	0.01101	0.06684	1.8862e+15	0.02365	0.08285	0.84458	0.00198	0.04683	1.8958e-08
15	1.015	2.9958e+15	0.02467	0.00467	0.39142	0.31392	0.14030	0.01152	0.06958	1.9830e+15	0.02367	0.07862	0.84719	0.00193	0.04847	1.9087e-08
16	1.034	3.0471e+15	0.02498	0.00464	0.38819	0.31544	0.14139	0.01167	0.07025	2.0201e+15	0.02355	0.07704	0.84839	0.00192	0.04897	1.9258e-08
17	1.011	2.9870e+15	0.02452	0.00468	0.39242	0.31372	0.14000	0.01146	0.06927	1.9752e+15	0.02366	0.07887	0.84713	0.00193	0.04829	1.9095e-08
18	1.009	2.9805e+15	0.02443	0.00468	0.39305	0.31353	0.13984	0.01143	0.06910	1.9695e+15	0.02365	0.07909	0.84701	0.00194	0.04818	1.9093e-08
19	1.024	3.0227e+15	0.02465	0.00465	0.39038	0.31483	0.14083	0.01154	0.06961	1.9992e+15	0.02353	0.07784	0.84799	0.00193	0.04858	1.9254e-08
20	0.990	2.9369e+15	0.02388	0.00468	0.39649	0.31242	0.13905	0.01124	0.06807	1.9337e+15	0.02362	0.08066	0.84606	0.00196	0.04757	1.9064e-08
21	0.966	2.8761e+15	0.02323	0.00471	0.40104	0.31068	0.13789	0.01101	0.06683	1.8859e+15	0.02365	0.08286	0.84457	0.00198	0.04682	1.8959e-08
22	1.038	3.0558e+15	0.02506	0.00464	0.38786	0.31559	0.14143	0.01169	0.07038	2.0263e+15	0.02356	0.07673	0.84862	0.00192	0.04905	1.9270e-08
23	1.036	3.0535e+15	0.02501	0.00464	0.38818	0.31550	0.14133	0.01167	0.07030	2.0240e+15	0.02355	0.07681	0.84860	0.00192	0.04899	1.9272e-08
24	1.010	2.9905e+15	0.02426	0.00465	0.39284	0.31405	0.14024	0.01141	0.06887	1.9731e+15	0.02351	0.07896	0.84733	0.00195	0.04813	1.9233e-08
25	0.967	2.8786e+15	0.02325	0.00470	0.40095	0.31072	0.13791	0.01102	0.06686	1.8876e+15	0.02364	0.08278	0.84463	0.00198	0.04684	1.8966e-08
26	1.031	3.0376e+15	0.02499	0.00466	0.38917	0.31492	0.14087	0.01164	0.07019	2.0135e+15	0.02363	0.07722	0.84823	0.00192	0.04888	1.9180e-08
27	1.047	3.0820e+15	0.02525	0.00463	0.38643	0.31615	0.14187	0.01176	0.07077	2.0451e+15	0.02353	0.07596	0.84917	0.00191	0.04932	1.9328e-08
28	1.036	3.0538e+15	0.02491	0.00463	0.38848	0.31554	0.14138	0.01164	0.07014	2.0223e+15	0.02351	0.07688	0.84863	0.00192	0.04893	1.9315e-08
29	0.987	2.9305e+15	0.02379	0.00469	0.39718	0.31219	0.13887	0.01121	0.06789	1.9280e+15	0.02362	0.08092	0.84591	0.00196	0.04747	1.9060e-08
30	0.961	2.8659e+15	0.02309	0.00471	0.40206	0.31031	0.13765	0.01096	0.06656	1.8770e+15	0.02364	0.08328	0.84430	0.00199	0.04667	1.8951e-08
31	1.018	3.0094e+15	0.02446	0.00465	0.39166	0.31445	0.14049	0.01148	0.06926	1.9877e+15	0.02352	0.07833	0.84773	0.00194	0.04836	1.9252e-08
32	0.969	2.8839e+15	0.02329	0.00470	0.40077	0.31080	0.13792	0.01103	0.06694	1.8913e+15	0.02364	0.08261	0.84476	0.00198	0.04689	1.8975e-08
33	0.953	2.8471e+15	0.02284	0.00471	0.40367	0.30973	0.13729	0.01088	0.06610	1.8615e+15	0.02363	0.08404	0.84380	0.00200	0.04641	1.8931e-08
34	0.981	2.9160e+15	0.02360	0.00469	0.39843	0.31176	0.13857	0.01114	0.06754	1.9159e+15	0.02361	0.08148	0.84556	0.00197	0.04726	1.9047e-08
35	0.956	2.8530e+15	0.02290	0.00471	0.40330	0.30989	0.13735	0.01090	0.06622	1.8660e+15	0.02363	0.08382	0.84396	0.00200	0.04647	1.8940e-08
36	0.946	2.8308e+15	0.02262	0.00472	0.40512	0.30923	0.13697	0.01080	0.06569	1.8478e+15	0.02362	0.08471	0.84336	0.00201	0.04617	1.8916e-08
37	0.946	2.8298e+15	0.02260	0.00472	0.40525	0.30919	0.13692	0.01080	0.06566	1.8469e+15	0.02362	0.08476	0.84334	0.00201	0.04615	1.8915e-08
38	0.941	2.8187e+15	0.02245	0.00472	0.40620	0.30886	0.13672	0.01075	0.06538	1.8377e+15	0.02362	0.08522	0.84303	0.00202	0.04599	1.8905e-08
39	0.938	2.8124e+15	0.02236	0.00472	0.40678	0.30866	0.13658	0.01072	0.06522	1.8325e+15	0.02361	0.08548	0.84286	0.00202	0.04590	1.8898e-08
Assembly total[c]		7.8196e+17	0.02413	0.00467	0.39456	0.31304	0.13966	0.01135	0.06859	5.1554e+17	0.02360	0.07986	0.84653	0.00195	0.04793	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.33. VENTURE results for PWR MOX benchmark multicycle depletion at EOC 1 (15.0 MWd/kg)

Total production/total absorption = 1.07095
Multiplication factor (k_{eff}) = 1.06654

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.056	3.4114e+15	0.02544	0.00392	0.36599	0.26879	0.16574	0.02164	0.09987	2.0570e+15	0.02271	0.07820	0.79618	0.00279	0.09963	1.7668e-08
2	1.042	3.3497e+15	0.02496	0.00396	0.36998	0.27135	0.16282	0.02095	0.09777	2.0295e+15	0.02258	0.07928	0.79886	0.00277	0.09605	1.7855e-08
3	1.033	3.3211e+15	0.02465	0.00397	0.37210	0.27195	0.16183	0.02065	0.09680	2.0124e+15	0.02252	0.07992	0.79963	0.00277	0.09470	1.7939e-08
4	1.028	3.3085e+15	0.02451	0.00397	0.37305	0.27192	0.16151	0.02055	0.09646	2.0036e+15	0.02250	0.08026	0.79973	0.00277	0.09427	1.7955e-08
5	1.009	3.2521e+15	0.02391	0.00398	0.37684	0.27178	0.16031	0.02012	0.09504	1.9652e+15	0.02243	0.08192	0.79986	0.00280	0.09253	1.8009e-08
6	0.968	3.1245e+15	0.02294	0.00404	0.38494	0.27151	0.15656	0.01921	0.09241	1.8865e+15	0.02243	0.08557	0.80013	0.00284	0.08859	1.7942e-08
7	1.030	3.3118e+15	0.02484	0.00397	0.37173	0.27065	0.16191	0.02079	0.09755	2.0061e+15	0.02265	0.08031	0.79838	0.00278	0.09541	1.7729e-08
8	1.021	3.2795e+15	0.02455	0.00399	0.37401	0.27175	0.16049	0.02044	0.09642	1.9899e+15	0.02258	0.08096	0.79956	0.00278	0.09365	1.7825e-08
9	1.036	3.3302e+15	0.02476	0.00397	0.37140	0.27188	0.16208	0.02074	0.09708	2.0186e+15	0.02253	0.07968	0.79949	0.00277	0.09506	1.7918e-08
10	1.014	3.2574e+15	0.02429	0.00400	0.37576	0.27210	0.15973	0.02021	0.09565	1.9761e+15	0.02254	0.08149	0.80010	0.00278	0.09265	1.7886e-08
11	1.010	3.2466e+15	0.02416	0.00400	0.37662	0.27205	0.15947	0.02012	0.09535	1.9683e+15	0.02252	0.08180	0.80016	0.00278	0.09228	1.7900e-08
12	1.022	3.2927e+15	0.02432	0.00397	0.37420	0.27187	0.16118	0.02042	0.09603	1.9924e+15	0.02247	0.08072	0.79979	0.00278	0.09377	1.7976e-08
13	0.991	3.1930e+15	0.02357	0.00402	0.38038	0.27179	0.15833	0.01970	0.09397	1.9311e+15	0.02246	0.08346	0.80016	0.00281	0.09066	1.7944e-08
14	0.966	3.1189e+15	0.02289	0.00404	0.38534	0.27147	0.15641	0.01917	0.09228	1.8828e+15	0.02243	0.08575	0.80012	0.00284	0.08843	1.7941e-08
15	1.019	3.2707e+15	0.02445	0.00400	0.37469	0.27200	0.16013	0.02034	0.09609	1.9850e+15	0.02256	0.08115	0.79986	0.00277	0.09319	1.7855e-08
16	1.036	3.3308e+15	0.02475	0.00397	0.37145	0.27195	0.16203	0.02073	0.09705	2.0191e+15	0.02253	0.07965	0.79958	0.00276	0.09502	1.7926e-08
17	1.016	3.2624e+15	0.02433	0.00400	0.37549	0.27213	0.15980	0.02024	0.09576	1.9794e+15	0.02254	0.08133	0.80013	0.00277	0.09277	1.7884e-08
18	1.012	3.2535e+15	0.02422	0.00400	0.37623	0.27207	0.15959	0.02016	0.09550	1.9728e+15	0.02253	0.08159	0.80018	0.00278	0.09247	1.7895e-08
19	1.024	3.2980e+15	0.02437	0.00397	0.37391	0.27187	0.16127	0.02045	0.09615	1.9958e+15	0.02248	0.08057	0.79980	0.00278	0.09392	1.7974e-08
20	0.992	3.1947e+15	0.02358	0.00401	0.38031	0.27179	0.15835	0.01971	0.09400	1.9321e+15	0.02246	0.08341	0.80017	0.00281	0.09070	1.7945e-08
21	0.966	3.1186e+15	0.02288	0.00404	0.38541	0.27145	0.15639	0.01917	0.09226	1.8825e+15	0.02243	0.08576	0.80012	0.00284	0.08841	1.7942e-08
22	1.040	3.3424e+15	0.02484	0.00396	0.37095	0.27197	0.16220	0.02079	0.09726	2.0263e+15	0.02254	0.07929	0.79967	0.00276	0.09528	1.7926e-08
23	1.038	3.3383e+15	0.02477	0.00396	0.37137	0.27191	0.16211	0.02075	0.09712	2.0227e+15	0.02253	0.07941	0.79970	0.00276	0.09514	1.7935e-08
24	1.009	3.2555e+15	0.02393	0.00398	0.37676	0.27176	0.16035	0.02013	0.09509	1.9670e+15	0.02243	0.08182	0.79989	0.00280	0.09261	1.8011e-08
25	0.967	3.1212e+15	0.02289	0.00404	0.38532	0.27144	0.15646	0.01918	0.09230	1.8837e+15	0.02242	0.08569	0.80013	0.00284	0.08848	1.7947e-08
26	1.035	3.3237e+15	0.02480	0.00398	0.37201	0.27207	0.16135	0.02066	0.09701	2.0170e+15	0.02257	0.07965	0.79995	0.00276	0.09461	1.7882e-08
27	1.048	3.3714e+15	0.02499	0.00395	0.36960	0.27177	0.16303	0.02097	0.09775	2.0419e+15	0.02253	0.07859	0.79949	0.00276	0.09617	1.7940e-08
28	1.035	3.3341e+15	0.02461	0.00396	0.37198	0.27175	0.16226	0.02069	0.09684	2.0169e+15	0.02249	0.07963	0.79962	0.00277	0.09503	1.7980e-08
29	0.988	3.1853e+15	0.02346	0.00402	0.38112	0.27170	0.15811	0.01963	0.09374	1.9251e+15	0.02245	0.08371	0.80019	0.00282	0.09039	1.7953e-08
30	0.961	3.1041e+15	0.02270	0.00405	0.38663	0.27128	0.15605	0.01904	0.09186	1.8717e+15	0.02241	0.08626	0.80008	0.00285	0.08796	1.7953e-08
31	1.017	3.2790e+15	0.02414	0.00398	0.37539	0.27178	0.16083	0.02029	0.09562	1.9821e+15	0.02245	0.08113	0.79988	0.00279	0.09329	1.7998e-08
32	0.968	3.1269e+15	0.02293	0.00404	0.38511	0.27142	0.15655	0.01920	0.09240	1.8869e+15	0.02242	0.08551	0.80017	0.00284	0.08861	1.7948e-08
33	0.951	3.0786e+15	0.02240	0.00405	0.38858	0.27105	0.15547	0.01885	0.09118	1.8536e+15	0.02238	0.08714	0.79997	0.00286	0.08720	1.7964e-08
34	0.981	3.1657e+15	0.02324	0.00402	0.38259	0.27156	0.15765	0.01948	0.09322	1.9113e+15	0.02243	0.08434	0.80018	0.00283	0.08979	1.7967e-08
35	0.954	3.0857e+15	0.02247	0.00405	0.38815	0.27108	0.15562	0.01889	0.09134	1.8582e+15	0.02239	0.08690	0.80001	0.00286	0.08739	1.7965e-08
36	0.943	3.0561e+15	0.02212	0.00406	0.39036	0.27081	0.15497	0.01867	0.09057	1.8374e+15	0.02236	0.08795	0.79985	0.00288	0.08653	1.7977e-08
37	0.942	3.0544e+15	0.02210	0.00406	0.39053	0.27078	0.15493	0.01865	0.09051	1.8360e+15	0.02236	0.08801	0.79985	0.00288	0.08647	1.7978e-08
38	0.937	3.0393e+15	0.02191	0.00406	0.39171	0.27061	0.15461	0.01854	0.09010	1.8251e+15	0.02234	0.08856	0.79975	0.00289	0.08602	1.7985e-08
39	0.933	3.0305e+15	0.02180	0.00406	0.39243	0.27051	0.15441	0.01847	0.08985	1.8187e+15	0.02233	0.08889	0.79969	0.00289	0.08576	1.7989e-08
Assembly total[c]		8.5085e+17	0.02381	0.00400	0.37847	0.27158	0.15928	0.01995	0.09468	5.1443e+17	0.02248	0.08267	0.79981	0.00280	0.09179	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.34. VENTURE results for PWR MOX benchmark multicycle depletion at BOC 2 (15.0 MWd/kg)

Total production/total absorption = 1.09455
Multiplication factor (k_{eff}) = 1.09013

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.038	3.3104e+15	0.02581	0.00393	0.36126	0.27211	0.16543	0.02196	0.10041	2.0231e+15	0.02270	0.07708	0.79725	0.00273	0.09976	1.7353e-08
2	1.053	3.3105e+15	0.02610	0.00397	0.36117	0.27786	0.16198	0.02151	0.09909	2.0533e+15	0.02255	0.07596	0.80212	0.00264	0.09628	1.7629e-08
3	1.054	3.3019e+15	0.02606	0.00398	0.36188	0.27944	0.16083	0.02130	0.09845	2.0552e+15	0.02250	0.07585	0.80358	0.00261	0.09501	1.7728e-08
4	1.050	3.2892e+15	0.02592	0.00398	0.36282	0.27943	0.16051	0.02119	0.09812	2.0461e+15	0.02248	0.07615	0.80372	0.00262	0.09458	1.7743e-08
5	1.017	3.2078e+15	0.02499	0.00399	0.36823	0.27821	0.15952	0.02064	0.09631	1.9833e+15	0.02240	0.07853	0.80321	0.00267	0.09274	1.7770e-08
6	0.949	3.0251e+15	0.02325	0.00405	0.38039	0.27475	0.15634	0.01948	0.09291	1.8501e+15	0.02241	0.08440	0.80129	0.00278	0.08868	1.7591e-08
7	1.015	3.2191e+15	0.02530	0.00398	0.36651	0.27432	0.16157	0.02113	0.09820	1.9786e+15	0.02264	0.07894	0.79969	0.00272	0.09554	1.7415e-08
8	1.022	3.2178e+15	0.02542	0.00400	0.36662	0.27704	0.15988	0.02090	0.09752	1.9917e+15	0.02257	0.07843	0.80200	0.00267	0.09387	1.7549e-08
9	1.056	3.3086e+15	0.02613	0.00398	0.36137	0.27925	0.16110	0.02137	0.09869	2.0591e+15	0.02251	0.07573	0.80333	0.00261	0.09536	1.7707e-08
10	1.022	3.2112e+15	0.02537	0.00401	0.36725	0.27818	0.15901	0.02074	0.09702	1.9925e+15	0.02253	0.07835	0.80309	0.00265	0.09293	1.7622e-08
11	1.018	3.1996e+15	0.02523	0.00401	0.36816	0.27810	0.15875	0.02064	0.09670	1.9837e+15	0.02252	0.07865	0.80316	0.00266	0.09256	1.7633e-08
12	1.041	3.2671e+15	0.02566	0.00398	0.36435	0.27913	0.16022	0.02103	0.09760	2.0288e+15	0.02245	0.07675	0.80366	0.00263	0.09405	1.7757e-08
13	0.987	3.1235e+15	0.02432	0.00402	0.37351	0.27676	0.15780	0.02012	0.09496	1.9244e+15	0.02244	0.08104	0.80251	0.00271	0.09085	1.7647e-08
14	0.946	3.0170e+15	0.02315	0.00405	0.38100	0.27455	0.15622	0.01943	0.09274	1.8439e+15	0.02241	0.08468	0.80117	0.00279	0.08851	1.7585e-08
15	1.024	3.2188e+15	0.02545	0.00401	0.36660	0.27779	0.15945	0.02085	0.09735	1.9960e+15	0.02255	0.07825	0.80264	0.00266	0.09345	1.7588e-08
16	1.059	3.3139e+15	0.02620	0.00398	0.36108	0.27955	0.16101	0.02139	0.09873	2.0642e+15	0.02251	0.07552	0.80358	0.00260	0.09533	1.7719e-08
17	1.026	3.2204e+15	0.02548	0.00401	0.36668	0.27841	0.15904	0.02079	0.09719	1.9999e+15	0.02254	0.07803	0.80327	0.00264	0.09307	1.7624e-08
18	1.022	3.2101e+15	0.02535	0.00401	0.36749	0.27831	0.15883	0.02071	0.09692	1.9919e+15	0.02253	0.07829	0.80331	0.00265	0.09277	1.7633e-08
19	1.043	3.2746e+15	0.02573	0.00398	0.36392	0.27924	0.16030	0.02108	0.09775	2.0344e+15	0.02246	0.07651	0.80375	0.00262	0.09421	1.7756e-08
20	0.988	3.1257e+15	0.02434	0.00402	0.37340	0.27679	0.15781	0.02014	0.09500	1.9259e+15	0.02245	0.08094	0.80256	0.00271	0.09090	1.7647e-08
21	0.945	3.0164e+15	0.02314	0.00405	0.38109	0.27452	0.15620	0.01943	0.09272	1.8432e+15	0.02241	0.08468	0.80118	0.00279	0.08850	1.7585e-08
22	1.069	3.3383e+15	0.02645	0.00398	0.35975	0.28015	0.16106	0.02151	0.09914	2.0837e+15	0.02253	0.07471	0.80406	0.00258	0.09566	1.7727e-08
23	1.067	3.3351e+15	0.02641	0.00398	0.36009	0.28016	0.16093	0.02147	0.09903	2.0811e+15	0.02252	0.07475	0.80418	0.00258	0.09552	1.7735e-08
24	1.019	3.2122e+15	0.02503	0.00399	0.36807	0.27826	0.15953	0.02066	0.09638	1.9862e+15	0.02240	0.07833	0.80333	0.00267	0.09283	1.7771e-08
25	0.947	3.0201e+15	0.02317	0.00405	0.38090	0.27460	0.15623	0.01944	0.09277	1.8457e+15	0.02241	0.08451	0.80129	0.00278	0.08857	1.7590e-08
26	1.061	3.3139e+15	0.02637	0.00399	0.36110	0.27992	0.16026	0.02136	0.09890	2.0690e+15	0.02257	0.07522	0.80414	0.00259	0.09503	1.7659e-08
27	1.085	3.3846e+15	0.02682	0.00396	0.35736	0.28076	0.16169	0.02177	0.09986	2.1162e+15	0.02253	0.07339	0.80446	0.00256	0.09661	1.7756e-08
28	1.064	3.3291e+15	0.02622	0.00397	0.36081	0.28003	0.16106	0.02140	0.09869	2.0736e+15	0.02247	0.07489	0.80420	0.00259	0.09539	1.7781e-08
29	0.983	3.1127e+15	0.02418	0.00402	0.37446	0.27656	0.15756	0.02004	0.09468	1.9156e+15	0.02243	0.08128	0.80254	0.00272	0.09059	1.7647e-08
30	0.937	2.9958e+15	0.02286	0.00405	0.38282	0.27403	0.15588	0.01927	0.09220	1.8264e+15	0.02239	0.08536	0.80098	0.00280	0.08803	1.7581e-08
31	1.032	3.2471e+15	0.02541	0.00399	0.36592	0.27885	0.15987	0.02088	0.09710	2.0127e+15	0.02243	0.07718	0.80373	0.00264	0.09357	1.7767e-08
32	0.950	3.0290e+15	0.02327	0.00404	0.38043	0.27481	0.15625	0.01949	0.09294	1.8521e+15	0.02241	0.08409	0.80155	0.00278	0.08874	1.7593e-08
33	0.922	2.9596e+15	0.02239	0.00406	0.38570	0.27314	0.15539	0.01902	0.09132	1.7977e+15	0.02237	0.08668	0.80046	0.00283	0.08723	1.7570e-08
34	0.971	3.0841e+15	0.02383	0.00403	0.37662	0.27596	0.15717	0.01984	0.09402	1.8928e+15	0.02241	0.08219	0.80226	0.00274	0.08995	1.7645e-08
35	0.926	2.9699e+15	0.02251	0.00405	0.38499	0.27340	0.15548	0.01909	0.09154	1.8055e+15	0.02237	0.08624	0.80069	0.00282	0.08744	1.7575e-08
36	0.909	2.9277e+15	0.02196	0.00406	0.38833	0.27234	0.15497	0.01880	0.09051	1.7721e+15	0.02234	0.08787	0.79997	0.00286	0.08652	1.7562e-08
37	0.908	2.9255e+15	0.02192	0.00406	0.38855	0.27228	0.15492	0.01878	0.09045	1.7702e+15	0.02234	0.08794	0.79997	0.00286	0.08646	1.7561e-08
38	0.899	2.9042e+15	0.02163	0.00406	0.39032	0.27172	0.15465	0.01863	0.08990	1.7530e+15	0.02232	0.08878	0.79960	0.00288	0.08599	1.7555e-08
39	0.894	2.8919e+15	0.02146	0.00407	0.39138	0.27139	0.15447	0.01854	0.08958	1.7431e+15	0.02231	0.08925	0.79941	0.00289	0.08571	1.7550e-08
Assembly total[c]		8.3456e+17	0.02468	0.00401	0.37104	0.27694	0.15868	0.02042	0.09579	5.1468e+17	0.02246	0.07992	0.80241	0.00269	0.09207	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.35. VENTURE results for PWR MOX benchmark multicycle depletion at MOC 2 (22.5 MWd/kg)

Total production/total absorption = 1.04124
Multiplication factor (k_{eff}) = 1.03704

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.031	3.5766e+15	0.02526	0.00335	0.35250	0.23331	0.17608	0.03028	0.12234	2.0071e+15	0.02150	0.08088	0.74358	0.00337	0.14958	1.6006e-08
2	1.044	3.5808e+15	0.02547	0.00338	0.35205	0.23743	0.17465	0.02982	0.12117	2.0313e+15	0.02144	0.07993	0.74854	0.00331	0.14572	1.6216e-08
3	1.045	3.5725e+15	0.02542	0.00339	0.35265	0.23878	0.17402	0.02957	0.12050	2.0325e+15	0.02140	0.07986	0.75032	0.00330	0.14408	1.6317e-08
4	1.040	3.5579e+15	0.02528	0.00340	0.35361	0.23901	0.17370	0.02940	0.12008	2.0239e+15	0.02137	0.08018	0.75081	0.00330	0.14329	1.6356e-08
5	1.011	3.4661e+15	0.02442	0.00342	0.35895	0.23965	0.17214	0.02854	0.11784	1.9677e+15	0.02123	0.08252	0.75243	0.00336	0.13944	1.6531e-08
6	0.959	3.2812e+15	0.02311	0.00348	0.36926	0.24157	0.16731	0.02682	0.11381	1.8669e+15	0.02111	0.08725	0.75620	0.00344	0.13102	1.6672e-08
7	1.017	3.4916e+15	0.02496	0.00340	0.35629	0.23734	0.17269	0.02920	0.11999	1.9797e+15	0.02141	0.08214	0.74914	0.00336	0.14289	1.6186e-08
8	1.023	3.4927e+15	0.02505	0.00342	0.35618	0.23939	0.17194	0.02896	0.11936	1.9909e+15	0.02138	0.08169	0.75157	0.00333	0.14099	1.6295e-08
9	1.047	3.5802e+15	0.02549	0.00339	0.35214	0.23852	0.17423	0.02968	0.12078	2.0364e+15	0.02142	0.07972	0.74989	0.00330	0.14464	1.6284e-08
10	1.023	3.4862e+15	0.02500	0.00343	0.35672	0.24038	0.17144	0.02877	0.11883	1.9913e+15	0.02135	0.08164	0.75290	0.00332	0.13976	1.6371e-08
11	1.019	3.4723e+15	0.02485	0.00343	0.35768	0.24051	0.17116	0.02861	0.11843	1.9825e+15	0.02133	0.08198	0.75327	0.00333	0.13907	1.6406e-08
12	1.032	3.5319e+15	0.02501	0.00340	0.35521	0.23917	0.17329	0.02914	0.11942	2.0074e+15	0.02133	0.08083	0.75131	0.00332	0.14218	1.6414e-08
13	0.991	3.3851e+15	0.02399	0.00345	0.36306	0.24089	0.16967	0.02778	0.11625	1.9277e+15	0.02120	0.08435	0.75457	0.00338	0.13549	1.6559e-08
14	0.957	3.2728e+15	0.02303	0.00349	0.36980	0.24161	0.16710	0.02674	0.11361	1.8620e+15	0.02110	0.08749	0.75632	0.00344	0.13066	1.6679e-08
15	1.025	3.4947e+15	0.02509	0.00342	0.35609	0.23994	0.17175	0.02891	0.11921	1.9950e+15	0.02138	0.08152	0.75223	0.00332	0.14053	1.6325e-08
16	1.049	3.5865e+15	0.02555	0.00339	0.35184	0.23864	0.17426	0.02971	0.12086	2.0410e+15	0.02142	0.07953	0.75001	0.00329	0.14471	1.6285e-08
17	1.027	3.4967e+15	0.02509	0.00343	0.35617	0.24038	0.17157	0.02885	0.11905	1.9979e+15	0.02137	0.08134	0.75285	0.00331	0.14011	1.6357e-08
18	1.023	3.4842e+15	0.02496	0.00343	0.35705	0.24045	0.17134	0.02871	0.11870	1.9897e+15	0.02134	0.08165	0.75315	0.00332	0.13952	1.6388e-08
19	1.034	3.5400e+15	0.02508	0.00340	0.35482	0.23908	0.17343	0.02921	0.11960	2.0119e+15	0.02134	0.08061	0.75118	0.00332	0.14252	1.6401e-08
20	0.991	3.3875e+15	0.02401	0.00345	0.36297	0.24086	0.16970	0.02780	0.11630	1.9289e+15	0.02121	0.08428	0.75455	0.00338	0.13558	1.6557e-08
21	0.957	3.2721e+15	0.02302	0.00349	0.36991	0.24159	0.16708	0.02673	0.11358	1.8612e+15	0.02110	0.08750	0.75635	0.00345	0.13063	1.6681e-08
22	1.057	3.6124e+15	0.02574	0.00339	0.35068	0.23853	0.17461	0.02989	0.12135	2.0562e+15	0.02145	0.07884	0.74983	0.00327	0.14556	1.6255e-08
23	1.055	3.6070e+15	0.02566	0.00339	0.35116	0.23853	0.17454	0.02982	0.12117	2.0520e+15	0.02143	0.07896	0.75000	0.00328	0.14529	1.6273e-08
24	1.012	3.4704e+15	0.02443	0.00342	0.35888	0.23956	0.17221	0.02856	0.11790	1.9694e+15	0.02124	0.08238	0.75241	0.00336	0.13960	1.6528e-08
25	0.957	3.2752e+15	0.02302	0.00349	0.36984	0.24152	0.16718	0.02675	0.11362	1.8623e+15	0.02110	0.08740	0.75631	0.00345	0.13076	1.6683e-08
26	1.053	3.5917e+15	0.02573	0.00340	0.35152	0.23919	0.17367	0.02967	0.12105	2.0490e+15	0.02145	0.07910	0.75090	0.00327	0.14424	1.6240e-08
27	1.067	3.6547e+15	0.02592	0.00337	0.34905	0.23767	0.17572	0.03024	0.12212	2.0754e+15	0.02147	0.07795	0.74871	0.00326	0.14754	1.6217e-08
28	1.048	3.5928e+15	0.02539	0.00338	0.35241	0.23823	0.17471	0.02967	0.12066	2.0384e+15	0.02138	0.07940	0.74993	0.00330	0.14495	1.6341e-08
29	0.986	3.3721e+15	0.02383	0.00345	0.36411	0.24088	0.16940	0.02764	0.11588	1.9184e+15	0.02118	0.08467	0.75485	0.00339	0.13491	1.6584e-08
30	0.948	3.2479e+15	0.02273	0.00349	0.37174	0.24153	0.16662	0.02648	0.11291	1.8447e+15	0.02106	0.08822	0.75664	0.00346	0.12963	1.6719e-08
31	1.023	3.5071e+15	0.02473	0.00341	0.35698	0.23921	0.17289	0.02888	0.11874	1.9903e+15	0.02128	0.08139	0.75183	0.00334	0.14113	1.6470e-08
32	0.959	3.2834e+15	0.02307	0.00348	0.36955	0.24142	0.16734	0.02680	0.11378	1.8662e+15	0.02110	0.08711	0.75629	0.00344	0.13107	1.6677e-08
33	0.934	3.2067e+15	0.02228	0.00350	0.37464	0.24149	0.16583	0.02608	0.11181	1.8178e+15	0.02101	0.08952	0.75703	0.00349	0.12797	1.6774e-08
34	0.975	3.3395e+15	0.02349	0.00346	0.36629	0.24094	0.16879	0.02732	0.11504	1.8975e+15	0.02114	0.08557	0.75531	0.00342	0.13357	1.6636e-08
35	0.937	3.2171e+15	0.02236	0.00350	0.37405	0.24143	0.16606	0.02617	0.11206	1.8236e+15	0.02102	0.08918	0.75695	0.00349	0.12839	1.6764e-08
36	0.921	3.1694e+15	0.02183	0.00351	0.37738	0.24135	0.16516	0.02571	0.11079	1.7926e+15	0.02096	0.09076	0.75730	0.00352	0.12649	1.6825e-08
37	0.920	3.1663e+15	0.02179	0.00351	0.37766	0.24131	0.16511	0.02568	0.11070	1.7902e+15	0.02096	0.09086	0.75733	0.00353	0.12636	1.6830e-08
38	0.911	3.1414e+15	0.02149	0.00352	0.37950	0.24121	0.16467	0.02543	0.11001	1.7734e+15	0.02092	0.09172	0.75746	0.00355	0.12538	1.6862e-08
39	0.906	3.1266e+15	0.02131	0.00352	0.38064	0.24112	0.16441	0.02529	0.10959	1.7633e+15	0.02090	0.09224	0.75754	0.00356	0.12480	1.6881e-08
Assembly total[c]		9.0375e+17	0.02425	0.00344	0.36103	0.23991	0.17077	0.02822	0.11723	5.1369e+17	0.02125	0.08349	0.75307	0.00337	0.13780	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.36. VENTURE results for PWR MOX benchmark multicycle depletion at EOC 2/BOC 3 (30.0 MWd/kg)

Total production/total absorption = 0.99479
Multiplication factor (k_{eff}) = 0.99077

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.026	3.8324e+15	0.02475	0.00283	0.34557	0.20167	0.17994	0.03708	0.14203	1.9942e+15	0.01992	0.08439	0.69270	0.00380	0.19719	1.4755e-08
2	1.036	3.8388e+15	0.02490	0.00285	0.34499	0.20450	0.17968	0.03673	0.14109	2.0133e+15	0.01993	0.08361	0.69691	0.00377	0.19384	1.4913e-08
3	1.037	3.8303e+15	0.02484	0.00286	0.34554	0.20564	0.17940	0.03648	0.14044	2.0138e+15	0.01990	0.08359	0.69877	0.00377	0.19205	1.5016e-08
4	1.032	3.8139e+15	0.02470	0.00287	0.34648	0.20605	0.17915	0.03627	0.13994	2.0058e+15	0.01988	0.08393	0.69960	0.00378	0.19090	1.5079e-08
5	1.007	3.7140e+15	0.02393	0.00290	0.35157	0.20809	0.17770	0.03518	0.13724	1.9566e+15	0.01973	0.08617	0.70342	0.00384	0.18497	1.5383e-08
6	0.969	3.5317e+15	0.02296	0.00298	0.35999	0.21331	0.17324	0.03312	0.13262	1.8819e+15	0.01958	0.08992	0.71231	0.00392	0.17249	1.5753e-08
7	1.019	3.7543e+15	0.02460	0.00288	0.34814	0.20639	0.17765	0.03595	0.13959	1.9789e+15	0.01987	0.08520	0.70026	0.00381	0.18894	1.5000e-08
8	1.023	3.7569e+15	0.02467	0.00289	0.34793	0.20787	0.17745	0.03577	0.13908	1.9882e+15	0.01987	0.08481	0.70242	0.00379	0.18721	1.5086e-08
9	1.039	3.8390e+15	0.02492	0.00286	0.34502	0.20532	0.17954	0.03661	0.14076	2.0176e+15	0.01992	0.08342	0.69817	0.00376	0.19279	1.4972e-08
10	1.023	3.7502e+15	0.02461	0.00290	0.34844	0.20872	0.17721	0.03556	0.13856	1.9880e+15	0.01985	0.08481	0.70383	0.00379	0.18584	1.5167e-08
11	1.019	3.7341e+15	0.02446	0.00291	0.34942	0.20904	0.17697	0.03536	0.13808	1.9795e+15	0.01983	0.08518	0.70453	0.00380	0.18480	1.5226e-08
12	1.024	3.7843e+15	0.02445	0.00288	0.34810	0.20658	0.17877	0.03594	0.13912	1.9902e+15	0.01982	0.08460	0.70070	0.00380	0.18917	1.5178e-08
13	0.994	3.6379e+15	0.02367	0.00293	0.35460	0.21079	0.17552	0.03430	0.13545	1.9303e+15	0.01969	0.08748	0.70792	0.00387	0.17922	1.5507e-08
14	0.967	3.5234e+15	0.02290	0.00298	0.36044	0.21351	0.17304	0.03302	0.13239	1.8782e+15	0.01958	0.09011	0.71267	0.00393	0.17194	1.5772e-08
15	1.025	3.7596e+15	0.02470	0.00290	0.34781	0.20825	0.17741	0.03573	0.13898	1.9918e+15	0.01988	0.08466	0.70298	0.00379	0.18682	1.5109e-08
16	1.040	3.8459e+15	0.02496	0.00286	0.34475	0.20530	0.17961	0.03666	0.14087	2.0214e+15	0.01993	0.08325	0.69812	0.00376	0.19301	1.4964e-08
17	1.026	3.7614e+15	0.02468	0.00290	0.34795	0.20853	0.17736	0.03566	0.13883	1.9935e+15	0.01987	0.08455	0.70352	0.00378	0.18641	1.5140e-08
18	1.022	3.7466e+15	0.02454	0.00290	0.34886	0.20877	0.17715	0.03548	0.13840	1.9854e+15	0.01984	0.08490	0.70411	0.00379	0.18550	1.5193e-08
19	1.026	3.7926e+15	0.02449	0.00287	0.34777	0.20637	0.17891	0.03602	0.13933	1.9937e+15	0.01983	0.08443	0.70037	0.00379	0.18967	1.5157e-08
20	0.994	3.6402e+15	0.02368	0.00293	0.35455	0.21071	0.17556	0.03432	0.13550	1.9310e+15	0.01969	0.08742	0.70785	0.00386	0.17935	1.5503e-08
21	0.966	3.5224e+15	0.02288	0.00298	0.36058	0.21350	0.17301	0.03300	0.13235	1.8773e+15	0.01957	0.09014	0.71271	0.00393	0.17187	1.5777e-08
22	1.046	3.8715e+15	0.02509	0.00285	0.34384	0.20471	0.18000	0.03687	0.14143	2.0322e+15	0.01995	0.08272	0.69727	0.00374	0.19437	1.4908e-08
23	1.043	3.8637e+15	0.02499	0.00285	0.34443	0.20475	0.17994	0.03676	0.14120	2.0269e+15	0.01993	0.08292	0.69753	0.00375	0.19392	1.4942e-08
24	1.007	3.7174e+15	0.02392	0.00290	0.35161	0.20792	0.17777	0.03520	0.13730	1.9569e+15	0.01973	0.08610	0.70328	0.00384	0.18517	1.5381e-08
25	0.966	3.5243e+15	0.02286	0.00298	0.36063	0.21334	0.17312	0.03301	0.13237	1.8769e+15	0.01957	0.09012	0.71256	0.00393	0.17204	1.5780e-08
26	1.044	3.8536e+15	0.02510	0.00286	0.34433	0.20568	0.17928	0.03662	0.14109	2.0288e+15	0.01995	0.08286	0.69900	0.00374	0.19254	1.4921e-08
27	1.051	3.9079e+15	0.02513	0.00283	0.34294	0.20312	0.18096	0.03723	0.14226	2.0412e+15	0.01996	0.08222	0.69496	0.00374	0.19715	1.4840e-08
28	1.035	3.8413e+15	0.02466	0.00285	0.34608	0.20460	0.18005	0.03653	0.14051	2.0098e+15	0.01987	0.08359	0.69766	0.00378	0.19316	1.5048e-08
29	0.988	3.6220e+15	0.02349	0.00294	0.35577	0.21094	0.17528	0.03409	0.13497	1.9205e+15	0.01966	0.08787	0.70848	0.00388	0.17829	1.5560e-08
30	0.958	3.4946e+15	0.02259	0.00299	0.36245	0.21381	0.17256	0.03267	0.13152	1.8611e+15	0.01953	0.09090	0.71357	0.00395	0.17029	1.5857e-08
31	1.015	3.7540e+15	0.02414	0.00288	0.35005	0.20694	0.17843	0.03557	0.13825	1.9723e+15	0.01976	0.08531	0.70175	0.00383	0.18745	1.5283e-08
32	0.967	3.5309e+15	0.02286	0.00297	0.36056	0.21303	0.17330	0.03306	0.13251	1.8782e+15	0.01957	0.08998	0.71227	0.00393	0.17247	1.5771e-08
33	0.945	3.4493e+15	0.02216	0.00300	0.36528	0.21444	0.17175	0.03215	0.13020	1.8364e+15	0.01947	0.09216	0.71495	0.00398	0.16769	1.5975e-08
34	0.979	3.5861e+15	0.02317	0.00295	0.35789	0.21152	0.17468	0.03368	0.13395	1.9013e+15	0.01961	0.08877	0.70973	0.00391	0.17618	1.5662e-08
35	0.947	3.4590e+15	0.02222	0.00300	0.36484	0.21416	0.17199	0.03224	0.13046	1.8403e+15	0.01948	0.09192	0.71457	0.00398	0.16830	1.5956e-08
36	0.933	3.4071e+15	0.02172	0.00301	0.36804	0.21489	0.17105	0.03166	0.12895	1.8123e+15	0.01941	0.09342	0.71607	0.00402	0.16535	1.6086e-08
37	0.931	3.4029e+15	0.02167	0.00301	0.36838	0.21488	0.17101	0.03160	0.12882	1.8094e+15	0.01940	0.09355	0.71615	0.00402	0.16514	1.6098e-08
38	0.923	3.3749e+15	0.02137	0.00302	0.37022	0.21516	0.17054	0.03128	0.12799	1.7934e+15	0.01936	0.09442	0.71685	0.00405	0.16360	1.6169e-08
39	0.918	3.3578e+15	0.02118	0.00303	0.37141	0.21528	0.17027	0.03108	0.12747	1.7832e+15	0.01934	0.09496	0.71724	0.00406	0.16267	1.6213e-08
Assembly total[c]		9.7032e+17	0.02385	0.00292	0.35302	0.20916	0.17639	0.03480	0.13656	5.1290e+17	0.01974	0.08682	0.70530	0.00385	0.18244	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.37. VENTURE results for PWR MOX benchmark multicycle depletion at MOC 3 (37.5 MWd/kg)

Total production/total absorption = 0.95420
Multiplication factor (k_{eff}) = 0.95035

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.023	4.0777e+15	0.02428	0.00235	0.33992	0.17680	0.17883	0.04190	0.15982	1.9847e+15	0.01802	0.08759	0.64923	0.00403	0.23788	1.3626e-08
2	1.030	4.0850e+15	0.02438	0.00237	0.33934	0.17864	0.17923	0.04172	0.15906	1.9994e+15	0.01807	0.08697	0.65224	0.00402	0.23552	1.3745e-08
3	1.030	4.0759e+15	0.02431	0.00238	0.33987	0.17958	0.17922	0.04150	0.15842	1.9993e+15	0.01807	0.08700	0.65395	0.00403	0.23382	1.3852e-08
4	1.026	4.0580e+15	0.02418	0.00239	0.34079	0.18011	0.17909	0.04128	0.15785	1.9919e+15	0.01804	0.08735	0.65503	0.00404	0.23241	1.3935e-08
5	1.005	3.9517e+15	0.02350	0.00243	0.34551	0.18303	0.17818	0.04013	0.15476	1.9495e+15	0.01793	0.08947	0.66045	0.00413	0.22498	1.4344e-08
6	0.976	3.7743e+15	0.02278	0.00252	0.35219	0.18980	0.17523	0.03805	0.14969	1.8945e+15	0.01787	0.09245	0.67255	0.00423	0.21005	1.4861e-08
7	1.019	4.0059e+15	0.02422	0.00240	0.34156	0.18136	0.17787	0.04095	0.15735	1.9766e+15	0.01805	0.08813	0.65719	0.00407	0.22947	1.3894e-08
8	1.022	4.0093e+15	0.02427	0.00241	0.34132	0.18237	0.17802	0.04083	0.15693	1.9842e+15	0.01807	0.08780	0.65884	0.00406	0.22817	1.3962e-08
9	1.032	4.0856e+15	0.02439	0.00238	0.33936	0.17923	0.17928	0.04164	0.15877	2.0030e+15	0.01808	0.08682	0.65325	0.00402	0.23468	1.3797e-08
10	1.022	4.0019e+15	0.02420	0.00242	0.34183	0.18309	0.17798	0.04065	0.15641	1.9835e+15	0.01806	0.08785	0.66018	0.00407	0.22681	1.4049e-08
11	1.018	3.9839e+15	0.02405	0.00243	0.34281	0.18355	0.17783	0.04042	0.15585	1.9755e+15	0.01804	0.08824	0.66114	0.00408	0.22548	1.4130e-08
12	1.019	4.0251e+15	0.02394	0.00240	0.34238	0.18091	0.17887	0.04092	0.15689	1.9777e+15	0.01800	0.08804	0.65659	0.00407	0.23020	1.4071e-08
13	0.996	3.8807e+15	0.02335	0.00247	0.34766	0.18624	0.17684	0.03928	0.15283	1.9324e+15	0.01793	0.09041	0.66620	0.00416	0.21835	1.4519e-08
14	0.975	3.7661e+15	0.02274	0.00252	0.35257	0.19009	0.17508	0.03795	0.14944	1.8917e+15	0.01786	0.09261	0.67308	0.00424	0.20937	1.4888e-08
15	1.024	4.0125e+15	0.02429	0.00242	0.34121	0.18261	0.17806	0.04082	0.15686	1.9872e+15	0.01808	0.08767	0.65924	0.00406	0.22791	1.3978e-08
16	1.034	4.0927e+15	0.02442	0.00238	0.33913	0.17911	0.17935	0.04169	0.15891	2.0059e+15	0.01808	0.08668	0.65307	0.00401	0.23501	1.3783e-08
17	1.024	4.0135e+15	0.02426	0.00242	0.34141	0.18278	0.17809	0.04075	0.15671	1.9878e+15	0.01807	0.08763	0.65966	0.00406	0.22754	1.4012e-08
18	1.020	3.9966e+15	0.02412	0.00242	0.34234	0.18316	0.17796	0.04054	0.15620	1.9799e+15	0.01804	0.08800	0.66050	0.00407	0.22635	1.4087e-08
19	1.020	4.0333e+15	0.02397	0.00240	0.34213	0.18062	0.17895	0.04099	0.15711	1.9801e+15	0.01800	0.08790	0.65614	0.00407	0.23079	1.4045e-08
20	0.996	3.8827e+15	0.02335	0.00246	0.34765	0.18614	0.17686	0.03929	0.15288	1.9326e+15	0.01793	0.09038	0.66609	0.00416	0.21849	1.4515e-08
21	0.974	3.7647e+15	0.02272	0.00252	0.35272	0.19009	0.17506	0.03793	0.14939	1.8906e+15	0.01786	0.09265	0.67314	0.00424	0.20927	1.4896e-08
22	1.037	4.1171e+15	0.02449	0.00236	0.33850	0.17828	0.17959	0.04188	0.15952	2.0128e+15	0.01809	0.08630	0.65179	0.00400	0.23664	1.3715e-08
23	1.034	4.1069e+15	0.02438	0.00237	0.33917	0.17840	0.17957	0.04175	0.15922	2.0070e+15	0.01806	0.08656	0.65218	0.00401	0.23601	1.3766e-08
24	1.004	3.9538e+15	0.02347	0.00242	0.34567	0.18282	0.17823	0.04013	0.15480	1.9486e+15	0.01792	0.08948	0.66026	0.00413	0.22517	1.4347e-08
25	0.973	3.7653e+15	0.02268	0.00252	0.35289	0.18990	0.17513	0.03792	0.14939	1.8892e+15	0.01785	0.09270	0.67294	0.00425	0.20942	1.4904e-08
26	1.036	4.1008e+15	0.02451	0.00237	0.33878	0.17923	0.17925	0.04164	0.15914	2.0107e+15	0.01809	0.08640	0.65368	0.00401	0.23469	1.3740e-08
27	1.038	4.1470e+15	0.02444	0.00234	0.33822	0.17655	0.18010	0.04215	0.16033	2.0150e+15	0.01806	0.08610	0.64903	0.00399	0.23959	1.3648e-08
28	1.025	4.0770e+15	0.02404	0.00237	0.34109	0.17855	0.17960	0.04144	0.15834	1.9887e+15	0.01799	0.08739	0.65272	0.00405	0.23469	1.3919e-08
29	0.990	3.8617e+15	0.02316	0.00247	0.34892	0.18653	0.17667	0.03903	0.15223	1.9220e+15	0.01790	0.09089	0.66703	0.00418	0.21707	1.4601e-08
30	0.966	3.7335e+15	0.02243	0.00253	0.35461	0.19069	0.17471	0.03753	0.14841	1.8751e+15	0.01782	0.09345	0.67450	0.00427	0.20714	1.5018e-08
31	1.010	3.9891e+15	0.02362	0.00241	0.34448	0.18152	0.17866	0.04048	0.15582	1.9592e+15	0.01794	0.08888	0.65812	0.00411	0.22787	1.4227e-08
32	0.973	3.7694e+15	0.02263	0.00251	0.35305	0.18950	0.17528	0.03794	0.14949	1.8879e+15	0.01783	0.09271	0.67248	0.00425	0.20987	1.4902e-08
33	0.955	3.6847e+15	0.02203	0.00255	0.35729	0.19181	0.17407	0.03695	0.14689	1.8528e+15	0.01777	0.09465	0.67674	0.00431	0.20375	1.5192e-08
34	0.981	3.8229e+15	0.02286	0.00248	0.35095	0.18747	0.17624	0.03857	0.15105	1.9047e+15	0.01785	0.09177	0.66891	0.00422	0.21434	1.4748e-08
35	0.956	3.6933e+15	0.02205	0.00254	0.35703	0.19141	0.17426	0.03704	0.14716	1.8547e+15	0.01776	0.09451	0.67614	0.00431	0.20448	1.5169e-08
36	0.943	3.6382e+15	0.02161	0.00256	0.36001	0.19271	0.17351	0.03638	0.14544	1.8300e+15	0.01771	0.09590	0.67863	0.00435	0.20065	1.5360e-08
37	0.941	3.6329e+15	0.02154	0.00256	0.36039	0.19274	0.17347	0.03631	0.14527	1.8268e+15	0.01770	0.09607	0.67877	0.00436	0.20034	1.5380e-08
38	0.934	3.6022e+15	0.02126	0.00258	0.36219	0.19333	0.17308	0.03594	0.14430	1.8117e+15	0.01767	0.09692	0.67999	0.00439	0.19829	1.5488e-08
39	0.928	3.5828e+15	0.02106	0.00258	0.36339	0.19363	0.17286	0.03570	0.14369	1.8017e+15	0.01764	0.09749	0.68068	0.00441	0.19705	1.5557e-08
Assembly total[c]	1.0341e+18	0.02346	0.00245	0.34647	0.18439	0.17725	0.03974	0.15402	5.1234e+17	0.01795	0.08992	0.66308	0.00414	0.22192		

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.38. VENTURE results for PWR MOX benchmark multicycle depletion at EOC 3 (45.0 MWd/kg)

Total production/total absorption = 0.91880
Multiplication factor (k_{eff}) = 0.91510

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.020	4.3117e+15	0.02387	0.00192	0.33511	0.15800	0.17387	0.04463	0.17611	1.9777e+15	0.01588	0.09051	0.61609	0.00409	0.26853	1.2636e-08
2	1.026	4.3189e+15	0.02394	0.00194	0.33460	0.15910	0.17458	0.04461	0.17552	1.9891e+15	0.01597	0.09002	0.61784	0.00410	0.26729	1.2725e-08
3	1.025	4.3089e+15	0.02387	0.00195	0.33513	0.15987	0.17478	0.04445	0.17488	1.9884e+15	0.01598	0.09010	0.61922	0.00411	0.26584	1.2836e-08
4	1.022	4.2895e+15	0.02374	0.00196	0.33601	0.16045	0.17480	0.04425	0.17425	1.9818e+15	0.01597	0.09046	0.62035	0.00413	0.26437	1.2937e-08
5	1.003	4.1787e+15	0.02315	0.00201	0.34031	0.16373	0.17469	0.04325	0.17087	1.9457e+15	0.01594	0.09243	0.62629	0.00424	0.25653	1.3424e-08
6	0.982	4.0070e+15	0.02262	0.00210	0.34549	0.17072	0.17372	0.04149	0.16554	1.9050e+15	0.01602	0.09485	0.63902	0.00439	0.24149	1.4021e-08
7	1.017	4.2449e+15	0.02386	0.00197	0.33608	0.16186	0.17420	0.04400	0.17369	1.9734e+15	0.01601	0.09090	0.62291	0.00416	0.26137	1.2898e-08
8	1.021	4.2485e+15	0.02389	0.00198	0.33585	0.16250	0.17453	0.04397	0.17335	1.9795e+15	0.01605	0.09064	0.62396	0.00416	0.26060	1.2952e-08
9	1.027	4.3194e+15	0.02394	0.00194	0.33463	0.15950	0.17475	0.04456	0.17527	1.9918e+15	0.01599	0.08991	0.61853	0.00410	0.26671	1.2772e-08
10	1.020	4.2401e+15	0.02382	0.00199	0.33638	0.16310	0.17465	0.04382	0.17283	1.9783e+15	0.01605	0.09074	0.62510	0.00417	0.25938	1.3045e-08
11	1.016	4.2204e+15	0.02368	0.00200	0.33732	0.16365	0.17463	0.04361	0.17220	1.9709e+15	0.01603	0.09113	0.62618	0.00420	0.25792	1.3146e-08
12	1.015	4.2540e+15	0.02353	0.00197	0.33753	0.16138	0.17480	0.04392	0.17318	1.9690e+15	0.01595	0.09114	0.62210	0.00417	0.26198	1.3103e-08
13	0.997	4.1122e+15	0.02307	0.00205	0.34176	0.16681	0.17434	0.04257	0.16887	1.9341e+15	0.01600	0.09315	0.63198	0.00430	0.25018	1.3618e-08
14	0.981	3.9991e+15	0.02259	0.00210	0.34580	0.17104	0.17365	0.04140	0.16527	1.9029e+15	0.01602	0.09498	0.63962	0.00440	0.24077	1.4052e-08
15	1.022	4.2518e+15	0.02390	0.00198	0.33576	0.16263	0.17461	0.04397	0.17330	1.9819e+15	0.01606	0.09053	0.62418	0.00416	0.26048	1.2964e-08
16	1.028	4.3265e+15	0.02396	0.00194	0.33445	0.15934	0.17478	0.04460	0.17542	1.9940e+15	0.01598	0.08980	0.61828	0.00409	0.26708	1.2756e-08
17	1.022	4.2515e+15	0.02386	0.00199	0.33605	0.16274	0.17468	0.04390	0.17315	1.9814e+15	0.01605	0.09056	0.62451	0.00417	0.26014	1.3004e-08
18	1.018	4.2328e+15	0.02372	0.00199	0.33697	0.16322	0.17466	0.04370	0.17256	1.9741e+15	0.01603	0.09095	0.62547	0.00419	0.25881	1.3098e-08
19	1.016	4.2618e+15	0.02354	0.00197	0.33736	0.16108	0.17480	0.04397	0.17341	1.9706e+15	0.01594	0.09104	0.62163	0.00416	0.26254	1.3076e-08
20	0.997	4.1138e+15	0.02306	0.00204	0.34179	0.16671	0.17435	0.04257	0.16892	1.9340e+15	0.01599	0.09315	0.63186	0.00430	0.25030	1.3616e-08
21	0.980	3.9972e+15	0.02256	0.00210	0.34598	0.17105	0.17364	0.04137	0.16520	1.9016e+15	0.01601	0.09504	0.63971	0.00440	0.24063	1.4065e-08
22	1.030	4.3487e+15	0.02398	0.00193	0.33409	0.15848	0.17480	0.04472	0.17604	1.9978e+15	0.01596	0.08957	0.61696	0.00408	0.26863	1.2688e-08
23	1.027	4.3363e+15	0.02387	0.00193	0.33480	0.15868	0.17482	0.04459	0.17567	1.9919e+15	0.01594	0.08987	0.61744	0.00410	0.26787	1.2756e-08
24	1.002	4.1791e+15	0.02310	0.00200	0.34058	0.16355	0.17469	0.04321	0.17087	1.9437e+15	0.01592	0.09251	0.62613	0.00424	0.25662	1.3436e-08
25	0.979	3.9963e+15	0.02251	0.00210	0.34624	0.17089	0.17367	0.04134	0.16517	1.8993e+15	0.01600	0.09515	0.63952	0.00441	0.24071	1.4080e-08
26	1.029	4.3330e+15	0.02399	0.00194	0.33426	0.15925	0.17482	0.04455	0.17564	1.9956e+15	0.01597	0.08970	0.61856	0.00410	0.26694	1.2719e-08
27	1.029	4.3725e+15	0.02388	0.00191	0.33428	0.15698	0.17480	0.04485	0.17679	1.9960e+15	0.01588	0.08958	0.61455	0.00406	0.27104	1.2641e-08
28	1.018	4.3001e+15	0.02354	0.00194	0.33686	0.15915	0.17486	0.04426	0.17462	1.9741e+15	0.01588	0.09076	0.61838	0.00413	0.26606	1.2956e-08
29	0.992	4.0899e+15	0.02286	0.00205	0.34309	0.16722	0.17428	0.04230	0.16817	1.9234e+15	0.01597	0.09371	0.63298	0.00433	0.24864	1.3730e-08
30	0.973	3.9628e+15	0.02228	0.00212	0.34784	0.17186	0.17346	0.04096	0.16409	1.8869e+15	0.01598	0.09585	0.64140	0.00444	0.23815	1.4225e-08
31	1.006	4.2122e+15	0.02319	0.00198	0.33973	0.16219	0.17478	0.04348	0.17192	1.9504e+15	0.01590	0.09209	0.62389	0.00422	0.25928	1.3309e-08
32	0.977	3.9974e+15	0.02242	0.00210	0.34663	0.17050	0.17374	0.04131	0.16522	1.8959e+15	0.01597	0.09530	0.63906	0.00441	0.24103	1.4091e-08
33	0.963	3.9114e+15	0.02191	0.00214	0.35034	0.17328	0.17313	0.04039	0.16241	1.8671e+15	0.01595	0.09699	0.64415	0.00449	0.23430	1.4447e-08
34	0.984	4.0485e+15	0.02259	0.00207	0.34502	0.16835	0.17412	0.04185	0.16685	1.9079e+15	0.01594	0.09456	0.63519	0.00437	0.24561	1.3914e-08
35	0.963	3.9184e+15	0.02191	0.00213	0.35023	0.17285	0.17323	0.04045	0.16266	1.8675e+15	0.01594	0.09694	0.64347	0.00449	0.23502	1.4425e-08
36	0.952	3.8612e+15	0.02151	0.00216	0.35294	0.17450	0.17281	0.03981	0.16077	1.8462e+15	0.01592	0.09820	0.64658	0.00454	0.23069	1.4665e-08
37	0.950	3.8548e+15	0.02144	0.00216	0.35336	0.17457	0.17279	0.03973	0.16057	1.8426e+15	0.01591	0.09839	0.64678	0.00455	0.23030	1.4695e-08
38	0.943	3.8219e+15	0.02117	0.00217	0.35508	0.17537	0.17256	0.03935	0.15949	1.8289e+15	0.01589	0.09921	0.64836	0.00459	0.22792	1.4835e-08
39	0.938	3.8006e+15	0.02098	0.00218	0.35627	0.17581	0.17243	0.03910	0.15879	1.8192e+15	0.01587	0.09978	0.64928	0.00461	0.22645	1.4927e-08
Assembly total[c]		1.0949e+18	0.02313	0.00202	0.34091	0.16507	0.17423	0.04288	0.17010	5.1204e+17	0.01597	0.09277	0.62912	0.00426	0.25339	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.39. VENTURE PWR MOX benchmark analysis assembly total actinide inventories and weight fractions

Burnup (MWd/kg)	U	^{235}U	^{236}U	^{237}U	^{238}U	Np	^{237}Np	^{238}Np	Pu	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
0.0	4.477e+05	2.00e-03	0.00e+00	0.00e+00	9.98e-01	0.000e+00	0.00e+00	0.00e+00	1.866e+04	0.00e+00	9.40e-01	5.00e-02	1.00e-02	0.00e+00
1.5	4.472e+05	1.95e-03	1.16e-05	1.51e-06	9.98e-01	2.101e+00	9.98e-01	1.87e-03	1.843e+04	1.12e-06	9.21e-01	6.37e-02	1.53e-02	2.00e-04
3.0	4.467e+05	1.91e-03	2.30e-05	1.59e-06	9.98e-01	4.869e+00	9.98e-01	2.01e-03	1.821e+04	6.46e-06	9.02e-01	7.69e-02	2.09e-02	4.89e-04
4.5	4.462e+05	1.86e-03	3.42e-05	1.64e-06	9.98e-01	7.649e+00	9.98e-01	2.07e-03	1.799e+04	1.71e-05	8.83e-01	8.96e-02	2.69e-02	8.75e-04
6.0	4.457e+05	1.81e-03	4.52e-05	1.68e-06	9.98e-01	1.042e+01	9.98e-01	2.10e-03	1.777e+04	3.37e-05	8.64e-01	1.02e-01	3.32e-02	1.36e-03
7.5	4.452e+05	1.77e-03	5.59e-05	1.72e-06	9.98e-01	1.318e+01	9.98e-01	2.13e-03	1.756e+04	5.73e-05	8.45e-01	1.14e-01	3.96e-02	1.96e-03
9.0	4.447e+05	1.72e-03	6.65e-05	1.76e-06	9.98e-01	1.593e+01	9.98e-01	2.16e-03	1.735e+04	8.87e-05	8.26e-01	1.25e-01	4.61e-02	2.67e-03
10.5	4.442e+05	1.67e-03	7.68e-05	1.80e-06	9.98e-01	1.866e+01	9.98e-01	2.18e-03	1.715e+04	1.29e-04	8.08e-01	1.36e-01	5.27e-02	3.50e-03
12.0	4.437e+05	1.63e-03	8.68e-05	1.83e-06	9.98e-01	2.137e+01	9.98e-01	2.21e-03	1.694e+04	1.79e-04	7.89e-01	1.47e-01	5.93e-02	4.44e-03
13.5	4.432e+05	1.58e-03	9.67e-05	1.87e-06	9.98e-01	2.406e+01	9.98e-01	2.23e-03	1.675e+04	2.40e-04	7.71e-01	1.57e-01	6.60e-02	5.51e-03
15.0	4.427e+05	1.54e-03	1.06e-04	1.91e-06	9.98e-01	2.672e+01	9.98e-01	2.25e-03	1.655e+04	3.13e-04	7.54e-01	1.67e-01	7.26e-02	6.70e-03
16.5	4.422e+05	1.50e-03	1.16e-04	1.90e-06	9.98e-01	2.932e+01	9.98e-01	2.23e-03	1.634e+04	3.99e-04	7.36e-01	1.77e-01	7.90e-02	8.05e-03
18.0	4.417e+05	1.45e-03	1.25e-04	1.94e-06	9.98e-01	3.187e+01	9.98e-01	2.25e-03	1.613e+04	4.98e-04	7.19e-01	1.86e-01	8.54e-02	9.52e-03
19.5	4.412e+05	1.41e-03	1.33e-04	1.98e-06	9.98e-01	3.441e+01	9.98e-01	2.28e-03	1.593e+04	6.13e-04	7.02e-01	1.95e-01	9.17e-02	1.11e-02
21.0	4.406e+05	1.37e-03	1.42e-04	2.02e-06	9.98e-01	3.692e+01	9.98e-01	2.31e-03	1.573e+04	7.44e-04	6.85e-01	2.03e-01	9.79e-02	1.29e-02
22.5	4.401e+05	1.33e-03	1.50e-04	2.06e-06	9.99e-01	3.941e+01	9.98e-01	2.33e-03	1.554e+04	8.92e-04	6.69e-01	2.12e-01	1.04e-01	1.47e-02
24.0	4.396e+05	1.29e-03	1.58e-04	2.10e-06	9.99e-01	4.188e+01	9.98e-01	2.36e-03	1.535e+04	1.06e-03	6.53e-01	2.19e-01	1.10e-01	1.68e-02
25.5	4.391e+05	1.25e-03	1.66e-04	2.13e-06	9.99e-01	4.431e+01	9.98e-01	2.39e-03	1.516e+04	1.25e-03	6.38e-01	2.26e-01	1.16e-01	1.89e-02
27.0	4.385e+05	1.21e-03	1.74e-04	2.17e-06	9.99e-01	4.672e+01	9.98e-01	2.41e-03	1.498e+04	1.45e-03	6.23e-01	2.33e-01	1.21e-01	2.12e-02
28.5	4.380e+05	1.17e-03	1.81e-04	2.21e-06	9.99e-01	4.909e+01	9.98e-01	2.44e-03	1.480e+04	1.68e-03	6.09e-01	2.39e-01	1.27e-01	2.36e-02
30.0	4.374e+05	1.13e-03	1.89e-04	2.25e-06	9.99e-01	5.143e+01	9.98e-01	2.47e-03	1.462e+04	1.93e-03	5.95e-01	2.45e-01	1.32e-01	2.62e-02
31.5	4.369e+05	1.09e-03	1.96e-04	2.28e-06	9.99e-01	5.373e+01	9.98e-01	2.49e-03	1.445e+04	2.20e-03	5.81e-01	2.51e-01	1.37e-01	2.89e-02
33.0	4.363e+05	1.05e-03	2.02e-04	2.32e-06	9.99e-01	5.600e+01	9.97e-01	2.52e-03	1.428e+04	2.49e-03	5.69e-01	2.56e-01	1.42e-01	3.17e-02
34.5	4.358e+05	1.01e-03	2.09e-04	2.35e-06	9.99e-01	5.822e+01	9.97e-01	2.55e-03	1.412e+04	2.81e-03	5.56e-01	2.60e-01	1.46e-01	3.46e-02
36.0	4.352e+05	9.78e-04	2.15e-04	2.38e-06	9.99e-01	6.041e+01	9.97e-01	2.57e-03	1.396e+04	3.15e-03	5.45e-01	2.64e-01	1.50e-01	3.77e-02
37.5	4.346e+05	9.43e-04	2.21e-04	2.42e-06	9.99e-01	6.256e+01	9.97e-01	2.60e-03	1.380e+04	3.51e-03	5.33e-01	2.68e-01	1.54e-01	4.09e-02
39.0	4.341e+05	9.08e-04	2.27e-04	2.45e-06	9.99e-01	6.466e+01	9.97e-01	2.63e-03	1.365e+04	3.89e-03	5.23e-01	2.71e-01	1.58e-01	4.42e-02
40.5	4.335e+05	8.74e-04	2.32e-04	2.48e-06	9.99e-01	6.672e+01	9.97e-01	2.65e-03	1.350e+04	4.30e-03	5.13e-01	2.74e-01	1.62e-01	4.76e-02
42.0	4.329e+05	8.41e-04	2.37e-04	2.51e-06	9.99e-01	6.873e+01	9.97e-01	2.68e-03	1.336e+04	4.73e-03	5.03e-01	2.76e-01	1.65e-01	5.11e-02
43.5	4.323e+05	8.08e-04	2.42e-04	2.55e-06	9.99e-01	7.070e+01	9.97e-01	2.71e-03	1.321e+04	5.18e-03	4.94e-01	2.78e-01	1.68e-01	5.46e-02
45.0	4.317e+05	7.76e-04	2.47e-04	2.58e-06	9.99e-01	7.262e+01	9.97e-01	2.73e-03	1.308e+04	5.65e-03	4.86e-01	2.80e-01	1.70e-01	5.83e-02

Table 4.39. (continued)

Burnup (MWd/kg)	Am	^{241}Am	^{242}Am	^{242m}Am	^{243}Am	Cm	^{242}Cm	^{243}Cm	^{244}Cm	^{245}Cm
0.0	0.000e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.000e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1.5	1.263e+00	9.45e-01	1.12e-03	3.63e-03	5.06e-02	2.220e-02	9.50e-01	1.50e-03	4.88e-02	1.83e-04
3.0	3.131e+00	9.00e-01	1.10e-03	6.16e-03	9.32e-02	1.035e-01	9.03e-01	2.82e-03	9.31e-02	6.87e-04
4.5	5.651e+00	8.61e-01	1.07e-03	7.97e-03	1.30e-01	2.640e-01	8.60e-01	3.95e-03	1.35e-01	1.47e-03
6.0	8.863e+00	8.26e-01	1.04e-03	9.31e-03	1.64e-01	5.254e-01	8.18e-01	4.91e-03	1.75e-01	2.50e-03
7.5	1.279e+01	7.94e-01	1.01e-03	1.03e-02	1.94e-01	9.106e-01	7.78e-01	5.74e-03	2.13e-01	3.75e-03
9.0	1.746e+01	7.65e-01	9.88e-04	1.10e-02	2.23e-01	1.444e+00	7.40e-01	6.46e-03	2.48e-01	5.19e-03
10.5	2.288e+01	7.38e-01	9.64e-04	1.16e-02	2.49e-01	2.150e+00	7.04e-01	7.07e-03	2.82e-01	6.80e-03
12.0	2.907e+01	7.12e-01	9.42e-04	1.20e-02	2.75e-01	3.057e+00	6.70e-01	7.58e-03	3.14e-01	8.56e-03
13.5	3.601e+01	6.88e-01	9.22e-04	1.22e-02	2.99e-01	4.190e+00	6.37e-01	8.02e-03	3.45e-01	1.05e-02
15.0	4.371e+01	6.65e-01	9.02e-04	1.24e-02	3.21e-01	5.578e+00	6.06e-01	8.38e-03	3.73e-01	1.25e-02
16.5	5.204e+01	6.45e-01	8.75e-04	1.24e-02	3.42e-01	7.204e+00	5.78e-01	8.65e-03	3.99e-01	1.44e-02
18.0	6.107e+01	6.25e-01	8.59e-04	1.23e-02	3.61e-01	9.131e+00	5.51e-01	8.86e-03	4.24e-01	1.65e-02
19.5	7.081e+01	6.06e-01	8.46e-04	1.23e-02	3.81e-01	1.139e+01	5.25e-01	9.04e-03	4.47e-01	1.86e-02
21.0	8.122e+01	5.87e-01	8.31e-04	1.22e-02	4.00e-01	1.402e+01	5.01e-01	9.19e-03	4.69e-01	2.08e-02
22.5	9.228e+01	5.69e-01	8.17e-04	1.20e-02	4.18e-01	1.703e+01	4.78e-01	9.30e-03	4.90e-01	2.30e-02
24.0	1.040e+02	5.51e-01	8.03e-04	1.19e-02	4.36e-01	2.046e+01	4.55e-01	9.38e-03	5.10e-01	2.53e-02
25.5	1.162e+02	5.34e-01	7.89e-04	1.17e-02	4.54e-01	2.433e+01	4.34e-01	9.43e-03	5.29e-01	2.76e-02
27.0	1.291e+02	5.17e-01	7.75e-04	1.15e-02	4.71e-01	2.868e+01	4.14e-01	9.45e-03	5.47e-01	2.99e-02
28.5	1.424e+02	5.01e-01	7.61e-04	1.12e-02	4.87e-01	3.353e+01	3.95e-01	9.44e-03	5.64e-01	3.22e-02
30.0	1.562e+02	4.85e-01	7.48e-04	1.10e-02	5.03e-01	3.890e+01	3.76e-01	9.42e-03	5.80e-01	3.46e-02
31.5	1.705e+02	4.70e-01	7.35e-04	1.07e-02	5.18e-01	4.482e+01	3.59e-01	9.37e-03	5.95e-01	3.69e-02
33.0	1.852e+02	4.55e-01	7.22e-04	1.05e-02	5.33e-01	5.132e+01	3.42e-01	9.31e-03	6.10e-01	3.92e-02
34.5	2.002e+02	4.41e-01	7.09e-04	1.02e-02	5.48e-01	5.840e+01	3.26e-01	9.23e-03	6.23e-01	4.15e-02
36.0	2.155e+02	4.27e-01	6.96e-04	9.94e-03	5.62e-01	6.610e+01	3.11e-01	9.13e-03	6.36e-01	4.38e-02
37.5	2.312e+02	4.14e-01	6.83e-04	9.67e-03	5.76e-01	7.442e+01	2.96e-01	9.03e-03	6.49e-01	4.60e-02
39.0	2.470e+02	4.01e-01	6.70e-04	9.40e-03	5.89e-01	8.339e+01	2.83e-01	8.91e-03	6.60e-01	4.82e-02
40.5	2.631e+02	3.88e-01	6.58e-04	9.12e-03	6.02e-01	9.302e+01	2.70e-01	8.78e-03	6.71e-01	5.04e-02
42.0	2.794e+02	3.76e-01	6.45e-04	8.85e-03	6.15e-01	1.033e+02	2.57e-01	8.64e-03	6.82e-01	5.25e-02
43.5	2.959e+02	3.63e-01	6.32e-04	8.58e-03	6.27e-01	1.143e+02	2.45e-01	8.49e-03	6.92e-01	5.45e-02
45.0	3.125e+02	3.52e-01	6.19e-04	8.31e-03	6.40e-01	1.260e+02	2.34e-01	8.33e-03	7.01e-01	5.65e-02

Table 4.40. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 1 (7.5 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.686e+03	1.75e-03	5.90e-05	1.73e-06	9.98e-01	4.997e-02	9.98e-01	2.23e-03	6.553e+01	6.10e-05	8.34e-01	1.22e-01	4.18e-02	2.26e-03
2	1.686e+03	1.76e-03	5.74e-05	1.72e-06	9.98e-01	4.992e-02	9.98e-01	2.18e-03	6.605e+01	5.92e-05	8.39e-01	1.18e-01	4.07e-02	2.10e-03
3	1.686e+03	1.76e-03	5.68e-05	1.72e-06	9.98e-01	4.985e-02	9.98e-01	2.17e-03	6.623e+01	5.84e-05	8.41e-01	1.16e-01	4.03e-02	2.05e-03
4	1.686e+03	1.76e-03	5.67e-05	1.72e-06	9.98e-01	4.984e-02	9.98e-01	2.16e-03	6.628e+01	5.82e-05	8.42e-01	1.16e-01	4.02e-02	2.04e-03
5	1.686e+03	1.76e-03	5.61e-05	1.72e-06	9.98e-01	4.989e-02	9.98e-01	2.14e-03	6.643e+01	5.75e-05	8.43e-01	1.15e-01	3.98e-02	1.98e-03
6	1.687e+03	1.77e-03	5.49e-05	1.72e-06	9.98e-01	5.000e-02	9.98e-01	2.09e-03	6.681e+01	5.61e-05	8.48e-01	1.11e-01	3.88e-02	1.87e-03
7	1.686e+03	1.76e-03	5.75e-05	1.73e-06	9.98e-01	5.000e-02	9.98e-01	2.18e-03	6.604e+01	5.92e-05	8.40e-01	1.17e-01	4.06e-02	2.10e-03
8	1.686e+03	1.76e-03	5.67e-05	1.72e-06	9.98e-01	4.996e-02	9.98e-01	2.16e-03	6.630e+01	5.83e-05	8.43e-01	1.15e-01	4.01e-02	2.03e-03
9	1.686e+03	1.76e-03	5.70e-05	1.72e-06	9.98e-01	4.987e-02	9.98e-01	2.17e-03	6.619e+01	5.86e-05	8.41e-01	1.17e-01	4.04e-02	2.06e-03
10	1.686e+03	1.76e-03	5.63e-05	1.72e-06	9.98e-01	4.990e-02	9.98e-01	2.15e-03	6.644e+01	5.77e-05	8.44e-01	1.14e-01	3.98e-02	1.99e-03
11	1.686e+03	1.76e-03	5.61e-05	1.72e-06	9.98e-01	4.989e-02	9.98e-01	2.14e-03	6.648e+01	5.75e-05	8.44e-01	1.14e-01	3.97e-02	1.98e-03
12	1.686e+03	1.76e-03	5.65e-05	1.72e-06	9.98e-01	4.985e-02	9.98e-01	2.16e-03	6.632e+01	5.80e-05	8.42e-01	1.16e-01	4.01e-02	2.02e-03
13	1.687e+03	1.77e-03	5.56e-05	1.72e-06	9.98e-01	4.993e-02	9.98e-01	2.12e-03	6.662e+01	5.69e-05	8.46e-01	1.13e-01	3.93e-02	1.93e-03
14	1.687e+03	1.77e-03	5.49e-05	1.72e-06	9.98e-01	5.000e-02	9.98e-01	2.09e-03	6.683e+01	5.60e-05	8.48e-01	1.11e-01	3.88e-02	1.86e-03
15	1.686e+03	1.76e-03	5.65e-05	1.72e-06	9.98e-01	4.993e-02	9.98e-01	2.15e-03	6.637e+01	5.80e-05	8.43e-01	1.15e-01	3.99e-02	2.01e-03
16	1.686e+03	1.76e-03	5.69e-05	1.72e-06	9.98e-01	4.985e-02	9.98e-01	2.17e-03	6.620e+01	5.85e-05	8.41e-01	1.16e-01	4.04e-02	2.06e-03
17	1.686e+03	1.76e-03	5.63e-05	1.72e-06	9.98e-01	4.988e-02	9.98e-01	2.15e-03	6.643e+01	5.77e-05	8.44e-01	1.14e-01	3.98e-02	1.99e-03
18	1.686e+03	1.76e-03	5.62e-05	1.72e-06	9.98e-01	4.988e-02	9.98e-01	2.15e-03	6.646e+01	5.76e-05	8.44e-01	1.14e-01	3.97e-02	1.98e-03
19	1.686e+03	1.76e-03	5.66e-05	1.72e-06	9.98e-01	4.985e-02	9.98e-01	2.16e-03	6.631e+01	5.81e-05	8.42e-01	1.16e-01	4.01e-02	2.03e-03
20	1.686e+03	1.77e-03	5.56e-05	1.72e-06	9.98e-01	4.993e-02	9.98e-01	2.12e-03	6.662e+01	5.69e-05	8.46e-01	1.13e-01	3.93e-02	1.93e-03
21	1.687e+03	1.77e-03	5.49e-05	1.72e-06	9.98e-01	5.000e-02	9.98e-01	2.09e-03	6.683e+01	5.60e-05	8.49e-01	1.11e-01	3.88e-02	1.86e-03
22	1.686e+03	1.76e-03	5.70e-05	1.72e-06	9.98e-01	4.981e-02	9.98e-01	2.18e-03	6.619e+01	5.86e-05	8.41e-01	1.17e-01	4.04e-02	2.07e-03
23	1.686e+03	1.76e-03	5.70e-05	1.72e-06	9.98e-01	4.981e-02	9.98e-01	2.17e-03	6.620e+01	5.85e-05	8.41e-01	1.17e-01	4.04e-02	2.06e-03
24	1.686e+03	1.76e-03	5.62e-05	1.72e-06	9.98e-01	4.989e-02	9.98e-01	2.14e-03	6.643e+01	5.76e-05	8.43e-01	1.15e-01	3.98e-02	1.99e-03
25	1.687e+03	1.77e-03	5.49e-05	1.72e-06	9.98e-01	5.001e-02	9.98e-01	2.09e-03	6.683e+01	5.60e-05	8.48e-01	1.11e-01	3.88e-02	1.86e-03
26	1.686e+03	1.76e-03	5.69e-05	1.72e-06	9.98e-01	4.982e-02	9.98e-01	2.17e-03	6.627e+01	5.84e-05	8.42e-01	1.16e-01	4.02e-02	2.05e-03
27	1.686e+03	1.76e-03	5.73e-05	1.72e-06	9.98e-01	4.978e-02	9.98e-01	2.19e-03	6.611e+01	5.89e-05	8.40e-01	1.18e-01	4.06e-02	2.09e-03
28	1.686e+03	1.76e-03	5.70e-05	1.72e-06	9.98e-01	4.982e-02	9.98e-01	2.17e-03	6.621e+01	5.85e-05	8.41e-01	1.17e-01	4.04e-02	2.06e-03
29	1.686e+03	1.77e-03	5.56e-05	1.72e-06	9.98e-01	4.995e-02	9.98e-01	2.12e-03	6.665e+01	5.68e-05	8.46e-01	1.13e-01	3.93e-02	1.92e-03
30	1.687e+03	1.77e-03	5.47e-05	1.72e-06	9.98e-01	5.003e-02	9.98e-01	2.09e-03	6.687e+01	5.59e-05	8.49e-01	1.10e-01	3.87e-02	1.85e-03
31	1.686e+03	1.76e-03	5.64e-05	1.72e-06	9.98e-01	4.988e-02	9.98e-01	2.15e-03	6.637e+01	5.78e-05	8.43e-01	1.15e-01	4.00e-02	2.01e-03
32	1.687e+03	1.77e-03	5.50e-05	1.72e-06	9.98e-01	5.001e-02	9.98e-01	2.09e-03	6.682e+01	5.61e-05	8.48e-01	1.11e-01	3.88e-02	1.87e-03
33	1.687e+03	1.77e-03	5.45e-05	1.72e-06	9.98e-01	5.006e-02	9.98e-01	2.08e-03	6.694e+01	5.56e-05	8.50e-01	1.10e-01	3.85e-02	1.83e-03
34	1.687e+03	1.77e-03	5.54e-05	1.72e-06	9.98e-01	4.998e-02	9.98e-01	2.11e-03	6.671e+01	5.65e-05	8.47e-01	1.12e-01	3.91e-02	1.90e-03
35	1.687e+03	1.77e-03	5.46e-05	1.72e-06	9.98e-01	5.006e-02	9.98e-01	2.08e-03	6.693e+01	5.56e-05	8.49e-01	1.10e-01	3.85e-02	1.83e-03
36	1.687e+03	1.77e-03	5.43e-05	1.72e-06	9.98e-01	5.010e-02	9.98e-01	2.07e-03	6.700e+01	5.53e-05	8.50e-01	1.09e-01	3.84e-02	1.81e-03
37	1.687e+03	1.78e-03	5.43e-05	1.72e-06	9.98e-01	5.010e-02	9.98e-01	2.07e-03	6.701e+01	5.53e-05	8.50e-01	1.09e-01	3.83e-02	1.80e-03
38	1.687e+03	1.78e-03	5.41e-05	1.72e-06	9.98e-01	5.012e-02	9.98e-01	2.06e-03	6.705e+01	5.51e-05	8.51e-01	1.09e-01	3.82e-02	1.79e-03
39	1.687e+03	1.78e-03	5.40e-05	1.72e-06	9.98e-01	5.014e-02	9.98e-01	2.06e-03	6.707e+01	5.50e-05	8.51e-01	1.09e-01	3.82e-02	1.78e-03
Total	4.452e+05	1.77e-03	5.59e-05	1.72e-06	9.98e-01	1.318e+01	9.98e-01	2.13e-03	1.756e+04	5.73e-05	8.45e-01	1.14e-01	3.96e-02	1.96e-03

Table 4.40. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	5.077e-02	7.76e-01	1.06e-03	1.03e-02	2.13e-01	3.822e-03	7.64e-01	5.72e-03	2.27e-01	4.12e-03
2	4.958e-02	7.85e-01	1.04e-03	1.03e-02	2.03e-01	3.637e-03	7.71e-01	5.74e-03	2.19e-01	3.94e-03
3	4.914e-02	7.89e-01	1.03e-03	1.03e-02	1.99e-01	3.569e-03	7.74e-01	5.75e-03	2.16e-01	3.88e-03
4	4.903e-02	7.90e-01	1.03e-03	1.03e-02	1.99e-01	3.551e-03	7.75e-01	5.75e-03	2.15e-01	3.86e-03
5	4.861e-02	7.94e-01	1.02e-03	1.03e-02	1.95e-01	3.480e-03	7.78e-01	5.74e-03	2.13e-01	3.80e-03
6	4.774e-02	8.00e-01	9.93e-04	1.03e-02	1.89e-01	3.325e-03	7.82e-01	5.73e-03	2.08e-01	3.60e-03
7	4.961e-02	7.85e-01	1.03e-03	1.03e-02	2.04e-01	3.628e-03	7.70e-01	5.73e-03	2.20e-01	3.90e-03
8	4.902e-02	7.89e-01	1.02e-03	1.03e-02	1.99e-01	3.539e-03	7.74e-01	5.74e-03	2.16e-01	3.81e-03
9	4.925e-02	7.88e-01	1.03e-03	1.03e-02	2.00e-01	3.587e-03	7.74e-01	5.74e-03	2.17e-01	3.89e-03
10	4.869e-02	7.92e-01	1.02e-03	1.03e-02	1.96e-01	3.488e-03	7.76e-01	5.74e-03	2.14e-01	3.77e-03
11	4.859e-02	7.93e-01	1.02e-03	1.03e-02	1.96e-01	3.472e-03	7.77e-01	5.75e-03	2.13e-01	3.76e-03
12	4.890e-02	7.91e-01	1.03e-03	1.03e-02	1.97e-01	3.529e-03	7.76e-01	5.75e-03	2.15e-01	3.84e-03
13	4.820e-02	7.96e-01	1.01e-03	1.03e-02	1.92e-01	3.405e-03	7.80e-01	5.74e-03	2.11e-01	3.69e-03
14	4.770e-02	8.00e-01	9.92e-04	1.03e-02	1.88e-01	3.319e-03	7.83e-01	5.73e-03	2.08e-01	3.60e-03
15	4.887e-02	7.91e-01	1.02e-03	1.03e-02	1.98e-01	3.515e-03	7.75e-01	5.74e-03	2.15e-01	3.79e-03
16	4.923e-02	7.88e-01	1.03e-03	1.03e-02	2.00e-01	3.583e-03	7.74e-01	5.75e-03	2.17e-01	3.89e-03
17	4.872e-02	7.92e-01	1.02e-03	1.03e-02	1.97e-01	3.493e-03	7.76e-01	5.75e-03	2.14e-01	3.77e-03
18	4.864e-02	7.93e-01	1.02e-03	1.03e-02	1.96e-01	3.479e-03	7.77e-01	5.75e-03	2.14e-01	3.76e-03
19	4.893e-02	7.91e-01	1.03e-03	1.03e-02	1.98e-01	3.535e-03	7.76e-01	5.75e-03	2.15e-01	3.85e-03
20	4.821e-02	7.96e-01	1.01e-03	1.03e-02	1.92e-01	3.407e-03	7.80e-01	5.74e-03	2.11e-01	3.70e-03
21	4.770e-02	8.00e-01	9.92e-04	1.03e-02	1.88e-01	3.318e-03	7.83e-01	5.73e-03	2.08e-01	3.60e-03
22	4.926e-02	7.88e-01	1.04e-03	1.03e-02	2.00e-01	3.591e-03	7.74e-01	5.75e-03	2.17e-01	3.90e-03
23	4.921e-02	7.89e-01	1.03e-03	1.03e-02	2.00e-01	3.584e-03	7.74e-01	5.76e-03	2.16e-01	3.90e-03
24	4.863e-02	7.94e-01	1.02e-03	1.03e-02	1.95e-01	3.483e-03	7.78e-01	5.75e-03	2.13e-01	3.80e-03
25	4.771e-02	8.00e-01	9.92e-04	1.03e-02	1.88e-01	3.320e-03	7.82e-01	5.74e-03	2.08e-01	3.60e-03
26	4.910e-02	7.89e-01	1.03e-03	1.03e-02	2.00e-01	3.563e-03	7.74e-01	5.76e-03	2.16e-01	3.86e-03
27	4.943e-02	7.87e-01	1.04e-03	1.03e-02	2.02e-01	3.623e-03	7.73e-01	5.76e-03	2.17e-01	3.95e-03
28	4.916e-02	7.89e-01	1.03e-03	1.04e-02	1.99e-01	3.577e-03	7.74e-01	5.76e-03	2.16e-01	3.91e-03
29	4.813e-02	7.97e-01	1.00e-03	1.03e-02	1.92e-01	3.394e-03	7.80e-01	5.75e-03	2.11e-01	3.69e-03
30	4.759e-02	8.01e-01	9.89e-04	1.03e-02	1.87e-01	3.300e-03	7.83e-01	5.74e-03	2.07e-01	3.58e-03
31	4.877e-02	7.92e-01	1.02e-03	1.03e-02	1.96e-01	3.508e-03	7.77e-01	5.76e-03	2.14e-01	3.83e-03
32	4.773e-02	8.00e-01	9.93e-04	1.03e-02	1.89e-01	3.325e-03	7.82e-01	5.74e-03	2.08e-01	3.61e-03
33	4.741e-02	8.03e-01	9.85e-04	1.03e-02	1.86e-01	3.270e-03	7.84e-01	5.74e-03	2.06e-01	3.55e-03
34	4.799e-02	7.98e-01	1.00e-03	1.03e-02	1.90e-01	3.370e-03	7.81e-01	5.75e-03	2.10e-01	3.67e-03
35	4.745e-02	8.03e-01	9.86e-04	1.03e-02	1.86e-01	3.276e-03	7.84e-01	5.74e-03	2.07e-01	3.56e-03
36	4.725e-02	8.04e-01	9.80e-04	1.03e-02	1.84e-01	3.242e-03	7.85e-01	5.74e-03	2.05e-01	3.53e-03
37	4.723e-02	8.04e-01	9.80e-04	1.03e-02	1.84e-01	3.239e-03	7.86e-01	5.74e-03	2.05e-01	3.53e-03
38	4.712e-02	8.05e-01	9.77e-04	1.03e-02	1.83e-01	3.221e-03	7.86e-01	5.74e-03	2.04e-01	3.51e-03
39	4.705e-02	8.06e-01	9.75e-04	1.03e-02	1.83e-01	3.210e-03	7.87e-01	5.74e-03	2.04e-01	3.50e-03
Total	1.279e+01	7.94e-01	1.01e-03	1.03e-02	1.94e-01	9.106e-01	7.78e-01	5.74e-03	2.13e-01	3.75e-03

Table 4.41. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 1/BOC 2 (15.00 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}N (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.676e+03	1.51e-03	1.11e-04	1.93e-06	9.98e-01	1.012e-01	9.98e-01	2.35e-03	6.101e+01	3.40e-04	7.34e-01	1.80e-01	7.78e-02	7.89e-03
2	1.677e+03	1.52e-03	1.09e-04	1.92e-06	9.98e-01	1.011e-01	9.98e-01	2.32e-03	6.177e+01	3.28e-04	7.43e-01	1.74e-01	7.55e-02	7.35e-03
3	1.677e+03	1.53e-03	1.08e-04	1.92e-06	9.98e-01	1.010e-01	9.98e-01	2.30e-03	6.208e+01	3.23e-04	7.46e-01	1.72e-01	7.46e-02	7.14e-03
4	1.677e+03	1.53e-03	1.08e-04	1.91e-06	9.98e-01	1.010e-01	9.98e-01	2.30e-03	6.217e+01	3.22e-04	7.47e-01	1.71e-01	7.44e-02	7.08e-03
5	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.26e-03	6.252e+01	3.16e-04	7.51e-01	1.69e-01	7.34e-02	6.82e-03
6	1.677e+03	1.55e-03	1.04e-04	1.91e-06	9.98e-01	1.014e-01	9.98e-01	2.21e-03	6.331e+01	3.03e-04	7.61e-01	1.61e-01	7.06e-02	6.26e-03
7	1.677e+03	1.52e-03	1.09e-04	1.92e-06	9.98e-01	1.013e-01	9.98e-01	2.31e-03	6.185e+01	3.26e-04	7.45e-01	1.73e-01	7.49e-02	7.26e-03
8	1.677e+03	1.53e-03	1.08e-04	1.92e-06	9.98e-01	1.013e-01	9.98e-01	2.29e-03	6.225e+01	3.20e-04	7.49e-01	1.70e-01	7.37e-02	6.99e-03
9	1.677e+03	1.53e-03	1.08e-04	1.92e-06	9.98e-01	1.011e-01	9.98e-01	2.31e-03	6.200e+01	3.24e-04	7.45e-01	1.73e-01	7.49e-02	7.19e-03
10	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.012e-01	9.98e-01	2.28e-03	6.248e+01	3.17e-04	7.52e-01	1.68e-01	7.31e-02	6.84e-03
11	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.27e-03	6.256e+01	3.15e-04	7.52e-01	1.68e-01	7.29e-02	6.79e-03
12	1.677e+03	1.53e-03	1.08e-04	1.91e-06	9.98e-01	1.010e-01	9.98e-01	2.29e-03	6.228e+01	3.20e-04	7.48e-01	1.71e-01	7.41e-02	7.00e-03
13	1.677e+03	1.54e-03	1.06e-04	1.91e-06	9.98e-01	1.012e-01	9.98e-01	2.24e-03	6.289e+01	3.10e-04	7.56e-01	1.65e-01	7.19e-02	6.56e-03
14	1.677e+03	1.55e-03	1.04e-04	1.90e-06	9.98e-01	1.014e-01	9.98e-01	2.20e-03	6.334e+01	3.03e-04	7.62e-01	1.61e-01	7.05e-02	6.24e-03
15	1.677e+03	1.53e-03	1.07e-04	1.92e-06	9.98e-01	1.012e-01	9.98e-01	2.28e-03	6.236e+01	3.19e-04	7.50e-01	1.69e-01	7.35e-02	6.92e-03
16	1.677e+03	1.53e-03	1.08e-04	1.92e-06	9.98e-01	1.010e-01	9.98e-01	2.31e-03	6.202e+01	3.24e-04	7.45e-01	1.72e-01	7.48e-02	7.19e-03
17	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.28e-03	6.246e+01	3.17e-04	7.51e-01	1.68e-01	7.32e-02	6.86e-03
18	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.27e-03	6.253e+01	3.16e-04	7.52e-01	1.68e-01	7.30e-02	6.82e-03
19	1.677e+03	1.53e-03	1.08e-04	1.91e-06	9.98e-01	1.010e-01	9.98e-01	2.29e-03	6.225e+01	3.20e-04	7.48e-01	1.71e-01	7.42e-02	7.02e-03
20	1.677e+03	1.54e-03	1.06e-04	1.91e-06	9.98e-01	1.012e-01	9.98e-01	2.24e-03	6.289e+01	3.10e-04	7.56e-01	1.65e-01	7.20e-02	6.56e-03
21	1.677e+03	1.55e-03	1.04e-04	1.90e-06	9.98e-01	1.014e-01	9.98e-01	2.20e-03	6.335e+01	3.03e-04	7.62e-01	1.61e-01	7.05e-02	6.24e-03
22	1.677e+03	1.53e-03	1.09e-04	1.92e-06	9.98e-01	1.010e-01	9.98e-01	2.32e-03	6.198e+01	3.25e-04	7.45e-01	1.73e-01	7.50e-02	7.23e-03
23	1.677e+03	1.53e-03	1.09e-04	1.92e-06	9.98e-01	1.009e-01	9.98e-01	2.31e-03	6.201e+01	3.24e-04	7.45e-01	1.73e-01	7.49e-02	7.21e-03
24	1.677e+03	1.54e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.27e-03	6.251e+01	3.16e-04	7.51e-01	1.69e-01	7.34e-02	6.83e-03
25	1.677e+03	1.55e-03	1.04e-04	1.90e-06	9.98e-01	1.014e-01	9.98e-01	2.20e-03	6.334e+01	3.03e-04	7.62e-01	1.61e-01	7.05e-02	6.25e-03
26	1.677e+03	1.53e-03	1.08e-04	1.92e-06	9.98e-01	1.010e-01	9.98e-01	2.31e-03	6.211e+01	3.23e-04	7.47e-01	1.72e-01	7.44e-02	7.13e-03
27	1.677e+03	1.52e-03	1.09e-04	1.92e-06	9.98e-01	1.009e-01	9.98e-01	2.33e-03	6.181e+01	3.28e-04	7.42e-01	1.75e-01	7.56e-02	7.36e-03
28	1.677e+03	1.53e-03	1.08e-04	1.91e-06	9.98e-01	1.009e-01	9.98e-01	2.31e-03	6.204e+01	3.24e-04	7.45e-01	1.73e-01	7.49e-02	7.19e-03
29	1.677e+03	1.55e-03	1.06e-04	1.91e-06	9.98e-01	1.013e-01	9.98e-01	2.23e-03	6.295e+01	3.09e-04	7.57e-01	1.65e-01	7.18e-02	6.52e-03
30	1.677e+03	1.56e-03	1.04e-04	1.90e-06	9.98e-01	1.014e-01	9.98e-01	2.19e-03	6.345e+01	3.01e-04	7.63e-01	1.60e-01	7.02e-02	6.17e-03
31	1.677e+03	1.53e-03	1.07e-04	1.91e-06	9.98e-01	1.011e-01	9.98e-01	2.28e-03	6.238e+01	3.18e-04	7.49e-01	1.70e-01	7.38e-02	6.94e-03
32	1.677e+03	1.55e-03	1.04e-04	1.90e-06	9.98e-01	1.014e-01	9.98e-01	2.20e-03	6.332e+01	3.03e-04	7.61e-01	1.62e-01	7.06e-02	6.27e-03
33	1.677e+03	1.56e-03	1.03e-04	1.90e-06	9.98e-01	1.015e-01	9.98e-01	2.18e-03	6.361e+01	2.99e-04	7.65e-01	1.59e-01	6.97e-02	6.07e-03
34	1.677e+03	1.55e-03	1.05e-04	1.91e-06	9.98e-01	1.013e-01	9.98e-01	2.22e-03	6.308e+01	3.07e-04	7.58e-01	1.64e-01	7.14e-02	6.43e-03
35	1.677e+03	1.56e-03	1.03e-04	1.90e-06	9.98e-01	1.015e-01	9.98e-01	2.18e-03	6.357e+01	2.99e-04	7.64e-01	1.60e-01	6.99e-02	6.10e-03
36	1.677e+03	1.56e-03	1.03e-04	1.90e-06	9.98e-01	1.015e-01	9.98e-01	2.17e-03	6.375e+01	2.97e-04	7.66e-01	1.58e-01	6.93e-02	5.98e-03
37	1.677e+03	1.56e-03	1.03e-04	1.90e-06	9.98e-01	1.016e-01	9.98e-01	2.16e-03	6.376e+01	2.96e-04	7.66e-01	1.58e-01	6.93e-02	5.97e-03
38	1.677e+03	1.56e-03	1.02e-04	1.90e-06	9.98e-01	1.016e-01	9.98e-01	2.16e-03	6.385e+01	2.95e-04	7.67e-01	1.57e-01	6.90e-02	5.91e-03
39	1.677e+03	1.57e-03	1.02e-04	1.90e-06	9.98e-01	1.016e-01	9.98e-01	2.15e-03	6.391e+01	2.94e-04	7.68e-01	1.57e-01	6.89e-02	5.87e-03
Total	4.427e+05	1.54e-03	1.06e-04	1.91e-06	9.98e-01	2.672e+01	9.98e-01	2.25e-03	1.655e+04	3.13e-04	7.54e-01	1.67e-01	7.26e-02	6.70e-03

Table 4.41. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	1.764e-01	6.40e-01	9.27e-04	1.19e-02	3.47e-01	2.388e-02	5.87e-01	8.21e-03	3.92e-01	1.34e-02
2	1.713e-01	6.51e-01	9.22e-04	1.21e-02	3.36e-01	2.265e-02	5.96e-01	8.30e-03	3.83e-01	1.30e-02
3	1.694e-01	6.56e-01	9.19e-04	1.23e-02	3.31e-01	2.218e-02	6.00e-01	8.33e-03	3.79e-01	1.28e-02
4	1.688e-01	6.58e-01	9.17e-04	1.23e-02	3.29e-01	2.202e-02	6.01e-01	8.35e-03	3.78e-01	1.28e-02
5	1.666e-01	6.64e-01	9.08e-04	1.24e-02	3.23e-01	2.140e-02	6.05e-01	8.38e-03	3.74e-01	1.26e-02
6	1.617e-01	6.75e-01	8.85e-04	1.25e-02	3.11e-01	2.007e-02	6.13e-01	8.43e-03	3.67e-01	1.20e-02
7	1.708e-01	6.51e-01	9.12e-04	1.21e-02	3.36e-01	2.243e-02	5.96e-01	8.29e-03	3.83e-01	1.28e-02
8	1.683e-01	6.57e-01	9.10e-04	1.22e-02	3.30e-01	2.183e-02	6.00e-01	8.33e-03	3.79e-01	1.26e-02
9	1.699e-01	6.55e-01	9.20e-04	1.22e-02	3.32e-01	2.231e-02	5.99e-01	8.32e-03	3.80e-01	1.29e-02
10	1.668e-01	6.61e-01	9.07e-04	1.23e-02	3.26e-01	2.148e-02	6.03e-01	8.36e-03	3.76e-01	1.25e-02
11	1.663e-01	6.63e-01	9.05e-04	1.23e-02	3.24e-01	2.134e-02	6.04e-01	8.37e-03	3.75e-01	1.25e-02
12	1.681e-01	6.60e-01	9.15e-04	1.23e-02	3.27e-01	2.184e-02	6.02e-01	8.36e-03	3.77e-01	1.27e-02
13	1.642e-01	6.69e-01	8.97e-04	1.24e-02	3.18e-01	2.077e-02	6.08e-01	8.40e-03	3.71e-01	1.23e-02
14	1.615e-01	6.76e-01	8.84e-04	1.26e-02	3.11e-01	2.002e-02	6.13e-01	8.43e-03	3.67e-01	1.20e-02
15	1.676e-01	6.59e-01	9.09e-04	1.23e-02	3.28e-01	2.167e-02	6.02e-01	8.35e-03	3.77e-01	1.25e-02
16	1.698e-01	6.55e-01	9.21e-04	1.22e-02	3.32e-01	2.229e-02	5.99e-01	8.33e-03	3.80e-01	1.29e-02
17	1.670e-01	6.61e-01	9.08e-04	1.23e-02	3.26e-01	2.152e-02	6.03e-01	8.36e-03	3.76e-01	1.25e-02
18	1.666e-01	6.62e-01	9.07e-04	1.23e-02	3.25e-01	2.141e-02	6.04e-01	8.37e-03	3.75e-01	1.25e-02
19	1.683e-01	6.59e-01	9.16e-04	1.23e-02	3.28e-01	2.189e-02	6.02e-01	8.36e-03	3.77e-01	1.28e-02
20	1.643e-01	6.68e-01	8.97e-04	1.24e-02	3.18e-01	2.078e-02	6.08e-01	8.40e-03	3.71e-01	1.23e-02
21	1.615e-01	6.76e-01	8.84e-04	1.26e-02	3.11e-01	2.001e-02	6.13e-01	8.43e-03	3.67e-01	1.20e-02
22	1.700e-01	6.54e-01	9.23e-04	1.22e-02	3.33e-01	2.238e-02	5.99e-01	8.34e-03	3.80e-01	1.29e-02
23	1.698e-01	6.55e-01	9.22e-04	1.22e-02	3.32e-01	2.231e-02	5.99e-01	8.34e-03	3.80e-01	1.29e-02
24	1.666e-01	6.64e-01	9.09e-04	1.24e-02	3.23e-01	2.143e-02	6.05e-01	8.38e-03	3.74e-01	1.26e-02
25	1.615e-01	6.76e-01	8.84e-04	1.26e-02	3.11e-01	2.003e-02	6.13e-01	8.43e-03	3.67e-01	1.20e-02
26	1.692e-01	6.55e-01	9.18e-04	1.22e-02	3.31e-01	2.214e-02	6.00e-01	8.35e-03	3.79e-01	1.27e-02
27	1.710e-01	6.52e-01	9.28e-04	1.22e-02	3.35e-01	2.266e-02	5.97e-01	8.34e-03	3.81e-01	1.30e-02
28	1.696e-01	6.56e-01	9.22e-04	1.23e-02	3.31e-01	2.225e-02	6.00e-01	8.35e-03	3.79e-01	1.29e-02
29	1.639e-01	6.70e-01	8.95e-04	1.25e-02	3.17e-01	2.067e-02	6.09e-01	8.41e-03	3.70e-01	1.23e-02
30	1.609e-01	6.77e-01	8.81e-04	1.26e-02	3.09e-01	1.985e-02	6.14e-01	8.44e-03	3.66e-01	1.20e-02
31	1.674e-01	6.62e-01	9.12e-04	1.24e-02	3.25e-01	2.165e-02	6.04e-01	8.38e-03	3.75e-01	1.27e-02
32	1.617e-01	6.75e-01	8.85e-04	1.25e-02	3.11e-01	2.007e-02	6.13e-01	8.44e-03	3.67e-01	1.21e-02
33	1.599e-01	6.80e-01	8.76e-04	1.26e-02	3.06e-01	1.959e-02	6.16e-01	8.46e-03	3.64e-01	1.19e-02
34	1.631e-01	6.72e-01	8.92e-04	1.25e-02	3.15e-01	2.046e-02	6.10e-01	8.43e-03	3.69e-01	1.22e-02
35	1.601e-01	6.80e-01	8.78e-04	1.26e-02	3.07e-01	1.965e-02	6.16e-01	8.46e-03	3.64e-01	1.19e-02
36	1.590e-01	6.83e-01	8.72e-04	1.27e-02	3.04e-01	1.936e-02	6.18e-01	8.47e-03	3.62e-01	1.18e-02
37	1.589e-01	6.83e-01	8.72e-04	1.27e-02	3.03e-01	1.933e-02	6.18e-01	8.47e-03	3.62e-01	1.18e-02
38	1.584e-01	6.85e-01	8.69e-04	1.27e-02	3.02e-01	1.918e-02	6.19e-01	8.48e-03	3.61e-01	1.18e-02
39	1.580e-01	6.86e-01	8.68e-04	1.27e-02	3.00e-01	1.908e-02	6.20e-01	8.49e-03	3.60e-01	1.18e-02
Total	4.371e+01	6.65e-01	9.02e-04	1.24e-02	3.21e-01	5.578e+00	6.06e-01	8.38e-03	3.73e-01	1.25e-02

Table 4.42. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 2 (22.50 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.667e+03	1.28e-03	1.56e-04	2.08e-06	9.99e-01	1.493e-01	9.98e-01	2.42e-03	5.683e+01	9.75e-04	6.44e-01	2.27e-01	1.11e-01	1.73e-02
2	1.667e+03	1.30e-03	1.55e-04	2.08e-06	9.99e-01	1.491e-01	9.98e-01	2.42e-03	5.744e+01	9.49e-04	6.51e-01	2.23e-01	1.09e-01	1.65e-02
3	1.667e+03	1.30e-03	1.54e-04	2.07e-06	9.99e-01	1.489e-01	9.98e-01	2.42e-03	5.774e+01	9.37e-04	6.54e-01	2.21e-01	1.08e-01	1.62e-02
4	1.667e+03	1.31e-03	1.53e-04	2.07e-06	9.99e-01	1.489e-01	9.98e-01	2.41e-03	5.788e+01	9.31e-04	6.56e-01	2.20e-01	1.07e-01	1.60e-02
5	1.667e+03	1.32e-03	1.51e-04	2.06e-06	9.99e-01	1.491e-01	9.98e-01	2.35e-03	5.854e+01	9.05e-04	6.64e-01	2.14e-01	1.05e-01	1.51e-02
6	1.667e+03	1.35e-03	1.47e-04	2.05e-06	9.99e-01	1.497e-01	9.98e-01	2.26e-03	5.993e+01	8.50e-04	6.82e-01	2.03e-01	1.00e-01	1.34e-02
7	1.667e+03	1.30e-03	1.53e-04	2.07e-06	9.99e-01	1.495e-01	9.98e-01	2.38e-03	5.784e+01	9.31e-04	6.58e-01	2.19e-01	1.07e-01	1.59e-02
8	1.667e+03	1.31e-03	1.52e-04	2.07e-06	9.99e-01	1.494e-01	9.98e-01	2.38e-03	5.816e+01	9.19e-04	6.61e-01	2.17e-01	1.06e-01	1.55e-02
9	1.667e+03	1.30e-03	1.54e-04	2.08e-06	9.99e-01	1.490e-01	9.98e-01	2.42e-03	5.763e+01	9.41e-04	6.53e-01	2.21e-01	1.08e-01	1.63e-02
10	1.667e+03	1.32e-03	1.52e-04	2.07e-06	9.99e-01	1.492e-01	9.98e-01	2.37e-03	5.840e+01	9.10e-04	6.64e-01	2.15e-01	1.05e-01	1.53e-02
11	1.667e+03	1.32e-03	1.51e-04	2.07e-06	9.99e-01	1.492e-01	9.98e-01	2.36e-03	5.853e+01	9.05e-04	6.65e-01	2.14e-01	1.05e-01	1.51e-02
12	1.667e+03	1.31e-03	1.53e-04	2.07e-06	9.99e-01	1.489e-01	9.98e-01	2.39e-03	5.807e+01	9.23e-04	6.58e-01	2.18e-01	1.07e-01	1.57e-02
13	1.667e+03	1.33e-03	1.49e-04	2.06e-06	9.99e-01	1.494e-01	9.98e-01	2.31e-03	5.916e+01	8.80e-04	6.73e-01	2.09e-01	1.03e-01	1.43e-02
14	1.668e+03	1.35e-03	1.47e-04	2.05e-06	9.98e-01	1.498e-01	9.98e-01	2.25e-03	6.000e+01	8.48e-04	6.83e-01	2.02e-01	1.00e-01	1.33e-02
15	1.667e+03	1.31e-03	1.52e-04	2.07e-06	9.99e-01	1.493e-01	9.98e-01	2.38e-03	5.825e+01	9.15e-04	6.62e-01	2.16e-01	1.05e-01	1.54e-02
16	1.667e+03	1.30e-03	1.54e-04	2.08e-06	9.99e-01	1.489e-01	9.98e-01	2.42e-03	5.763e+01	9.42e-04	6.53e-01	2.21e-01	1.08e-01	1.63e-02
17	1.667e+03	1.32e-03	1.52e-04	2.07e-06	9.99e-01	1.492e-01	9.98e-01	2.38e-03	5.834e+01	9.12e-04	6.63e-01	2.15e-01	1.05e-01	1.53e-02
18	1.667e+03	1.32e-03	1.52e-04	2.07e-06	9.99e-01	1.492e-01	9.98e-01	2.37e-03	5.845e+01	9.08e-04	6.64e-01	2.15e-01	1.05e-01	1.52e-02
19	1.667e+03	1.31e-03	1.53e-04	2.07e-06	9.99e-01	1.489e-01	9.98e-01	2.40e-03	5.802e+01	9.26e-04	6.58e-01	2.19e-01	1.07e-01	1.58e-02
20	1.667e+03	1.33e-03	1.49e-04	2.06e-06	9.99e-01	1.494e-01	9.98e-01	2.31e-03	5.915e+01	8.80e-04	6.73e-01	2.09e-01	1.03e-01	1.43e-02
21	1.668e+03	1.35e-03	1.47e-04	2.05e-06	9.98e-01	1.498e-01	9.98e-01	2.25e-03	6.001e+01	8.48e-04	6.83e-01	2.02e-01	1.00e-01	1.33e-02
22	1.667e+03	1.30e-03	1.55e-04	2.08e-06	9.99e-01	1.487e-01	9.98e-01	2.44e-03	5.750e+01	9.47e-04	6.51e-01	2.23e-01	1.08e-01	1.65e-02
23	1.667e+03	1.30e-03	1.54e-04	2.07e-06	9.99e-01	1.487e-01	9.98e-01	2.43e-03	5.755e+01	9.45e-04	6.52e-01	2.22e-01	1.08e-01	1.64e-02
24	1.667e+03	1.32e-03	1.51e-04	2.06e-06	9.99e-01	1.491e-01	9.98e-01	2.35e-03	5.852e+01	9.06e-04	6.64e-01	2.15e-01	1.06e-01	1.52e-02
25	1.667e+03	1.35e-03	1.47e-04	2.05e-06	9.98e-01	1.497e-01	9.98e-01	2.25e-03	5.999e+01	8.48e-04	6.83e-01	2.03e-01	1.00e-01	1.33e-02
26	1.667e+03	1.30e-03	1.54e-04	2.07e-06	9.99e-01	1.488e-01	9.98e-01	2.43e-03	5.768e+01	9.39e-04	6.54e-01	2.21e-01	1.07e-01	1.62e-02
27	1.667e+03	1.29e-03	1.56e-04	2.08e-06	9.99e-01	1.485e-01	9.98e-01	2.46e-03	5.721e+01	9.59e-04	6.47e-01	2.25e-01	1.10e-01	1.70e-02
28	1.667e+03	1.30e-03	1.54e-04	2.07e-06	9.99e-01	1.486e-01	9.98e-01	2.42e-03	5.765e+01	9.41e-04	6.52e-01	2.22e-01	1.08e-01	1.64e-02
29	1.667e+03	1.34e-03	1.49e-04	2.05e-06	9.99e-01	1.494e-01	9.98e-01	2.30e-03	5.927e+01	8.75e-04	6.74e-01	2.08e-01	1.03e-01	1.42e-02
30	1.668e+03	1.36e-03	1.46e-04	2.04e-06	9.98e-01	1.498e-01	9.98e-01	2.24e-03	6.020e+01	8.41e-04	6.85e-01	2.01e-01	9.96e-02	1.31e-02
31	1.667e+03	1.32e-03	1.52e-04	2.06e-06	9.99e-01	1.489e-01	9.98e-01	2.37e-03	5.827e+01	9.15e-04	6.60e-01	2.17e-01	1.06e-01	1.55e-02
32	1.667e+03	1.35e-03	1.47e-04	2.04e-06	9.99e-01	1.496e-01	9.98e-01	2.25e-03	5.994e+01	8.50e-04	6.82e-01	2.03e-01	1.00e-01	1.34e-02
33	1.668e+03	1.36e-03	1.45e-04	2.04e-06	9.98e-01	1.499e-01	9.98e-01	2.21e-03	6.051e+01	8.29e-04	6.89e-01	1.99e-01	9.88e-02	1.28e-02
34	1.667e+03	1.34e-03	1.48e-04	2.05e-06	9.99e-01	1.494e-01	9.98e-01	2.28e-03	5.952e+01	8.66e-04	6.77e-01	2.07e-01	1.02e-01	1.39e-02
35	1.668e+03	1.36e-03	1.45e-04	2.04e-06	9.98e-01	1.498e-01	9.98e-01	2.22e-03	6.043e+01	8.32e-04	6.88e-01	1.99e-01	9.90e-02	1.29e-02
36	1.668e+03	1.37e-03	1.44e-04	2.03e-06	9.98e-01	1.499e-01	9.98e-01	2.19e-03	6.078e+01	8.19e-04	6.92e-01	1.97e-01	9.80e-02	1.25e-02
37	1.668e+03	1.37e-03	1.44e-04	2.03e-06	9.98e-01	1.499e-01	9.98e-01	2.19e-03	6.081e+01	8.18e-04	6.92e-01	1.97e-01	9.79e-02	1.24e-02
38	1.668e+03	1.37e-03	1.44e-04	2.03e-06	9.98e-01	1.500e-01	9.98e-01	2.17e-03	6.099e+01	8.12e-04	6.94e-01	1.95e-01	9.74e-02	1.23e-02
39	1.668e+03	1.38e-03	1.43e-04	2.03e-06	9.98e-01	1.500e-01	9.98e-01	2.16e-03	6.110e+01	8.08e-04	6.96e-01	1.94e-01	9.71e-02	1.21e-02
Total	4.401e+05	1.33e-03	1.50e-04	2.06e-06	9.99e-01	3.941e+01	9.98e-01	2.33e-03	1.554e+04	8.92e-04	6.69e-01	2.12e-01	1.04e-01	1.47e-02

Table 4.42. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	3.740e-01	5.42e-01	8.25e-04	1.13e-02	4.46e-01	7.304e-02	4.58e-01	9.01e-03	5.09e-01	2.44e-02
2	3.638e-01	5.50e-01	8.36e-04	1.15e-02	4.38e-01	7.019e-02	4.67e-01	9.13e-03	5.00e-01	2.37e-02
3	3.599e-01	5.54e-01	8.38e-04	1.16e-02	4.34e-01	6.898e-02	4.71e-01	9.18e-03	4.96e-01	2.35e-02
4	3.584e-01	5.56e-01	8.37e-04	1.17e-02	4.32e-01	6.841e-02	4.72e-01	9.20e-03	4.95e-01	2.35e-02
5	3.523e-01	5.66e-01	8.25e-04	1.20e-02	4.21e-01	6.573e-02	4.77e-01	9.28e-03	4.91e-01	2.33e-02
6	3.394e-01	5.84e-01	7.96e-04	1.24e-02	4.03e-01	6.014e-02	4.86e-01	9.41e-03	4.83e-01	2.24e-02
7	3.612e-01	5.54e-01	8.18e-04	1.16e-02	4.33e-01	6.834e-02	4.67e-01	9.15e-03	5.00e-01	2.34e-02
8	3.562e-01	5.58e-01	8.23e-04	1.17e-02	4.29e-01	6.696e-02	4.72e-01	9.21e-03	4.95e-01	2.31e-02
9	3.610e-01	5.52e-01	8.39e-04	1.16e-02	4.35e-01	6.939e-02	4.70e-01	9.17e-03	4.97e-01	2.36e-02
10	3.533e-01	5.62e-01	8.25e-04	1.18e-02	4.26e-01	6.606e-02	4.75e-01	9.25e-03	4.93e-01	2.29e-02
11	3.520e-01	5.64e-01	8.23e-04	1.18e-02	4.24e-01	6.557e-02	4.76e-01	9.27e-03	4.92e-01	2.29e-02
12	3.566e-01	5.59e-01	8.34e-04	1.18e-02	4.28e-01	6.762e-02	4.74e-01	9.23e-03	4.94e-01	2.34e-02
13	3.462e-01	5.74e-01	8.11e-04	1.21e-02	4.14e-01	6.309e-02	4.81e-01	9.34e-03	4.87e-01	2.27e-02
14	3.388e-01	5.85e-01	7.95e-04	1.25e-02	4.02e-01	5.991e-02	4.86e-01	9.42e-03	4.82e-01	2.23e-02
15	3.550e-01	5.59e-01	8.25e-04	1.17e-02	4.28e-01	6.663e-02	4.74e-01	9.23e-03	4.94e-01	2.30e-02
16	3.610e-01	5.52e-01	8.40e-04	1.16e-02	4.36e-01	6.944e-02	4.70e-01	9.17e-03	4.97e-01	2.35e-02
17	3.538e-01	5.61e-01	8.26e-04	1.18e-02	4.27e-01	6.630e-02	4.75e-01	9.25e-03	4.93e-01	2.29e-02
18	3.527e-01	5.62e-01	8.25e-04	1.18e-02	4.25e-01	6.587e-02	4.76e-01	9.27e-03	4.92e-01	2.29e-02
19	3.571e-01	5.58e-01	8.35e-04	1.18e-02	4.29e-01	6.784e-02	4.73e-01	9.23e-03	4.94e-01	2.35e-02
20	3.464e-01	5.73e-01	8.12e-04	1.21e-02	4.14e-01	6.315e-02	4.81e-01	9.34e-03	4.87e-01	2.28e-02
21	3.388e-01	5.85e-01	7.95e-04	1.25e-02	4.02e-01	5.988e-02	4.86e-01	9.42e-03	4.82e-01	2.24e-02
22	3.620e-01	5.50e-01	8.44e-04	1.15e-02	4.38e-01	6.998e-02	4.70e-01	9.17e-03	4.98e-01	2.36e-02
23	3.614e-01	5.51e-01	8.43e-04	1.15e-02	4.37e-01	6.974e-02	4.70e-01	9.18e-03	4.97e-01	2.36e-02
24	3.525e-01	5.66e-01	8.25e-04	1.20e-02	4.21e-01	6.583e-02	4.77e-01	9.28e-03	4.91e-01	2.33e-02
25	3.389e-01	5.85e-01	7.95e-04	1.25e-02	4.02e-01	5.995e-02	4.86e-01	9.43e-03	4.82e-01	2.24e-02
26	3.598e-01	5.52e-01	8.40e-04	1.15e-02	4.36e-01	6.904e-02	4.71e-01	9.20e-03	4.97e-01	2.33e-02
27	3.646e-01	5.46e-01	8.50e-04	1.14e-02	4.41e-01	7.125e-02	4.68e-01	9.16e-03	4.99e-01	2.38e-02
28	3.605e-01	5.53e-01	8.42e-04	1.16e-02	4.34e-01	6.942e-02	4.71e-01	9.20e-03	4.96e-01	2.37e-02
29	3.452e-01	5.75e-01	8.10e-04	1.22e-02	4.12e-01	6.266e-02	4.82e-01	9.36e-03	4.86e-01	2.27e-02
30	3.371e-01	5.88e-01	7.91e-04	1.26e-02	3.98e-01	5.919e-02	4.87e-01	9.45e-03	4.81e-01	2.23e-02
31	3.547e-01	5.62e-01	8.30e-04	1.19e-02	4.25e-01	6.681e-02	4.75e-01	9.27e-03	4.92e-01	2.34e-02
32	3.392e-01	5.85e-01	7.96e-04	1.24e-02	4.02e-01	6.010e-02	4.86e-01	9.43e-03	4.82e-01	2.24e-02
33	3.344e-01	5.93e-01	7.85e-04	1.27e-02	3.94e-01	5.808e-02	4.89e-01	9.49e-03	4.79e-01	2.22e-02
34	3.430e-01	5.79e-01	8.05e-04	1.23e-02	4.08e-01	6.174e-02	4.83e-01	9.39e-03	4.85e-01	2.27e-02
35	3.350e-01	5.92e-01	7.86e-04	1.27e-02	3.95e-01	5.832e-02	4.89e-01	9.49e-03	4.79e-01	2.23e-02
36	3.320e-01	5.97e-01	7.79e-04	1.28e-02	3.89e-01	5.707e-02	4.91e-01	9.52e-03	4.77e-01	2.22e-02
37	3.318e-01	5.98e-01	7.79e-04	1.28e-02	3.89e-01	5.697e-02	4.92e-01	9.53e-03	4.77e-01	2.22e-02
38	3.302e-01	6.01e-01	7.75e-04	1.29e-02	3.86e-01	5.632e-02	4.93e-01	9.55e-03	4.75e-01	2.21e-02
39	3.292e-01	6.02e-01	7.73e-04	1.30e-02	3.84e-01	5.592e-02	4.94e-01	9.56e-03	4.75e-01	2.21e-02
Total	9.228e+01	5.69e-01	8.17e-04	1.20e-02	4.18e-01	1.703e+01	4.78e-01	9.30e-03	4.90e-01	2.30e-02

Table 4.43. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 2/BOC (30.00 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.656e+03	1.08e-03	1.95e-04	2.27e-06	9.99e-01	1.944e-01	9.97e-01	2.57e-03	5.311e+01	2.12e-03	5.67e-01	2.60e-01	1.40e-01	3.07e-02
2	1.656e+03	1.09e-03	1.94e-04	2.27e-06	9.99e-01	1.942e-01	9.97e-01	2.57e-03	5.359e+01	2.07e-03	5.72e-01	2.58e-01	1.38e-01	2.97e-02
3	1.656e+03	1.10e-03	1.93e-04	2.26e-06	9.99e-01	1.941e-01	9.97e-01	2.56e-03	5.389e+01	2.05e-03	5.75e-01	2.56e-01	1.37e-01	2.92e-02
4	1.656e+03	1.10e-03	1.92e-04	2.26e-06	9.99e-01	1.941e-01	9.97e-01	2.55e-03	5.407e+01	2.03e-03	5.78e-01	2.55e-01	1.37e-01	2.88e-02
5	1.657e+03	1.12e-03	1.90e-04	2.25e-06	9.99e-01	1.946e-01	9.98e-01	2.48e-03	5.501e+01	1.96e-03	5.89e-01	2.48e-01	1.34e-01	2.70e-02
6	1.658e+03	1.16e-03	1.84e-04	2.23e-06	9.99e-01	1.957e-01	9.98e-01	2.38e-03	5.680e+01	1.82e-03	6.12e-01	2.35e-01	1.27e-01	2.35e-02
7	1.657e+03	1.10e-03	1.92e-04	2.26e-06	9.99e-01	1.948e-01	9.97e-01	2.52e-03	5.419e+01	2.02e-03	5.81e-01	2.53e-01	1.35e-01	2.83e-02
8	1.657e+03	1.11e-03	1.91e-04	2.26e-06	9.99e-01	1.947e-01	9.97e-01	2.52e-03	5.445e+01	2.00e-03	5.84e-01	2.52e-01	1.34e-01	2.78e-02
9	1.656e+03	1.09e-03	1.93e-04	2.26e-06	9.99e-01	1.941e-01	9.97e-01	2.57e-03	5.376e+01	2.06e-03	5.74e-01	2.57e-01	1.37e-01	2.94e-02
10	1.657e+03	1.11e-03	1.91e-04	2.26e-06	9.99e-01	1.946e-01	9.97e-01	2.51e-03	5.469e+01	1.98e-03	5.87e-01	2.50e-01	1.34e-01	2.74e-02
11	1.657e+03	1.12e-03	1.90e-04	2.25e-06	9.99e-01	1.946e-01	9.97e-01	2.50e-03	5.486e+01	1.96e-03	5.89e-01	2.49e-01	1.33e-01	2.70e-02
12	1.657e+03	1.11e-03	1.92e-04	2.26e-06	9.99e-01	1.942e-01	9.97e-01	2.53e-03	5.435e+01	2.01e-03	5.81e-01	2.53e-01	1.36e-01	2.82e-02
13	1.657e+03	1.14e-03	1.87e-04	2.24e-06	9.99e-01	1.950e-01	9.98e-01	2.44e-03	5.577e+01	1.90e-03	5.99e-01	2.43e-01	1.31e-01	2.54e-02
14	1.658e+03	1.16e-03	1.84e-04	2.23e-06	9.99e-01	1.957e-01	9.98e-01	2.38e-03	5.689e+01	1.81e-03	6.13e-01	2.35e-01	1.27e-01	2.33e-02
15	1.657e+03	1.11e-03	1.91e-04	2.26e-06	9.99e-01	1.946e-01	9.97e-01	2.52e-03	5.452e+01	1.99e-03	5.85e-01	2.52e-01	1.34e-01	2.77e-02
16	1.656e+03	1.09e-03	1.93e-04	2.26e-06	9.99e-01	1.940e-01	9.97e-01	2.57e-03	5.374e+01	2.06e-03	5.74e-01	2.57e-01	1.37e-01	2.95e-02
17	1.657e+03	1.11e-03	1.91e-04	2.26e-06	9.99e-01	1.945e-01	9.97e-01	2.52e-03	5.460e+01	1.98e-03	5.86e-01	2.51e-01	1.34e-01	2.75e-02
18	1.657e+03	1.11e-03	1.91e-04	2.25e-06	9.99e-01	1.945e-01	9.97e-01	2.51e-03	5.476e+01	1.97e-03	5.87e-01	2.50e-01	1.33e-01	2.73e-02
19	1.656e+03	1.10e-03	1.92e-04	2.26e-06	9.99e-01	1.941e-01	9.97e-01	2.53e-03	5.428e+01	2.02e-03	5.80e-01	2.54e-01	1.36e-01	2.84e-02
20	1.657e+03	1.14e-03	1.88e-04	2.24e-06	9.99e-01	1.950e-01	9.98e-01	2.44e-03	5.575e+01	1.90e-03	5.99e-01	2.43e-01	1.31e-01	2.54e-02
21	1.658e+03	1.16e-03	1.84e-04	2.23e-06	9.99e-01	1.957e-01	9.98e-01	2.38e-03	5.690e+01	1.81e-03	6.13e-01	2.35e-01	1.27e-01	2.33e-02
22	1.656e+03	1.09e-03	1.94e-04	2.27e-06	9.99e-01	1.937e-01	9.97e-01	2.59e-03	5.355e+01	2.07e-03	5.71e-01	2.59e-01	1.38e-01	2.99e-02
23	1.656e+03	1.09e-03	1.94e-04	2.26e-06	9.99e-01	1.937e-01	9.97e-01	2.58e-03	5.363e+01	2.07e-03	5.72e-01	2.58e-01	1.38e-01	2.98e-02
24	1.657e+03	1.12e-03	1.90e-04	2.25e-06	9.99e-01	1.944e-01	9.98e-01	2.49e-03	5.499e+01	1.96e-03	5.88e-01	2.49e-01	1.34e-01	2.70e-02
25	1.658e+03	1.16e-03	1.84e-04	2.23e-06	9.99e-01	1.956e-01	9.98e-01	2.38e-03	5.689e+01	1.81e-03	6.13e-01	2.35e-01	1.27e-01	2.33e-02
26	1.656e+03	1.09e-03	1.94e-04	2.26e-06	9.99e-01	1.938e-01	9.97e-01	2.58e-03	5.374e+01	2.05e-03	5.74e-01	2.57e-01	1.37e-01	2.94e-02
27	1.656e+03	1.08e-03	1.95e-04	2.27e-06	9.99e-01	1.933e-01	9.97e-01	2.61e-03	5.321e+01	2.11e-03	5.66e-01	2.61e-01	1.40e-01	3.08e-02
28	1.656e+03	1.09e-03	1.93e-04	2.26e-06	9.99e-01	1.937e-01	9.97e-01	2.56e-03	5.382e+01	2.06e-03	5.74e-01	2.57e-01	1.38e-01	2.95e-02
29	1.657e+03	1.14e-03	1.87e-04	2.24e-06	9.99e-01	1.950e-01	9.98e-01	2.43e-03	5.593e+01	1.88e-03	6.01e-01	2.42e-01	1.30e-01	2.51e-02
30	1.658e+03	1.17e-03	1.83e-04	2.23e-06	9.99e-01	1.958e-01	9.98e-01	2.36e-03	5.718e+01	1.79e-03	6.16e-01	2.33e-01	1.26e-01	2.28e-02
31	1.657e+03	1.11e-03	1.91e-04	2.25e-06	9.99e-01	1.941e-01	9.97e-01	2.51e-03	5.465e+01	1.99e-03	5.84e-01	2.51e-01	1.35e-01	2.77e-02
32	1.657e+03	1.16e-03	1.84e-04	2.23e-06	9.99e-01	1.955e-01	9.98e-01	2.38e-03	5.683e+01	1.82e-03	6.12e-01	2.35e-01	1.27e-01	2.35e-02
33	1.658e+03	1.18e-03	1.82e-04	2.22e-06	9.99e-01	1.960e-01	9.98e-01	2.33e-03	5.763e+01	1.76e-03	6.21e-01	2.30e-01	1.25e-01	2.21e-02
34	1.657e+03	1.15e-03	1.86e-04	2.23e-06	9.99e-01	1.951e-01	9.98e-01	2.41e-03	5.628e+01	1.86e-03	6.05e-01	2.39e-01	1.29e-01	2.45e-02
35	1.658e+03	1.17e-03	1.82e-04	2.22e-06	9.99e-01	1.959e-01	9.98e-01	2.33e-03	5.753e+01	1.77e-03	6.20e-01	2.30e-01	1.25e-01	2.23e-02
36	1.658e+03	1.18e-03	1.81e-04	2.21e-06	9.99e-01	1.961e-01	9.98e-01	2.30e-03	5.804e+01	1.74e-03	6.26e-01	2.27e-01	1.24e-01	2.15e-02
37	1.658e+03	1.19e-03	1.81e-04	2.21e-06	9.99e-01	1.961e-01	9.98e-01	2.30e-03	5.808e+01	1.73e-03	6.26e-01	2.27e-01	1.24e-01	2.14e-02
38	1.658e+03	1.19e-03	1.80e-04	2.21e-06	9.99e-01	1.963e-01	9.98e-01	2.28e-03	5.835e+01	1.71e-03	6.29e-01	2.25e-01	1.23e-01	2.10e-02
39	1.658e+03	1.19e-03	1.80e-04	2.21e-06	9.99e-01	1.963e-01	9.98e-01	2.27e-03	5.851e+01	1.70e-03	6.31e-01	2.24e-01	1.23e-01	2.08e-02
Total	4.374e+05	1.13e-03	1.89e-04	2.25e-06	9.99e-01	5.143e+01	9.98e-01	2.47e-03	1.462e+04	1.93e-03	5.95e-01	2.45e-01	1.32e-01	2.62e-02

Table 4.43. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	6.314e-01	4.57e-01	7.51e-04	1.02e-02	5.32e-01	1.670e-01	3.58e-01	9.04e-03	5.97e-01	3.61e-02
2	6.178e-01	4.62e-01	7.59e-04	1.03e-02	5.27e-01	1.615e-01	3.65e-01	9.18e-03	5.91e-01	3.54e-02
3	6.122e-01	4.66e-01	7.61e-04	1.04e-02	5.23e-01	1.590e-01	3.68e-01	9.24e-03	5.88e-01	3.52e-02
4	6.095e-01	4.69e-01	7.60e-04	1.05e-02	5.20e-01	1.575e-01	3.69e-01	9.27e-03	5.87e-01	3.52e-02
5	5.973e-01	4.82e-01	7.53e-04	1.09e-02	5.06e-01	1.505e-01	3.75e-01	9.39e-03	5.81e-01	3.51e-02
6	5.719e-01	5.05e-01	7.36e-04	1.16e-02	4.83e-01	1.362e-01	3.86e-01	9.60e-03	5.71e-01	3.38e-02
7	6.106e-01	4.70e-01	7.48e-04	1.05e-02	5.19e-01	1.561e-01	3.67e-01	9.22e-03	5.89e-01	3.48e-02
8	6.038e-01	4.73e-01	7.52e-04	1.05e-02	5.16e-01	1.535e-01	3.71e-01	9.29e-03	5.85e-01	3.45e-02
9	6.140e-01	4.64e-01	7.61e-04	1.03e-02	5.25e-01	1.599e-01	3.67e-01	9.22e-03	5.89e-01	3.53e-02
10	5.995e-01	4.76e-01	7.54e-04	1.06e-02	5.13e-01	1.516e-01	3.73e-01	9.35e-03	5.83e-01	3.44e-02
11	5.972e-01	4.78e-01	7.53e-04	1.07e-02	5.11e-01	1.503e-01	3.74e-01	9.37e-03	5.82e-01	3.44e-02
12	6.059e-01	4.73e-01	7.58e-04	1.06e-02	5.16e-01	1.555e-01	3.71e-01	9.31e-03	5.85e-01	3.52e-02
13	5.856e-01	4.91e-01	7.46e-04	1.11e-02	4.97e-01	1.438e-01	3.80e-01	9.49e-03	5.77e-01	3.43e-02
14	5.709e-01	5.06e-01	7.36e-04	1.16e-02	4.82e-01	1.356e-01	3.87e-01	9.61e-03	5.70e-01	3.37e-02
15	6.022e-01	4.73e-01	7.53e-04	1.05e-02	5.15e-01	1.529e-01	3.72e-01	9.31e-03	5.85e-01	3.44e-02
16	6.142e-01	4.64e-01	7.62e-04	1.03e-02	5.25e-01	1.601e-01	3.67e-01	9.22e-03	5.89e-01	3.53e-02
17	6.006e-01	4.74e-01	7.54e-04	1.06e-02	5.14e-01	1.522e-01	3.73e-01	9.34e-03	5.84e-01	3.44e-02
18	5.986e-01	4.76e-01	7.53e-04	1.06e-02	5.12e-01	1.511e-01	3.74e-01	9.36e-03	5.83e-01	3.44e-02
19	6.069e-01	4.72e-01	7.59e-04	1.06e-02	5.17e-01	1.560e-01	3.70e-01	9.30e-03	5.85e-01	3.52e-02
20	5.859e-01	4.91e-01	7.46e-04	1.11e-02	4.97e-01	1.440e-01	3.80e-01	9.49e-03	5.77e-01	3.43e-02
21	5.707e-01	5.06e-01	7.36e-04	1.16e-02	4.81e-01	1.355e-01	3.87e-01	9.62e-03	5.70e-01	3.37e-02
22	6.167e-01	4.61e-01	7.64e-04	1.02e-02	5.28e-01	1.617e-01	3.66e-01	9.21e-03	5.90e-01	3.53e-02
23	6.156e-01	4.62e-01	7.63e-04	1.03e-02	5.27e-01	1.611e-01	3.66e-01	9.23e-03	5.89e-01	3.53e-02
24	5.977e-01	4.82e-01	7.54e-04	1.09e-02	5.07e-01	1.507e-01	3.74e-01	9.39e-03	5.81e-01	3.51e-02
25	5.710e-01	5.06e-01	7.36e-04	1.16e-02	4.82e-01	1.357e-01	3.87e-01	9.62e-03	5.70e-01	3.38e-02
26	6.128e-01	4.63e-01	7.61e-04	1.02e-02	5.26e-01	1.594e-01	3.67e-01	9.25e-03	5.89e-01	3.49e-02
27	6.220e-01	4.57e-01	7.66e-04	1.01e-02	5.33e-01	1.649e-01	3.63e-01	9.18e-03	5.92e-01	3.57e-02
28	6.138e-01	4.66e-01	7.62e-04	1.04e-02	5.23e-01	1.601e-01	3.67e-01	9.26e-03	5.88e-01	3.56e-02
29	5.836e-01	4.93e-01	7.44e-04	1.12e-02	4.95e-01	1.427e-01	3.81e-01	9.52e-03	5.76e-01	3.43e-02
30	5.674e-01	5.10e-01	7.33e-04	1.18e-02	4.77e-01	1.337e-01	3.88e-01	9.66e-03	5.68e-01	3.37e-02
31	6.022e-01	4.77e-01	7.56e-04	1.08e-02	5.11e-01	1.533e-01	3.72e-01	9.36e-03	5.83e-01	3.52e-02
32	5.717e-01	5.05e-01	7.36e-04	1.16e-02	4.82e-01	1.361e-01	3.86e-01	9.63e-03	5.70e-01	3.38e-02
33	5.621e-01	5.16e-01	7.29e-04	1.20e-02	4.71e-01	1.308e-01	3.91e-01	9.71e-03	5.66e-01	3.36e-02
34	5.793e-01	4.98e-01	7.41e-04	1.14e-02	4.89e-01	1.403e-01	3.83e-01	9.56e-03	5.74e-01	3.42e-02
35	5.632e-01	5.15e-01	7.30e-04	1.19e-02	4.72e-01	1.314e-01	3.90e-01	9.71e-03	5.66e-01	3.37e-02
36	5.572e-01	5.22e-01	7.25e-04	1.22e-02	4.65e-01	1.282e-01	3.93e-01	9.77e-03	5.63e-01	3.36e-02
37	5.568e-01	5.23e-01	7.25e-04	1.22e-02	4.64e-01	1.279e-01	3.94e-01	9.77e-03	5.63e-01	3.36e-02
38	5.536e-01	5.27e-01	7.22e-04	1.24e-02	4.60e-01	1.262e-01	3.95e-01	9.81e-03	5.61e-01	3.36e-02
39	5.517e-01	5.29e-01	7.20e-04	1.25e-02	4.58e-01	1.252e-01	3.96e-01	9.83e-03	5.60e-01	3.35e-02
Total	1.562e+02	4.85e-01	7.48e-04	1.10e-02	5.03e-01	3.890e+01	3.76e-01	9.42e-03	5.80e-01	3.46e-02

Table 4.44. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 3 (37.50 MWd/kg)

Pin	U(g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.645e+03	8.86e-04	2.27e-04	2.44e-06	9.99e-01	2.359e-01	9.97e-01	2.71e-03	4.982e+01	3.86e-03	5.05e-01	2.81e-01	1.62e-01	4.79e-02
2	1.646e+03	8.96e-04	2.26e-04	2.44e-06	9.99e-01	2.356e-01	9.97e-01	2.71e-03	5.020e+01	3.79e-03	5.09e-01	2.80e-01	1.61e-01	4.67e-02
3	1.646e+03	9.04e-04	2.26e-04	2.44e-06	9.99e-01	2.356e-01	9.97e-01	2.70e-03	5.049e+01	3.75e-03	5.12e-01	2.79e-01	1.60e-01	4.59e-02
4	1.646e+03	9.08e-04	2.25e-04	2.44e-06	9.99e-01	2.357e-01	9.97e-01	2.69e-03	5.072e+01	3.72e-03	5.14e-01	2.78e-01	1.59e-01	4.53e-02
5	1.646e+03	9.35e-04	2.22e-04	2.42e-06	9.99e-01	2.366e-01	9.97e-01	2.62e-03	5.187e+01	3.57e-03	5.27e-01	2.70e-01	1.57e-01	4.21e-02
6	1.647e+03	9.80e-04	2.16e-04	2.40e-06	9.99e-01	2.385e-01	9.97e-01	2.51e-03	5.392e+01	3.30e-03	5.52e-01	2.59e-01	1.50e-01	3.64e-02
7	1.646e+03	9.11e-04	2.24e-04	2.43e-06	9.99e-01	2.366e-01	9.97e-01	2.66e-03	5.089e+01	3.68e-03	5.18e-01	2.76e-01	1.58e-01	4.43e-02
8	1.646e+03	9.17e-04	2.24e-04	2.43e-06	9.99e-01	2.364e-01	9.97e-01	2.66e-03	5.111e+01	3.65e-03	5.20e-01	2.76e-01	1.57e-01	4.37e-02
9	1.646e+03	9.00e-04	2.26e-04	2.44e-06	9.99e-01	2.355e-01	9.97e-01	2.71e-03	5.035e+01	3.77e-03	5.10e-01	2.80e-01	1.60e-01	4.63e-02
10	1.646e+03	9.22e-04	2.23e-04	2.43e-06	9.99e-01	2.364e-01	9.97e-01	2.66e-03	5.135e+01	3.62e-03	5.23e-01	2.74e-01	1.56e-01	4.31e-02
11	1.646e+03	9.27e-04	2.23e-04	2.43e-06	9.99e-01	2.365e-01	9.97e-01	2.64e-03	5.157e+01	3.59e-03	5.25e-01	2.73e-01	1.56e-01	4.26e-02
12	1.646e+03	9.17e-04	2.24e-04	2.43e-06	9.99e-01	2.359e-01	9.97e-01	2.67e-03	5.108e+01	3.68e-03	5.18e-01	2.75e-01	1.59e-01	4.43e-02
13	1.647e+03	9.53e-04	2.20e-04	2.41e-06	9.99e-01	2.374e-01	9.97e-01	2.57e-03	5.270e+01	3.45e-03	5.38e-01	2.66e-01	1.53e-01	3.96e-02
14	1.647e+03	9.82e-04	2.16e-04	2.40e-06	9.99e-01	2.385e-01	9.97e-01	2.50e-03	5.402e+01	3.29e-03	5.53e-01	2.58e-01	1.49e-01	3.62e-02
15	1.646e+03	9.18e-04	2.24e-04	2.43e-06	9.99e-01	2.364e-01	9.97e-01	2.66e-03	5.116e+01	3.64e-03	5.21e-01	2.75e-01	1.57e-01	4.36e-02
16	1.646e+03	8.99e-04	2.26e-04	2.44e-06	9.99e-01	2.354e-01	9.97e-01	2.72e-03	5.031e+01	3.77e-03	5.09e-01	2.80e-01	1.60e-01	4.65e-02
17	1.646e+03	9.19e-04	2.24e-04	2.43e-06	9.99e-01	2.362e-01	9.97e-01	2.66e-03	5.124e+01	3.63e-03	5.21e-01	2.75e-01	1.57e-01	4.34e-02
18	1.646e+03	9.24e-04	2.23e-04	2.43e-06	9.99e-01	2.363e-01	9.97e-01	2.65e-03	5.144e+01	3.61e-03	5.23e-01	2.74e-01	1.56e-01	4.29e-02
19	1.646e+03	9.15e-04	2.25e-04	2.43e-06	9.99e-01	2.358e-01	9.97e-01	2.67e-03	5.099e+01	3.69e-03	5.17e-01	2.76e-01	1.59e-01	4.46e-02
20	1.647e+03	9.52e-04	2.20e-04	2.41e-06	9.99e-01	2.373e-01	9.97e-01	2.58e-03	5.268e+01	3.45e-03	5.37e-01	2.66e-01	1.53e-01	3.96e-02
21	1.647e+03	9.82e-04	2.16e-04	2.40e-06	9.99e-01	2.385e-01	9.98e-01	2.50e-03	5.404e+01	3.29e-03	5.54e-01	2.58e-01	1.49e-01	3.61e-02
22	1.645e+03	8.93e-04	2.27e-04	2.44e-06	9.99e-01	2.350e-01	9.97e-01	2.73e-03	5.009e+01	3.80e-03	5.07e-01	2.81e-01	1.61e-01	4.72e-02
23	1.645e+03	8.96e-04	2.27e-04	2.44e-06	9.99e-01	2.350e-01	9.97e-01	2.73e-03	5.021e+01	3.79e-03	5.08e-01	2.81e-01	1.61e-01	4.69e-02
24	1.646e+03	9.35e-04	2.22e-04	2.42e-06	9.99e-01	2.365e-01	9.97e-01	2.62e-03	5.186e+01	3.58e-03	5.27e-01	2.70e-01	1.57e-01	4.22e-02
25	1.647e+03	9.82e-04	2.16e-04	2.40e-06	9.99e-01	2.384e-01	9.98e-01	2.50e-03	5.404e+01	3.29e-03	5.53e-01	2.58e-01	1.49e-01	3.62e-02
26	1.646e+03	8.96e-04	2.27e-04	2.44e-06	9.99e-01	2.351e-01	9.97e-01	2.72e-03	5.028e+01	3.77e-03	5.09e-01	2.81e-01	1.60e-01	4.65e-02
27	1.645e+03	8.85e-04	2.28e-04	2.45e-06	9.99e-01	2.345e-01	9.97e-01	2.75e-03	4.976e+01	3.86e-03	5.02e-01	2.83e-01	1.62e-01	4.85e-02
28	1.645e+03	9.02e-04	2.26e-04	2.44e-06	9.99e-01	2.352e-01	9.97e-01	2.70e-03	5.050e+01	3.76e-03	5.11e-01	2.79e-01	1.61e-01	4.62e-02
29	1.647e+03	9.57e-04	2.19e-04	2.41e-06	9.99e-01	2.374e-01	9.97e-01	2.56e-03	5.292e+01	3.43e-03	5.40e-01	2.65e-01	1.53e-01	3.91e-02
30	1.647e+03	9.90e-04	2.15e-04	2.40e-06	9.99e-01	2.387e-01	9.98e-01	2.48e-03	5.441e+01	3.24e-03	5.57e-01	2.56e-01	1.48e-01	3.53e-02
31	1.646e+03	9.25e-04	2.23e-04	2.43e-06	9.99e-01	2.360e-01	9.97e-01	2.64e-03	5.147e+01	3.63e-03	5.22e-01	2.73e-01	1.58e-01	4.33e-02
32	1.647e+03	9.80e-04	2.16e-04	2.40e-06	9.99e-01	2.383e-01	9.97e-01	2.50e-03	5.399e+01	3.29e-03	5.53e-01	2.58e-01	1.50e-01	3.63e-02
33	1.647e+03	1.00e-03	2.14e-04	2.39e-06	9.99e-01	2.391e-01	9.98e-01	2.45e-03	5.497e+01	3.18e-03	5.64e-01	2.52e-01	1.47e-01	3.41e-02
34	1.647e+03	9.67e-04	2.18e-04	2.41e-06	9.99e-01	2.377e-01	9.97e-01	2.53e-03	5.336e+01	3.37e-03	5.45e-01	2.62e-01	1.52e-01	3.80e-02
35	1.647e+03	1.00e-03	2.14e-04	2.39e-06	9.99e-01	2.389e-01	9.98e-01	2.45e-03	5.487e+01	3.19e-03	5.62e-01	2.53e-01	1.47e-01	3.43e-02
36	1.648e+03	1.01e-03	2.12e-04	2.38e-06	9.99e-01	2.394e-01	9.98e-01	2.42e-03	5.550e+01	3.12e-03	5.69e-01	2.49e-01	1.46e-01	3.29e-02
37	1.648e+03	1.01e-03	2.12e-04	2.38e-06	9.99e-01	2.394e-01	9.98e-01	2.41e-03	5.556e+01	3.12e-03	5.70e-01	2.48e-01	1.46e-01	3.28e-02
38	1.648e+03	1.02e-03	2.11e-04	2.38e-06	9.99e-01	2.397e-01	9.98e-01	2.39e-03	5.591e+01	3.08e-03	5.74e-01	2.46e-01	1.45e-01	3.21e-02
39	1.648e+03	1.03e-03	2.11e-04	2.38e-06	9.99e-01	2.398e-01	9.98e-01	2.38e-03	5.613e+01	3.06e-03	5.76e-01	2.45e-01	1.44e-01	3.17e-02
Total	4.346e+05	9.43e-04	2.21e-04	2.42e-06	9.99e-01	6.256e+01	9.97e-01	2.60e-03	1.380e+04	3.51e-03	5.33e-01	2.68e-01	1.54e-01	4.09e-02

Table 4.44. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	9.296e-01	3.84e-01	6.80e-04	8.76e-03	6.06e-01	3.187e-01	2.80e-01	8.60e-03	6.64e-01	4.74e-02
2	9.144e-01	3.88e-01	6.86e-04	8.85e-03	6.02e-01	3.100e-01	2.84e-01	8.71e-03	6.60e-01	4.68e-02
3	9.076e-01	3.92e-01	6.88e-04	8.95e-03	5.99e-01	3.057e-01	2.87e-01	8.78e-03	6.58e-01	4.67e-02
4	9.037e-01	3.94e-01	6.88e-04	9.05e-03	5.96e-01	3.028e-01	2.88e-01	8.81e-03	6.56e-01	4.67e-02
5	8.843e-01	4.10e-01	6.87e-04	9.60e-03	5.79e-01	2.882e-01	2.94e-01	8.98e-03	6.50e-01	4.67e-02
6	8.448e-01	4.36e-01	6.80e-04	1.03e-02	5.53e-01	2.593e-01	3.08e-01	9.29e-03	6.38e-01	4.52e-02
7	9.014e-01	3.97e-01	6.81e-04	9.07e-03	5.93e-01	2.984e-01	2.89e-01	8.81e-03	6.57e-01	4.60e-02
8	8.937e-01	3.99e-01	6.85e-04	9.12e-03	5.91e-01	2.941e-01	2.91e-01	8.87e-03	6.54e-01	4.57e-02
9	9.101e-01	3.90e-01	6.88e-04	8.89e-03	6.01e-01	3.075e-01	2.86e-01	8.75e-03	6.59e-01	4.67e-02
10	8.885e-01	4.02e-01	6.86e-04	9.20e-03	5.88e-01	2.909e-01	2.93e-01	8.92e-03	6.53e-01	4.56e-02
11	8.850e-01	4.05e-01	6.86e-04	9.30e-03	5.85e-01	2.884e-01	2.94e-01	8.96e-03	6.51e-01	4.56e-02
12	8.980e-01	3.99e-01	6.88e-04	9.23e-03	5.91e-01	2.985e-01	2.90e-01	8.87e-03	6.54e-01	4.68e-02
13	8.665e-01	4.20e-01	6.83e-04	9.84e-03	5.69e-01	2.749e-01	3.00e-01	9.12e-03	6.45e-01	4.57e-02
14	8.431e-01	4.37e-01	6.80e-04	1.04e-02	5.52e-01	2.581e-01	3.08e-01	9.31e-03	6.37e-01	4.51e-02
15	8.920e-01	4.00e-01	6.86e-04	9.13e-03	5.91e-01	2.932e-01	2.92e-01	8.89e-03	6.54e-01	4.56e-02
16	9.108e-01	3.89e-01	6.88e-04	8.87e-03	6.01e-01	3.081e-01	2.86e-01	8.75e-03	6.59e-01	4.67e-02
17	8.904e-01	4.00e-01	6.86e-04	9.15e-03	5.90e-01	2.923e-01	2.92e-01	8.91e-03	6.53e-01	4.56e-02
18	8.873e-01	4.03e-01	6.86e-04	9.24e-03	5.87e-01	2.901e-01	2.93e-01	8.94e-03	6.52e-01	4.56e-02
19	8.996e-01	3.98e-01	6.88e-04	9.19e-03	5.92e-01	2.997e-01	2.89e-01	8.86e-03	6.55e-01	4.68e-02
20	8.670e-01	4.20e-01	6.83e-04	9.83e-03	5.70e-01	2.752e-01	3.00e-01	9.12e-03	6.45e-01	4.57e-02
21	8.429e-01	4.37e-01	6.80e-04	1.04e-02	5.51e-01	2.579e-01	3.08e-01	9.31e-03	6.37e-01	4.51e-02
22	9.151e-01	3.86e-01	6.88e-04	8.77e-03	6.05e-01	3.114e-01	2.84e-01	8.72e-03	6.60e-01	4.67e-02
23	9.134e-01	3.87e-01	6.88e-04	8.83e-03	6.03e-01	3.101e-01	2.85e-01	8.74e-03	6.60e-01	4.68e-02
24	8.850e-01	4.10e-01	6.86e-04	9.59e-03	5.80e-01	2.887e-01	2.94e-01	8.98e-03	6.50e-01	4.68e-02
25	8.434e-01	4.37e-01	6.79e-04	1.04e-02	5.51e-01	2.582e-01	3.08e-01	9.31e-03	6.37e-01	4.52e-02
26	9.097e-01	3.87e-01	6.87e-04	8.79e-03	6.03e-01	3.069e-01	2.86e-01	8.77e-03	6.59e-01	4.62e-02
27	9.233e-01	3.81e-01	6.88e-04	8.68e-03	6.09e-01	3.179e-01	2.81e-01	8.67e-03	6.63e-01	4.72e-02
28	9.102e-01	3.92e-01	6.88e-04	9.02e-03	5.99e-01	3.079e-01	2.86e-01	8.78e-03	6.58e-01	4.73e-02
29	8.633e-01	4.23e-01	6.83e-04	9.95e-03	5.66e-01	2.725e-01	3.01e-01	9.16e-03	6.44e-01	4.57e-02
30	8.376e-01	4.42e-01	6.78e-04	1.06e-02	5.46e-01	2.541e-01	3.10e-01	9.37e-03	6.35e-01	4.52e-02
31	8.921e-01	4.05e-01	6.86e-04	9.42e-03	5.85e-01	2.940e-01	2.92e-01	8.93e-03	6.52e-01	4.69e-02
32	8.446e-01	4.37e-01	6.79e-04	1.04e-02	5.52e-01	2.590e-01	3.08e-01	9.32e-03	6.38e-01	4.53e-02
33	8.290e-01	4.50e-01	6.76e-04	1.09e-02	5.39e-01	2.481e-01	3.13e-01	9.45e-03	6.32e-01	4.52e-02
34	8.564e-01	4.29e-01	6.81e-04	1.02e-02	5.60e-01	2.674e-01	3.04e-01	9.22e-03	6.41e-01	4.58e-02
35	8.309e-01	4.48e-01	6.76e-04	1.08e-02	5.40e-01	2.494e-01	3.12e-01	9.44e-03	6.33e-01	4.52e-02
36	8.212e-01	4.57e-01	6.74e-04	1.11e-02	5.31e-01	2.427e-01	3.16e-01	9.52e-03	6.30e-01	4.52e-02
37	8.205e-01	4.58e-01	6.73e-04	1.12e-02	5.30e-01	2.421e-01	3.16e-01	9.53e-03	6.29e-01	4.52e-02
38	8.153e-01	4.62e-01	6.72e-04	1.13e-02	5.26e-01	2.385e-01	3.18e-01	9.58e-03	6.27e-01	4.52e-02
39	8.122e-01	4.65e-01	6.71e-04	1.15e-02	5.23e-01	2.364e-01	3.19e-01	9.62e-03	6.26e-01	4.53e-02
Total	2.312e+02	4.14e-01	6.83e-04	9.67e-03	5.76e-01	7.442e+01	2.96e-01	9.03e-03	6.49e-01	4.60e-02

Table 4.45. VENTURE PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 3 (45.00 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{238}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{242}Pu (wt. %)
1	1.634e+03	7.16e-04	2.53e-04	2.60e-06	9.99e-01	2.729e-01	9.97e-01	2.86e-03	4.693e+01	6.20e-03	4.59e-01	2.91e-01	1.76e-01	6.80e-02
2	1.634e+03	7.25e-04	2.52e-04	2.60e-06	9.99e-01	2.727e-01	9.97e-01	2.86e-03	4.723e+01	6.11e-03	4.61e-01	2.91e-01	1.75e-01	6.69e-02
3	1.634e+03	7.32e-04	2.52e-04	2.60e-06	9.99e-01	2.727e-01	9.97e-01	2.85e-03	4.752e+01	6.05e-03	4.63e-01	2.90e-01	1.75e-01	6.58e-02
4	1.634e+03	7.38e-04	2.51e-04	2.59e-06	9.99e-01	2.730e-01	9.97e-01	2.83e-03	4.778e+01	6.00e-03	4.66e-01	2.89e-01	1.75e-01	6.49e-02
5	1.635e+03	7.68e-04	2.48e-04	2.58e-06	9.99e-01	2.747e-01	9.97e-01	2.75e-03	4.910e+01	5.76e-03	4.80e-01	2.82e-01	1.73e-01	6.00e-02
6	1.636e+03	8.17e-04	2.43e-04	2.56e-06	9.99e-01	2.774e-01	9.97e-01	2.63e-03	5.128e+01	5.32e-03	5.04e-01	2.73e-01	1.66e-01	5.20e-02
7	1.635e+03	7.41e-04	2.50e-04	2.59e-06	9.99e-01	2.740e-01	9.97e-01	2.81e-03	4.795e+01	5.94e-03	4.70e-01	2.88e-01	1.73e-01	6.34e-02
8	1.635e+03	7.46e-04	2.50e-04	2.59e-06	9.99e-01	2.738e-01	9.97e-01	2.81e-03	4.813e+01	5.89e-03	4.71e-01	2.88e-01	1.72e-01	6.28e-02
9	1.634e+03	7.28e-04	2.52e-04	2.60e-06	9.99e-01	2.726e-01	9.97e-01	2.86e-03	4.736e+01	6.08e-03	4.62e-01	2.91e-01	1.75e-01	6.64e-02
10	1.635e+03	7.51e-04	2.50e-04	2.59e-06	9.99e-01	2.739e-01	9.97e-01	2.80e-03	4.837e+01	5.84e-03	4.73e-01	2.87e-01	1.72e-01	6.20e-02
11	1.635e+03	7.57e-04	2.49e-04	2.58e-06	9.99e-01	2.741e-01	9.97e-01	2.78e-03	4.863e+01	5.80e-03	4.76e-01	2.86e-01	1.72e-01	6.11e-02
12	1.635e+03	7.47e-04	2.50e-04	2.59e-06	9.99e-01	2.735e-01	9.97e-01	2.81e-03	4.820e+01	5.93e-03	4.70e-01	2.86e-01	1.74e-01	6.33e-02
13	1.636e+03	7.87e-04	2.46e-04	2.57e-06	9.99e-01	2.757e-01	9.97e-01	2.70e-03	4.994e+01	5.57e-03	4.89e-01	2.79e-01	1.70e-01	5.66e-02
14	1.636e+03	8.19e-04	2.43e-04	2.56e-06	9.99e-01	2.775e-01	9.97e-01	2.62e-03	5.139e+01	5.30e-03	5.05e-01	2.72e-01	1.66e-01	5.16e-02
15	1.635e+03	7.47e-04	2.50e-04	2.59e-06	9.99e-01	2.738e-01	9.97e-01	2.81e-03	4.816e+01	5.88e-03	4.71e-01	2.88e-01	1.72e-01	6.27e-02
16	1.634e+03	7.27e-04	2.52e-04	2.60e-06	9.99e-01	2.724e-01	9.97e-01	2.86e-03	4.731e+01	6.09e-03	4.61e-01	2.91e-01	1.75e-01	6.66e-02
17	1.635e+03	7.48e-04	2.50e-04	2.59e-06	9.99e-01	2.736e-01	9.97e-01	2.81e-03	4.825e+01	5.87e-03	4.72e-01	2.88e-01	1.72e-01	6.25e-02
18	1.635e+03	7.53e-04	2.50e-04	2.59e-06	9.99e-01	2.739e-01	9.97e-01	2.79e-03	4.849e+01	5.83e-03	4.74e-01	2.87e-01	1.72e-01	6.16e-02
19	1.635e+03	7.45e-04	2.51e-04	2.59e-06	9.99e-01	2.733e-01	9.97e-01	2.81e-03	4.812e+01	5.94e-03	4.69e-01	2.87e-01	1.74e-01	6.37e-02
20	1.636e+03	7.86e-04	2.46e-04	2.57e-06	9.99e-01	2.757e-01	9.97e-01	2.71e-03	4.993e+01	5.57e-03	4.89e-01	2.79e-01	1.70e-01	5.67e-02
21	1.636e+03	8.20e-04	2.43e-04	2.56e-06	9.99e-01	2.775e-01	9.97e-01	2.62e-03	5.142e+01	5.29e-03	5.05e-01	2.72e-01	1.66e-01	5.16e-02
22	1.634e+03	7.21e-04	2.53e-04	2.60e-06	9.99e-01	2.719e-01	9.97e-01	2.88e-03	4.709e+01	6.14e-03	4.59e-01	2.92e-01	1.76e-01	6.77e-02
23	1.634e+03	7.24e-04	2.53e-04	2.60e-06	9.99e-01	2.721e-01	9.97e-01	2.87e-03	4.724e+01	6.11e-03	4.60e-01	2.91e-01	1.76e-01	6.72e-02
24	1.635e+03	7.68e-04	2.48e-04	2.58e-06	9.99e-01	2.745e-01	9.97e-01	2.75e-03	4.911e+01	5.76e-03	4.80e-01	2.82e-01	1.73e-01	6.01e-02
25	1.636e+03	8.20e-04	2.43e-04	2.56e-06	9.99e-01	2.774e-01	9.97e-01	2.62e-03	5.143e+01	5.29e-03	5.05e-01	2.72e-01	1.66e-01	5.16e-02
26	1.634e+03	7.24e-04	2.53e-04	2.60e-06	9.99e-01	2.721e-01	9.97e-01	2.87e-03	4.727e+01	6.08e-03	4.61e-01	2.92e-01	1.75e-01	6.67e-02
27	1.634e+03	7.13e-04	2.54e-04	2.61e-06	9.99e-01	2.714e-01	9.97e-01	2.90e-03	4.680e+01	6.22e-03	4.55e-01	2.92e-01	1.77e-01	6.92e-02
28	1.634e+03	7.33e-04	2.52e-04	2.60e-06	9.99e-01	2.725e-01	9.97e-01	2.84e-03	4.764e+01	6.06e-03	4.64e-01	2.88e-01	1.76e-01	6.59e-02
29	1.636e+03	7.92e-04	2.46e-04	2.57e-06	9.99e-01	2.759e-01	9.97e-01	2.69e-03	5.022e+01	5.52e-03	4.92e-01	2.78e-01	1.69e-01	5.57e-02
30	1.636e+03	8.29e-04	2.42e-04	2.55e-06	9.99e-01	2.779e-01	9.97e-01	2.60e-03	5.187e+01	5.22e-03	5.10e-01	2.70e-01	1.65e-01	5.03e-02
31	1.635e+03	7.57e-04	2.49e-04	2.59e-06	9.99e-01	2.739e-01	9.97e-01	2.77e-03	4.870e+01	5.84e-03	4.75e-01	2.84e-01	1.74e-01	6.17e-02
32	1.636e+03	8.18e-04	2.43e-04	2.56e-06	9.99e-01	2.773e-01	9.97e-01	2.62e-03	5.141e+01	5.30e-03	5.05e-01	2.72e-01	1.66e-01	5.17e-02
33	1.637e+03	8.43e-04	2.40e-04	2.55e-06	9.99e-01	2.786e-01	9.97e-01	2.56e-03	5.253e+01	5.11e-03	5.16e-01	2.66e-01	1.64e-01	4.84e-02
34	1.636e+03	8.03e-04	2.44e-04	2.56e-06	9.99e-01	2.764e-01	9.97e-01	2.66e-03	5.074e+01	5.43e-03	4.97e-01	2.75e-01	1.68e-01	5.41e-02
35	1.637e+03	8.40e-04	2.40e-04	2.55e-06	9.99e-01	2.784e-01	9.97e-01	2.57e-03	5.243e+01	5.13e-03	5.15e-01	2.67e-01	1.64e-01	4.87e-02
36	1.637e+03	8.56e-04	2.39e-04	2.54e-06	9.99e-01	2.792e-01	9.97e-01	2.53e-03	5.317e+01	5.01e-03	5.23e-01	2.63e-01	1.63e-01	4.66e-02
37	1.637e+03	8.58e-04	2.38e-04	2.54e-06	9.99e-01	2.793e-01	9.97e-01	2.52e-03	5.325e+01	5.00e-03	5.24e-01	2.62e-01	1.63e-01	4.64e-02
38	1.637e+03	8.67e-04	2.38e-04	2.54e-06	9.99e-01	2.797e-01	9.97e-01	2.50e-03	5.367e+01	4.94e-03	5.28e-01	2.60e-01	1.62e-01	4.53e-02
39	1.637e+03	8.72e-04	2.37e-04	2.53e-06	9.99e-01	2.800e-01	9.98e-01	2.49e-03	5.394e+01	4.90e-03	5.31e-01	2.59e-01	1.61e-01	4.46e-02
Total	4.317e+05	7.76e-04	2.47e-04	2.58e-06	9.99e-01	7.262e+01	9.97e-01	2.73e-03	1.308e+04	5.65e-03	4.86e-01	2.80e-01	1.70e-01	5.83e-02

Table 4.45. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	1.250e+00	3.20e-01	6.08e-04	7.35e-03	6.72e-01	5.375e-01	2.18e-01	7.86e-03	7.16e-01	5.74e-02
2	1.235e+00	3.24e-01	6.14e-04	7.42e-03	6.68e-01	5.255e-01	2.22e-01	7.95e-03	7.13e-01	5.69e-02
3	1.228e+00	3.27e-01	6.16e-04	7.53e-03	6.65e-01	5.190e-01	2.24e-01	8.01e-03	7.11e-01	5.69e-02
4	1.222e+00	3.30e-01	6.17e-04	7.64e-03	6.62e-01	5.140e-01	2.25e-01	8.06e-03	7.10e-01	5.70e-02
5	1.195e+00	3.48e-01	6.21e-04	8.23e-03	6.43e-01	4.882e-01	2.32e-01	8.28e-03	7.03e-01	5.74e-02
6	1.142e+00	3.75e-01	6.25e-04	9.02e-03	6.15e-01	4.379e-01	2.46e-01	8.68e-03	6.90e-01	5.57e-02
7	1.216e+00	3.33e-01	6.14e-04	7.65e-03	6.59e-01	5.046e-01	2.27e-01	8.09e-03	7.09e-01	5.59e-02
8	1.208e+00	3.35e-01	6.17e-04	7.69e-03	6.57e-01	4.987e-01	2.29e-01	8.14e-03	7.08e-01	5.56e-02
9	1.231e+00	3.25e-01	6.15e-04	7.46e-03	6.67e-01	5.220e-01	2.23e-01	7.99e-03	7.12e-01	5.68e-02
10	1.203e+00	3.37e-01	6.18e-04	7.78e-03	6.54e-01	4.938e-01	2.30e-01	8.19e-03	7.06e-01	5.57e-02
11	1.198e+00	3.41e-01	6.19e-04	7.89e-03	6.51e-01	4.893e-01	2.31e-01	8.24e-03	7.05e-01	5.58e-02
12	1.214e+00	3.36e-01	6.18e-04	7.83e-03	6.56e-01	5.063e-01	2.27e-01	8.13e-03	7.08e-01	5.72e-02
13	1.172e+00	3.58e-01	6.22e-04	8.48e-03	6.33e-01	4.653e-01	2.38e-01	8.45e-03	6.98e-01	5.61e-02
14	1.139e+00	3.77e-01	6.25e-04	9.06e-03	6.14e-01	4.358e-01	2.46e-01	8.70e-03	6.89e-01	5.57e-02
15	1.207e+00	3.35e-01	6.18e-04	7.70e-03	6.57e-01	4.976e-01	2.29e-01	8.15e-03	7.07e-01	5.56e-02
16	1.232e+00	3.24e-01	6.15e-04	7.43e-03	6.68e-01	5.232e-01	2.23e-01	7.98e-03	7.13e-01	5.68e-02
17	1.205e+00	3.36e-01	6.18e-04	7.73e-03	6.56e-01	4.964e-01	2.29e-01	8.17e-03	7.07e-01	5.56e-02
18	1.201e+00	3.39e-01	6.18e-04	7.83e-03	6.53e-01	4.924e-01	2.30e-01	8.21e-03	7.06e-01	5.58e-02
19	1.217e+00	3.35e-01	6.18e-04	7.79e-03	6.57e-01	5.085e-01	2.26e-01	8.11e-03	7.08e-01	5.72e-02
20	1.172e+00	3.58e-01	6.22e-04	8.47e-03	6.33e-01	4.658e-01	2.38e-01	8.45e-03	6.98e-01	5.62e-02
21	1.139e+00	3.77e-01	6.25e-04	9.07e-03	6.13e-01	4.355e-01	2.46e-01	8.70e-03	6.89e-01	5.57e-02
22	1.238e+00	3.21e-01	6.13e-04	7.34e-03	6.71e-01	5.293e-01	2.21e-01	7.94e-03	7.14e-01	5.69e-02
23	1.236e+00	3.22e-01	6.14e-04	7.41e-03	6.70e-01	5.270e-01	2.21e-01	7.96e-03	7.13e-01	5.71e-02
24	1.196e+00	3.48e-01	6.20e-04	8.23e-03	6.43e-01	4.890e-01	2.31e-01	8.28e-03	7.03e-01	5.75e-02
25	1.140e+00	3.77e-01	6.24e-04	9.09e-03	6.13e-01	4.360e-01	2.46e-01	8.70e-03	6.89e-01	5.58e-02
26	1.232e+00	3.22e-01	6.13e-04	7.37e-03	6.70e-01	5.219e-01	2.22e-01	7.99e-03	7.13e-01	5.63e-02
27	1.249e+00	3.17e-01	6.11e-04	7.27e-03	6.76e-01	5.404e-01	2.18e-01	7.87e-03	7.16e-01	5.76e-02
28	1.231e+00	3.28e-01	6.15e-04	7.63e-03	6.64e-01	5.226e-01	2.23e-01	8.02e-03	7.12e-01	5.78e-02
29	1.167e+00	3.62e-01	6.22e-04	8.61e-03	6.29e-01	4.610e-01	2.39e-01	8.49e-03	6.96e-01	5.63e-02
30	1.131e+00	3.83e-01	6.24e-04	9.29e-03	6.07e-01	4.287e-01	2.48e-01	8.77e-03	6.87e-01	5.59e-02
31	1.206e+00	3.42e-01	6.18e-04	8.06e-03	6.49e-01	4.983e-01	2.29e-01	8.21e-03	7.05e-01	5.76e-02
32	1.141e+00	3.77e-01	6.24e-04	9.09e-03	6.14e-01	4.373e-01	2.45e-01	8.70e-03	6.90e-01	5.60e-02
33	1.119e+00	3.91e-01	6.25e-04	9.60e-03	5.99e-01	4.180e-01	2.51e-01	8.88e-03	6.84e-01	5.60e-02
34	1.157e+00	3.68e-01	6.23e-04	8.85e-03	6.22e-01	4.520e-01	2.41e-01	8.58e-03	6.94e-01	5.65e-02
35	1.122e+00	3.90e-01	6.24e-04	9.56e-03	6.00e-01	4.202e-01	2.51e-01	8.86e-03	6.84e-01	5.61e-02
36	1.108e+00	3.99e-01	6.24e-04	9.92e-03	5.90e-01	4.082e-01	2.54e-01	8.98e-03	6.81e-01	5.62e-02
37	1.107e+00	4.00e-01	6.24e-04	9.96e-03	5.89e-01	4.072e-01	2.55e-01	8.99e-03	6.80e-01	5.62e-02
38	1.100e+00	4.06e-01	6.24e-04	1.02e-02	5.83e-01	4.008e-01	2.56e-01	9.05e-03	6.78e-01	5.63e-02
39	1.095e+00	4.09e-01	6.24e-04	1.03e-02	5.80e-01	3.969e-01	2.58e-01	9.10e-03	6.77e-01	5.64e-02
Total	3.125e+02	3.52e-01	6.19e-04	8.31e-03	6.40e-01	1.260e+02	2.34e-01	8.33e-03	7.01e-01	5.65e-02

Table 4.46. HELIOS results for PWR MOX benchmark Case BOL-1

Total production/total absorption = 1.30590
Multiplication factor (k_{eff}) = 1.30240

			Fraction of total capture rate								Fraction of total fission rate					
pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.065	2.3640e+15	0.00000	0.00615	0.32981	0.39625	0.09009	0.00347	0.00000	2.0850e+15	0.02733	0.05770	0.90235	0.00065	0.01197	0.0000e+00
2	1.063	2.3600e+15	0.00000	0.00616	0.32989	0.39609	0.09006	0.00347	0.00000	2.0810e+15	0.02735	0.05771	0.90232	0.00065	0.01197	0.0000e+00
3	1.061	2.3580e+15	0.00000	0.00615	0.33027	0.39588	0.09014	0.00347	0.00000	2.0780e+15	0.02734	0.05778	0.90226	0.00065	0.01197	0.0000e+00
4	1.060	2.3570e+15	0.00000	0.00616	0.33042	0.39579	0.09012	0.00347	0.00000	2.0760e+15	0.02735	0.05755	0.90247	0.00065	0.01198	0.0000e+00
5	1.029	2.3100e+15	0.00000	0.00614	0.33484	0.39287	0.09086	0.00343	0.00000	2.0160e+15	0.02726	0.05896	0.90117	0.00066	0.01195	0.0000e+00
6	0.930	2.1460e+15	0.00000	0.00615	0.34872	0.38341	0.09370	0.00330	0.00000	1.8210e+15	0.02706	0.06424	0.89607	0.00072	0.01190	0.0000e+00
7	1.006	2.2640e+15	0.00000	0.00615	0.33737	0.39111	0.09187	0.00340	0.00000	1.9700e+15	0.02720	0.06139	0.89880	0.00069	0.01193	0.0000e+00
8	1.011	2.2750e+15	0.00000	0.00615	0.33734	0.39187	0.09213	0.00340	0.00000	1.9800e+15	0.02718	0.06040	0.89981	0.00068	0.01194	0.0000e+00
9	1.064	2.3610e+15	0.00000	0.00616	0.32993	0.39649	0.09015	0.00347	0.00000	2.0840e+15	0.02734	0.05760	0.90244	0.00065	0.01197	0.0000e+00
10	1.010	2.2740e+15	0.00000	0.00615	0.33757	0.39170	0.09219	0.00340	0.00000	1.9780e+15	0.02717	0.06053	0.89969	0.00068	0.01193	0.0000e+00
11	1.008	2.2730e+15	0.00000	0.00615	0.33785	0.39156	0.09222	0.00340	0.00000	1.9750e+15	0.02718	0.06019	0.90001	0.00068	0.01194	0.0000e+00
12	1.056	2.3490e+15	0.00000	0.00615	0.33138	0.39555	0.09030	0.00346	0.00000	2.0680e+15	0.02732	0.05801	0.90206	0.00065	0.01197	0.0000e+00
13	0.982	2.2310e+15	0.00000	0.00614	0.34193	0.38875	0.09278	0.00336	0.00000	1.9230e+15	0.02710	0.06200	0.89829	0.00070	0.01191	0.0000e+00
14	0.925	2.1360e+15	0.00000	0.00614	0.34953	0.38295	0.09393	0.00330	0.00000	1.8120e+15	0.02701	0.06540	0.89497	0.00073	0.01189	0.0000e+00
15	1.006	2.2650e+15	0.00000	0.00615	0.33733	0.39111	0.09187	0.00340	0.00000	1.9710e+15	0.02720	0.06137	0.89882	0.00069	0.01193	0.0000e+00
16	1.066	2.3650e+15	0.00000	0.00616	0.32979	0.39662	0.09016	0.00347	0.00000	2.0880e+15	0.02734	0.05752	0.90252	0.00064	0.01197	0.0000e+00
17	1.014	2.2820e+15	0.00000	0.00615	0.33700	0.39209	0.09209	0.00341	0.00000	1.9870e+15	0.02719	0.06027	0.89993	0.00068	0.01194	0.0000e+00
18	1.013	2.2810e+15	0.00000	0.00615	0.33730	0.39194	0.09212	0.00341	0.00000	1.9840e+15	0.02720	0.05993	0.90026	0.00067	0.01194	0.0000e+00
19	1.058	2.3540e+15	0.00000	0.00616	0.33105	0.39575	0.09023	0.00346	0.00000	2.0730e+15	0.02732	0.05800	0.90206	0.00065	0.01197	0.0000e+00
20	0.984	2.2350e+15	0.00000	0.00614	0.34171	0.38891	0.09274	0.00337	0.00000	1.9270e+15	0.02710	0.06183	0.89845	0.00069	0.01192	0.0000e+00
21	0.926	2.1380e+15	0.00000	0.00614	0.34952	0.38296	0.09392	0.00330	0.00000	1.8130e+15	0.02701	0.06531	0.89506	0.00073	0.01189	0.0000e+00
22	1.082	2.3910e+15	0.00000	0.00616	0.32794	0.39791	0.08980	0.00349	0.00000	2.1190e+15	0.02738	0.05682	0.90318	0.00064	0.01198	0.0000e+00
23	1.084	2.3940e+15	0.00000	0.00617	0.32775	0.39806	0.08968	0.00349	0.00000	2.1230e+15	0.02741	0.05634	0.90362	0.00063	0.01199	0.0000e+00
24	1.035	2.3190e+15	0.00000	0.00615	0.33429	0.39361	0.09081	0.00343	0.00000	2.0280e+15	0.02728	0.05838	0.90172	0.00066	0.01196	0.0000e+00
25	0.929	2.1450e+15	0.00000	0.00615	0.34908	0.38337	0.09376	0.00330	0.00000	1.8200e+15	0.02705	0.06442	0.89590	0.00073	0.01190	0.0000e+00
26	1.064	2.3630e+15	0.00000	0.00615	0.33042	0.39626	0.09066	0.00347	0.00000	2.0850e+15	0.02731	0.05814	0.90194	0.00065	0.01197	0.0000e+00
27	1.120	2.4590e+15	0.00000	0.00615	0.32443	0.40089	0.08936	0.00352	0.00000	2.1940e+15	0.02740	0.05464	0.90535	0.00061	0.01200	0.0000e+00
28	1.099	2.4260e+15	0.00000	0.00614	0.32706	0.39908	0.08973	0.00350	0.00000	2.1520e+15	0.02736	0.05542	0.90460	0.00062	0.01199	0.0000e+00
29	0.982	2.2340e+15	0.00000	0.00614	0.34217	0.38863	0.09275	0.00336	0.00000	1.9240e+15	0.02711	0.06179	0.89849	0.00069	0.01192	0.0000e+00
30	0.921	2.1300e+15	0.00000	0.00614	0.35066	0.38214	0.09397	0.00329	0.00000	1.8030e+15	0.02698	0.06624	0.89416	0.00074	0.01188	0.0000e+00
31	1.056	2.3540e+15	0.00000	0.00615	0.33185	0.39533	0.09029	0.00346	0.00000	2.0690e+15	0.02733	0.05759	0.90246	0.00065	0.01197	0.0000e+00
32	0.938	2.1590e+15	0.00000	0.00615	0.34805	0.38405	0.09348	0.00331	0.00000	1.8380e+15	0.02706	0.06449	0.89582	0.00072	0.01190	0.0000e+00
33	0.908	2.1140e+15	0.00000	0.00614	0.35276	0.38086	0.09436	0.00327	0.00000	1.7790e+15	0.02698	0.06570	0.89470	0.00074	0.01188	0.0000e+00
34	0.968	2.2110e+15	0.00000	0.00615	0.34368	0.38698	0.09269	0.00335	0.00000	1.8960e+15	0.02714	0.06206	0.89818	0.00070	0.01193	0.0000e+00
35	0.916	2.1250e+15	0.00000	0.00614	0.35165	0.38156	0.09406	0.00328	0.00000	1.7940e+15	0.02699	0.06592	0.89447	0.00074	0.01188	0.0000e+00
36	0.899	2.0990e+15	0.00000	0.00613	0.35446	0.37965	0.09453	0.00325	0.00000	1.7610e+15	0.02694	0.06672	0.89372	0.00075	0.01187	0.0000e+00
37	0.899	2.0970e+15	0.00000	0.00614	0.35425	0.37930	0.09430	0.00326	0.00000	1.7600e+15	0.02696	0.06715	0.89327	0.00076	0.01187	0.0000e+00
38	0.895	2.0920e+15	0.00000	0.00613	0.35544	0.37899	0.09460	0.00325	0.00000	1.7520e+15	0.02692	0.06727	0.89320	0.00076	0.01186	0.0000e+00
39	0.890	2.0850e+15	0.00000	0.00614	0.35583	0.37825	0.09447	0.00324	0.00000	1.7440e+15	0.02693	0.06768	0.89277	0.00076	0.01187	0.0000e+00
Assembly total[c]		5.9670e+17	0.00000	0.00615	0.33942	0.39009	0.09202	0.00339	0.00000	5.1710e+17	0.02718	0.06105	0.89916	0.00069	0.01193	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.47. HELIOS results for PWR MOX benchmark Case BOL-2

Total production/total absorption = 1.23502
Multiplication factor (k_{eff}) = 1.23162

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.114	2.5020e+15	0.00000	0.00614	0.33408	0.39361	0.09116	0.00343	0.00000	2.1830e+15	0.02723	0.05797	0.90219	0.00065	0.01196	0.0000e+00
2	1.031	2.3710e+15	0.00000	0.00611	0.34575	0.38635	0.09361	0.00332	0.00000	2.0190e+15	0.02695	0.06192	0.89853	0.00070	0.01190	0.0000e+00
3	1.011	2.3430e+15	0.00000	0.00610	0.34890	0.38433	0.09420	0.00329	0.00000	1.9810e+15	0.02687	0.06284	0.89769	0.00071	0.01188	0.0000e+00
4	1.011	2.3430e+15	0.00000	0.00610	0.34915	0.38420	0.09422	0.00329	0.00000	1.9800e+15	0.02688	0.06269	0.89784	0.00071	0.01189	0.0000e+00
5	1.003	2.3320e+15	0.00000	0.00610	0.35068	0.38310	0.09434	0.00328	0.00000	1.9650e+15	0.02687	0.06333	0.89721	0.00071	0.01188	0.0000e+00
6	0.977	2.2810e+15	0.00000	0.00613	0.35331	0.38053	0.09475	0.00326	0.00000	1.9130e+15	0.02695	0.06480	0.89562	0.00073	0.01189	0.0000e+00
7	1.046	2.3870e+15	0.00000	0.00614	0.34264	0.38774	0.09310	0.00335	0.00000	2.0490e+15	0.02708	0.06194	0.89837	0.00070	0.01192	0.0000e+00
8	1.012	2.3390e+15	0.00000	0.00611	0.34822	0.38453	0.09437	0.00330	0.00000	1.9830e+15	0.02694	0.06310	0.89736	0.00071	0.01189	0.0000e+00
9	1.014	2.3450e+15	0.00000	0.00610	0.34838	0.38486	0.09415	0.00329	0.00000	1.9860e+15	0.02688	0.06277	0.89776	0.00071	0.01188	0.0000e+00
10	0.998	2.3180e+15	0.00000	0.00611	0.35058	0.38296	0.09479	0.00328	0.00000	1.9550e+15	0.02689	0.06384	0.89667	0.00072	0.01188	0.0000e+00
11	0.998	2.3190e+15	0.00000	0.00611	0.35088	0.38281	0.09483	0.00328	0.00000	1.9540e+15	0.02689	0.06358	0.89692	0.00072	0.01188	0.0000e+00
12	1.010	2.3420e+15	0.00000	0.00610	0.34966	0.38402	0.09426	0.00328	0.00000	1.9780e+15	0.02686	0.06317	0.89738	0.00071	0.01188	0.0000e+00
13	0.991	2.3090e+15	0.00000	0.00611	0.35223	0.38179	0.09487	0.00327	0.00000	1.9410e+15	0.02687	0.06458	0.89594	0.00073	0.01187	0.0000e+00
14	0.975	2.2750e+15	0.00000	0.00613	0.35366	0.38032	0.09485	0.00326	0.00000	1.9090e+15	0.02692	0.06575	0.89471	0.00074	0.01188	0.0000e+00
15	1.001	2.3180e+15	0.00000	0.00612	0.34932	0.38317	0.09438	0.00329	0.00000	1.9600e+15	0.02693	0.06426	0.89620	0.00072	0.01189	0.0000e+00
16	1.014	2.3460e+15	0.00000	0.00610	0.34863	0.38470	0.09422	0.00329	0.00000	1.9850e+15	0.02687	0.06275	0.89779	0.00071	0.01188	0.0000e+00
17	1.000	2.3220e+15	0.00000	0.00611	0.35041	0.38308	0.09479	0.00328	0.00000	1.9590e+15	0.02689	0.06368	0.89684	0.00072	0.01188	0.0000e+00
18	1.000	2.3230e+15	0.00000	0.00611	0.35072	0.38292	0.09480	0.00328	0.00000	1.9580e+15	0.02690	0.06343	0.89708	0.00072	0.01189	0.0000e+00
19	1.011	2.3440e+15	0.00000	0.00610	0.34961	0.38405	0.09425	0.00328	0.00000	1.9810e+15	0.02686	0.06322	0.89733	0.00071	0.01188	0.0000e+00
20	0.993	2.3130e+15	0.00000	0.00611	0.35218	0.38183	0.09487	0.00327	0.00000	1.9440e+15	0.02687	0.06448	0.89604	0.00073	0.01187	0.0000e+00
21	0.976	2.2780e+15	0.00000	0.00613	0.35368	0.38031	0.09484	0.00326	0.00000	1.9110e+15	0.02692	0.06571	0.89475	0.00074	0.01188	0.0000e+00
22	1.017	2.3550e+15	0.00000	0.00609	0.34848	0.38488	0.09422	0.00329	0.00000	1.9930e+15	0.02686	0.06252	0.89803	0.00070	0.01188	0.0000e+00
23	1.018	2.3570e+15	0.00000	0.00610	0.34866	0.38482	0.09417	0.00329	0.00000	1.9930e+15	0.02688	0.06227	0.89826	0.00070	0.01189	0.0000e+00
24	1.006	2.3380e+15	0.00000	0.00610	0.35073	0.38329	0.09437	0.00328	0.00000	1.9700e+15	0.02686	0.06315	0.89739	0.00071	0.01188	0.0000e+00
25	0.977	2.2820e+15	0.00000	0.00613	0.35370	0.38040	0.09479	0.00326	0.00000	1.9140e+15	0.02694	0.06519	0.89525	0.00074	0.01189	0.0000e+00
26	1.013	2.3490e+15	0.00000	0.00610	0.34906	0.38386	0.09447	0.00329	0.00000	1.9850e+15	0.02688	0.06321	0.89731	0.00071	0.01188	0.0000e+00
27	1.030	2.3860e+15	0.00000	0.00607	0.34828	0.38547	0.09433	0.00329	0.00000	2.0180e+15	0.02682	0.06155	0.89906	0.00069	0.01188	0.0000e+00
28	1.025	2.3780e+15	0.00000	0.00607	0.34917	0.38482	0.09438	0.00329	0.00000	2.0080e+15	0.02682	0.06194	0.89867	0.00070	0.01188	0.0000e+00
29	0.994	2.3180e+15	0.00000	0.00611	0.35246	0.38166	0.09485	0.00326	0.00000	1.9480e+15	0.02688	0.06451	0.89601	0.00073	0.01187	0.0000e+00
30	0.977	2.2810e+15	0.00000	0.00613	0.35409	0.37997	0.09481	0.00325	0.00000	1.9140e+15	0.02691	0.06641	0.89406	0.00075	0.01187	0.0000e+00
31	1.014	2.3540e+15	0.00000	0.00609	0.35016	0.38375	0.09427	0.00328	0.00000	1.9860e+15	0.02686	0.06297	0.89758	0.00071	0.01188	0.0000e+00
32	0.982	2.2930e+15	0.00000	0.00613	0.35358	0.38046	0.09473	0.00326	0.00000	1.9240e+15	0.02693	0.06555	0.89490	0.00074	0.01188	0.0000e+00
33	0.974	2.2800e+15	0.00000	0.00613	0.35484	0.37955	0.09486	0.00325	0.00000	1.9080e+15	0.02693	0.06577	0.89467	0.00074	0.01188	0.0000e+00
34	0.990	2.3100e+15	0.00000	0.00612	0.35283	0.38089	0.09460	0.00326	0.00000	1.9380e+15	0.02692	0.06458	0.89588	0.00073	0.01189	0.0000e+00
35	0.978	2.2860e+15	0.00000	0.00613	0.35446	0.37978	0.09477	0.00325	0.00000	1.9160e+15	0.02692	0.06608	0.89438	0.00075	0.01187	0.0000e+00
36	0.973	2.2780e+15	0.00000	0.00613	0.35537	0.37913	0.09486	0.00324	0.00000	1.9050e+15	0.02692	0.06635	0.89411	0.00075	0.01187	0.0000e+00
37	0.972	2.2760e+15	0.00000	0.00614	0.35523	0.37873	0.09466	0.00324	0.00000	1.9040e+15	0.02693	0.06683	0.89361	0.00075	0.01187	0.0000e+00
38	0.973	2.2800e+15	0.00000	0.00613	0.35562	0.37894	0.09481	0.00324	0.00000	1.9070e+15	0.02691	0.06669	0.89378	0.00075	0.01187	0.0000e+00
39	0.971	2.2760e+15	0.00000	0.00614	0.35566	0.37841	0.09462	0.00324	0.00000	1.9030e+15	0.02693	0.06713	0.89331	0.00076	0.01187	0.0000e+00
Assembly total[c]		6.1350e+17	0.00000	0.00611	0.35096	0.38265	0.09449	0.00328	0.00000	5.1710e+17	0.02690	0.06399	0.89650	0.00072	0.01188	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.48. HELIOS results for PWR MOX benchmark Case BOL-3

Total production/total absorption = 1.26646
Multiplication factor(k_{eff}) = 1.26137

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.061	2.5230e+15	0.00000	0.00590	0.38551	0.39590	0.09984	0.00307	0.00000	2.0780e+15	0.02438	0.07206	0.89118	0.00082	0.01155	0.0000e+00
2	1.058	2.5170e+15	0.00000	0.00591	0.38578	0.39556	0.09981	0.00307	0.00000	2.0710e+15	0.02441	0.07213	0.89108	0.00083	0.01156	0.0000e+00
3	1.055	2.5130e+15	0.00000	0.00591	0.38632	0.39513	0.09986	0.00306	0.00000	2.0660e+15	0.02441	0.07225	0.89096	0.00083	0.01155	0.0000e+00
4	1.052	2.5080e+15	0.00000	0.00591	0.38681	0.39474	0.09985	0.00306	0.00000	2.0600e+15	0.02442	0.07214	0.89105	0.00083	0.01156	0.0000e+00
5	1.019	2.4580e+15	0.00000	0.00592	0.39181	0.39020	0.10045	0.00302	0.00000	1.9960e+15	0.02444	0.07404	0.88913	0.00085	0.01154	0.0000e+00
6	0.935	2.3150e+15	0.00000	0.00599	0.40435	0.37834	0.10240	0.00294	0.00000	1.8320e+15	0.02464	0.07974	0.88315	0.00092	0.01155	0.0000e+00
7	1.017	2.4470e+15	0.00000	0.00593	0.39152	0.39028	0.10109	0.00302	0.00000	1.9920e+15	0.02443	0.07552	0.88765	0.00086	0.01154	0.0000e+00
8	1.024	2.4630e+15	0.00000	0.00592	0.39120	0.39112	0.10134	0.00303	0.00000	2.0050e+15	0.02440	0.07436	0.88885	0.00085	0.01154	0.0000e+00
9	1.059	2.5180e+15	0.00000	0.00591	0.38568	0.39590	0.09987	0.00307	0.00000	2.0740e+15	0.02440	0.07197	0.89125	0.00082	0.01156	0.0000e+00
10	1.022	2.4600e+15	0.00000	0.00592	0.39162	0.39074	0.10137	0.00302	0.00000	2.0010e+15	0.02440	0.07454	0.88866	0.00085	0.01154	0.0000e+00
11	1.019	2.4560e+15	0.00000	0.00592	0.39216	0.39033	0.10140	0.00302	0.00000	1.9950e+15	0.02441	0.07429	0.88890	0.00085	0.01154	0.0000e+00
12	1.046	2.4980e+15	0.00000	0.00591	0.38787	0.39403	0.09999	0.00305	0.00000	2.0480e+15	0.02441	0.07273	0.89047	0.00083	0.01155	0.0000e+00
13	0.987	2.4050e+15	0.00000	0.00593	0.39702	0.38585	0.10184	0.00298	0.00000	1.9340e+15	0.02443	0.07674	0.88643	0.00088	0.01152	0.0000e+00
14	0.932	2.3080e+15	0.00000	0.00599	0.40485	0.37787	0.10257	0.00293	0.00000	1.8260e+15	0.02460	0.08085	0.88208	0.00093	0.01154	0.0000e+00
15	1.017	2.4480e+15	0.00000	0.00593	0.39155	0.39023	0.10109	0.00302	0.00000	1.9920e+15	0.02443	0.07549	0.88767	0.00086	0.01154	0.0000e+00
16	1.062	2.5240e+15	0.00000	0.00591	0.38544	0.39618	0.09987	0.00307	0.00000	2.0800e+15	0.02439	0.07182	0.89141	0.00082	0.01155	0.0000e+00
17	1.026	2.4670e+15	0.00000	0.00592	0.39100	0.39132	0.10128	0.00303	0.00000	2.0090e+15	0.02440	0.07421	0.88900	0.00085	0.01154	0.0000e+00
18	1.023	2.4630e+15	0.00000	0.00592	0.39157	0.39089	0.10130	0.00302	0.00000	2.0030e+15	0.02442	0.07397	0.88922	0.00085	0.01155	0.0000e+00
19	1.049	2.5020e+15	0.00000	0.00591	0.38749	0.39438	0.09990	0.00306	0.00000	2.0530e+15	0.02441	0.07268	0.89053	0.00083	0.01155	0.0000e+00
20	0.989	2.4090e+15	0.00000	0.00593	0.39679	0.38609	0.10181	0.00298	0.00000	1.9380e+15	0.02443	0.07652	0.88664	0.00088	0.01153	0.0000e+00
21	0.932	2.3090e+15	0.00000	0.00599	0.40491	0.37784	0.10255	0.00293	0.00000	1.8260e+15	0.02461	0.08078	0.88215	0.00093	0.01154	0.0000e+00
22	1.075	2.5460e+15	0.00000	0.00590	0.38368	0.39791	0.09957	0.00308	0.00000	2.1060e+15	0.02438	0.07098	0.89226	0.00081	0.01156	0.0000e+00
23	1.074	2.5440e+15	0.00000	0.00591	0.38389	0.39781	0.09946	0.00309	0.00000	2.1030e+15	0.02441	0.07064	0.89257	0.00081	0.01157	0.0000e+00
24	1.024	2.4670e+15	0.00000	0.00592	0.39115	0.39108	0.10038	0.00303	0.00000	2.0060e+15	0.02444	0.07336	0.88981	0.00084	0.01155	0.0000e+00
25	0.933	2.3110e+15	0.00000	0.00599	0.40480	0.37810	0.10241	0.00293	0.00000	1.8280e+15	0.02464	0.07998	0.88291	0.00092	0.01155	0.0000e+00
26	1.069	2.5390e+15	0.00000	0.00589	0.38509	0.39691	0.10020	0.00307	0.00000	2.0940e+15	0.02433	0.07183	0.89148	0.00082	0.01154	0.0000e+00
27	1.111	2.6140e+15	0.00000	0.00586	0.38029	0.40183	0.09935	0.00310	0.00000	2.1750e+15	0.02426	0.06845	0.89496	0.00078	0.01155	0.0000e+00
28	1.087	2.5750e+15	0.00000	0.00587	0.38347	0.39888	0.09965	0.00308	0.00000	2.1280e+15	0.02429	0.06961	0.89376	0.00080	0.01154	0.0000e+00
29	0.985	2.4030e+15	0.00000	0.00593	0.39759	0.38546	0.10177	0.00298	0.00000	1.9300e+15	0.02444	0.07662	0.88652	0.00088	0.01153	0.0000e+00
30	0.924	2.2930e+15	0.00000	0.00599	0.40658	0.37634	0.10254	0.00292	0.00000	1.8090e+15	0.02461	0.08203	0.88089	0.00094	0.01153	0.0000e+00
31	1.043	2.4960e+15	0.00000	0.00591	0.38878	0.39346	0.09993	0.00305	0.00000	2.0420e+15	0.02442	0.07244	0.89076	0.00083	0.01155	0.0000e+00
32	0.940	2.3210e+15	0.00000	0.00599	0.40402	0.37892	0.10215	0.00294	0.00000	1.8400e+15	0.02461	0.08009	0.88283	0.00092	0.01154	0.0000e+00
33	0.911	2.2760e+15	0.00000	0.00600	0.40898	0.37430	0.10284	0.00290	0.00000	1.7830e+15	0.02466	0.08171	0.88115	0.00094	0.01154	0.0000e+00
34	0.968	2.3730e+15	0.00000	0.00595	0.39984	0.38303	0.10164	0.00297	0.00000	1.8950e+15	0.02453	0.07726	0.88577	0.00089	0.01155	0.0000e+00
35	0.916	2.2830e+15	0.00000	0.00599	0.40803	0.37519	0.10258	0.00291	0.00000	1.7940e+15	0.02464	0.08192	0.88096	0.00094	0.01153	0.0000e+00
36	0.898	2.2550e+15	0.00000	0.00600	0.41120	0.37227	0.10296	0.00289	0.00000	1.7590e+15	0.02467	0.08308	0.87976	0.00096	0.01153	0.0000e+00
37	0.897	2.2510e+15	0.00000	0.00600	0.41124	0.37194	0.10277	0.00289	0.00000	1.7560e+15	0.02468	0.08360	0.87923	0.00096	0.01153	0.0000e+00
38	0.892	2.2450e+15	0.00000	0.00600	0.41253	0.37109	0.10300	0.00288	0.00000	1.7460e+15	0.02467	0.08388	0.87896	0.00097	0.01152	0.0000e+00
39	0.886	2.2340e+15	0.00000	0.00601	0.41330	0.37013	0.10288	0.00287	0.00000	1.7350e+15	0.02469	0.08447	0.87834	0.00097	0.01152	0.0000e+00
Assembly total[c]		6.3980e+17	0.00000	0.00594	0.39513	0.38731	0.10120	0.00300	0.00000	5.1700e+17	0.02448	0.07593	0.88718	0.00087	0.01154	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.49. HELIOS results for PWR MOX benchmark Case BOL-4

Total production/total absorption = 1.19420
Multiplication factor (k_{eff}) = 1.18932

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.103	2.6670e+15	0.00000	0.00591	0.39210	0.39009	0.10084	0.00302	0.00000	2.1590e+15	0.02442	0.07271	0.89048	0.00084	0.01155	0.0000e+00
2	1.035	2.5630e+15	0.00000	0.00593	0.40262	0.38077	0.10237	0.00294	0.00000	2.0270e+15	0.02448	0.07678	0.88632	0.00089	0.01154	0.0000e+00
3	1.015	2.5330e+15	0.00000	0.00594	0.40618	0.37762	0.10280	0.00291	0.00000	1.9880e+15	0.02448	0.07802	0.88506	0.00090	0.01153	0.0000e+00
4	1.013	2.5310e+15	0.00000	0.00594	0.40659	0.37731	0.10279	0.00291	0.00000	1.9830e+15	0.02449	0.07794	0.88514	0.00090	0.01153	0.0000e+00
5	1.002	2.5130e+15	0.00000	0.00594	0.40835	0.37569	0.10291	0.00290	0.00000	1.9630e+15	0.02451	0.07881	0.88424	0.00091	0.01153	0.0000e+00
6	0.975	2.4560e+15	0.00000	0.00600	0.41100	0.37255	0.10327	0.00289	0.00000	1.9100e+15	0.02469	0.08069	0.88213	0.00093	0.01156	0.0000e+00
7	1.050	2.5760e+15	0.00000	0.00595	0.39933	0.38333	0.10220	0.00296	0.00000	2.0560e+15	0.02449	0.07662	0.88647	0.00088	0.01154	0.0000e+00
8	1.021	2.5370e+15	0.00000	0.00595	0.40475	0.37869	0.10310	0.00292	0.00000	1.9980e+15	0.02450	0.07793	0.88513	0.00090	0.01154	0.0000e+00
9	1.019	2.5370e+15	0.00000	0.00594	0.40538	0.37841	0.10277	0.00292	0.00000	1.9950e+15	0.02447	0.07782	0.88528	0.00090	0.01153	0.0000e+00
10	1.004	2.5140e+15	0.00000	0.00595	0.40763	0.37611	0.10340	0.00290	0.00000	1.9670e+15	0.02452	0.07900	0.88404	0.00091	0.01153	0.0000e+00
11	1.003	2.5120e+15	0.00000	0.00595	0.40807	0.37579	0.10342	0.00290	0.00000	1.9630e+15	0.02453	0.07879	0.88424	0.00091	0.01153	0.0000e+00
12	1.010	2.5260e+15	0.00000	0.00594	0.40713	0.37691	0.10283	0.00290	0.00000	1.9780e+15	0.02448	0.07851	0.88457	0.00091	0.01153	0.0000e+00
13	0.993	2.4930e+15	0.00000	0.00596	0.40966	0.37427	0.10344	0.00289	0.00000	1.9440e+15	0.02454	0.08009	0.88292	0.00092	0.01152	0.0000e+00
14	0.974	2.4510e+15	0.00000	0.00600	0.41124	0.37229	0.10337	0.00288	0.00000	1.9070e+15	0.02467	0.08166	0.88119	0.00094	0.01154	0.0000e+00
15	1.008	2.5130e+15	0.00000	0.00596	0.40623	0.37687	0.10306	0.00291	0.00000	1.9740e+15	0.02454	0.07934	0.88367	0.00091	0.01154	0.0000e+00
16	1.018	2.5380e+15	0.00000	0.00593	0.40572	0.37814	0.10281	0.00291	0.00000	1.9940e+15	0.02447	0.07782	0.88528	0.00090	0.01153	0.0000e+00
17	1.006	2.5170e+15	0.00000	0.00595	0.40750	0.37624	0.10340	0.00290	0.00000	1.9700e+15	0.02452	0.07881	0.88423	0.00091	0.01153	0.0000e+00
18	1.004	2.5160e+15	0.00000	0.00595	0.40796	0.37591	0.10339	0.00290	0.00000	1.9660e+15	0.02453	0.07863	0.88440	0.00091	0.01154	0.0000e+00
19	1.011	2.5270e+15	0.00000	0.00594	0.40712	0.37694	0.10280	0.00291	0.00000	1.9800e+15	0.02448	0.07856	0.88453	0.00091	0.01153	0.0000e+00
20	0.994	2.4970e+15	0.00000	0.00595	0.40962	0.37432	0.10344	0.00289	0.00000	1.9460e+15	0.02454	0.07998	0.88304	0.00092	0.01153	0.0000e+00
21	0.974	2.4530e+15	0.00000	0.00600	0.41130	0.37225	0.10335	0.00288	0.00000	1.9080e+15	0.02467	0.08163	0.88121	0.00094	0.01155	0.0000e+00
22	1.021	2.5450e+15	0.00000	0.00593	0.40575	0.37822	0.10280	0.00291	0.00000	1.9980e+15	0.02446	0.07760	0.88552	0.00090	0.01153	0.0000e+00
23	1.019	2.5430e+15	0.00000	0.00593	0.40611	0.37801	0.10272	0.00291	0.00000	1.9950e+15	0.02448	0.07743	0.88566	0.00089	0.01154	0.0000e+00
24	1.004	2.5170e+15	0.00000	0.00594	0.40838	0.37583	0.10290	0.00290	0.00000	1.9660e+15	0.02451	0.07861	0.88444	0.00091	0.01153	0.0000e+00
25	0.974	2.4550e+15	0.00000	0.00600	0.41138	0.37230	0.10327	0.00288	0.00000	1.9080e+15	0.02468	0.08113	0.88169	0.00094	0.01155	0.0000e+00
26	1.018	2.5430e+15	0.00000	0.00593	0.40649	0.37729	0.10309	0.00291	0.00000	1.9940e+15	0.02446	0.07822	0.88490	0.00090	0.01152	0.0000e+00
27	1.033	2.5790e+15	0.00000	0.00589	0.40567	0.37888	0.10292	0.00291	0.00000	2.0230e+15	0.02437	0.07643	0.88681	0.00088	0.01151	0.0000e+00
28	1.026	2.5660e+15	0.00000	0.00590	0.40667	0.37793	0.10295	0.00290	0.00000	2.0090e+15	0.02439	0.07698	0.88623	0.00089	0.01151	0.0000e+00
29	0.994	2.4980e+15	0.00000	0.00596	0.40999	0.37405	0.10339	0.00289	0.00000	1.9460e+15	0.02455	0.08007	0.88293	0.00092	0.01153	0.0000e+00
30	0.973	2.4500e+15	0.00000	0.00600	0.41180	0.37175	0.10329	0.00288	0.00000	1.9050e+15	0.02466	0.08248	0.88037	0.00095	0.01154	0.0000e+00
31	1.011	2.5320e+15	0.00000	0.00594	0.40778	0.37649	0.10277	0.00290	0.00000	1.9800e+15	0.02449	0.07837	0.88472	0.00091	0.01153	0.0000e+00
32	0.978	2.4620e+15	0.00000	0.00600	0.41130	0.37241	0.10320	0.00288	0.00000	1.9150e+15	0.02466	0.08153	0.88132	0.00094	0.01154	0.0000e+00
33	0.969	2.4460e+15	0.00000	0.00600	0.41268	0.37110	0.10331	0.00288	0.00000	1.8970e+15	0.02470	0.08192	0.88089	0.00095	0.01155	0.0000e+00
34	0.986	2.4830e+15	0.00000	0.00597	0.41067	0.37313	0.10311	0.00288	0.00000	1.9310e+15	0.02461	0.08032	0.88259	0.00093	0.01154	0.0000e+00
35	0.972	2.4510e+15	0.00000	0.00600	0.41227	0.37144	0.10323	0.00288	0.00000	1.9030e+15	0.02468	0.08222	0.88060	0.00095	0.01154	0.0000e+00
36	0.966	2.4400e+15	0.00000	0.00601	0.41327	0.37051	0.10329	0.00287	0.00000	1.8910e+15	0.02470	0.08264	0.88016	0.00096	0.01154	0.0000e+00
37	0.964	2.4360e+15	0.00000	0.00601	0.41331	0.37017	0.10312	0.00287	0.00000	1.8880e+15	0.02471	0.08318	0.87961	0.00096	0.01154	0.0000e+00
38	0.965	2.4390e+15	0.00000	0.00601	0.41357	0.37023	0.10324	0.00287	0.00000	1.8900e+15	0.02470	0.08307	0.87974	0.00096	0.01154	0.0000e+00
39	0.962	2.4330e+15	0.00000	0.00601	0.41381	0.36973	0.10307	0.00287	0.00000	1.8840e+15	0.02472	0.08358	0.87920	0.00097	0.01154	0.0000e+00
Assembly total[c]		6.6130e+17	0.00000	0.00596	0.40843	0.37538	0.10306	0.00290	0.00000	5.1700e+17	0.02455	0.07948	0.88352	0.00092	0.01153	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.50. HELIOS results for PWR MOX benchmark Case BOL-5

Total production/total absorption = 1.22556
Multiplication factor (k_{eff}) = 1.22065

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.062	2.6820e+15	0.02729	0.00555	0.38970	0.37556	0.10021	0.00287	0.02729	2.0790e+15	0.02413	0.07349	0.89007	0.00084	0.01146	1.9983e-08
2	1.058	2.6750e+15	0.02723	0.00556	0.38999	0.37527	0.10018	0.00287	0.02723	2.0730e+15	0.02415	0.07357	0.88997	0.00084	0.01147	1.9953e-08
3	1.056	2.6710e+15	0.02713	0.00556	0.39058	0.37486	0.10024	0.00287	0.02713	2.0670e+15	0.02416	0.07368	0.88985	0.00085	0.01147	1.9944e-08
4	1.052	2.6650e+15	0.02704	0.00556	0.39109	0.37451	0.10022	0.00286	0.02704	2.0600e+15	0.02417	0.07358	0.88993	0.00085	0.01147	1.9917e-08
5	1.020	2.6100e+15	0.02602	0.00557	0.39640	0.37045	0.10085	0.00283	0.02602	1.9970e+15	0.02419	0.07551	0.88798	0.00087	0.01145	1.9775e-08
6	0.935	2.4530e+15	0.02345	0.00565	0.40975	0.35976	0.10300	0.00275	0.02345	1.8310e+15	0.02439	0.08138	0.88183	0.00094	0.01146	1.9272e-08
7	1.017	2.5980e+15	0.02599	0.00559	0.39608	0.37053	0.10157	0.00283	0.02599	1.9930e+15	0.02417	0.07705	0.88645	0.00088	0.01145	1.9775e-08
8	1.024	2.6150e+15	0.02608	0.00558	0.39574	0.37125	0.10183	0.00283	0.02608	2.0050e+15	0.02414	0.07587	0.88767	0.00087	0.01145	1.9841e-08
9	1.060	2.6770e+15	0.02726	0.00556	0.38984	0.37559	0.10026	0.00287	0.02726	2.0750e+15	0.02415	0.07340	0.89015	0.00084	0.01147	1.9968e-08
10	1.022	2.6120e+15	0.02601	0.00558	0.39619	0.37089	0.10186	0.00283	0.02601	2.0010e+15	0.02415	0.07606	0.88748	0.00087	0.01145	1.9832e-08
11	1.018	2.6070e+15	0.02591	0.00558	0.39678	0.37052	0.10189	0.00283	0.02591	1.9940e+15	0.02416	0.07580	0.88771	0.00087	0.01145	1.9811e-08
12	1.046	2.6540e+15	0.02685	0.00556	0.39216	0.37390	0.10038	0.00286	0.02685	2.0490e+15	0.02416	0.07417	0.88935	0.00085	0.01146	1.9904e-08
13	0.987	2.5510e+15	0.02494	0.00559	0.40193	0.36650	0.10235	0.00279	0.02494	1.9340e+15	0.02419	0.07829	0.88520	0.00090	0.01143	1.9654e-08
14	0.932	2.4450e+15	0.02333	0.00565	0.41025	0.35935	0.10319	0.00275	0.02333	1.8250e+15	0.02436	0.08252	0.88074	0.00095	0.01144	1.9275e-08
15	1.017	2.5980e+15	0.02599	0.00559	0.39612	0.37047	0.10157	0.00283	0.02599	1.9920e+15	0.02418	0.07703	0.88646	0.00088	0.01145	1.9772e-08
16	1.062	2.6830e+15	0.02732	0.00556	0.38959	0.37582	0.10026	0.00287	0.02732	2.0810e+15	0.02414	0.07324	0.89031	0.00084	0.01147	1.9989e-08
17	1.026	2.6200e+15	0.02614	0.00557	0.39554	0.37141	0.10177	0.00283	0.02614	2.0090e+15	0.02414	0.07572	0.88782	0.00087	0.01145	1.9850e-08
18	1.023	2.6150e+15	0.02604	0.00558	0.39615	0.37102	0.10179	0.00283	0.02604	2.0030e+15	0.02416	0.07547	0.88804	0.00087	0.01146	1.9829e-08
19	1.049	2.6580e+15	0.02694	0.00556	0.39176	0.37420	0.10029	0.00286	0.02694	2.0540e+15	0.02416	0.07412	0.88941	0.00085	0.01146	1.9917e-08
20	0.989	2.5560e+15	0.02500	0.00559	0.40168	0.36672	0.10232	0.00279	0.02500	1.9380e+15	0.02418	0.07806	0.88542	0.00090	0.01144	1.9667e-08
21	0.932	2.4460e+15	0.02333	0.00565	0.41032	0.35931	0.10317	0.00275	0.02333	1.8250e+15	0.02436	0.08244	0.88081	0.00095	0.01144	1.9278e-08
22	1.076	2.7070e+15	0.02772	0.00555	0.38772	0.37736	0.09994	0.00288	0.02772	2.1070e+15	0.02413	0.07239	0.89117	0.00083	0.01147	2.0043e-08
23	1.074	2.7040e+15	0.02770	0.00556	0.38794	0.37726	0.09983	0.00289	0.02770	2.1040e+15	0.02416	0.07205	0.89148	0.00083	0.01148	2.0019e-08
24	1.025	2.6190e+15	0.02617	0.00557	0.39566	0.37125	0.10078	0.00283	0.02617	2.0070e+15	0.02419	0.07481	0.88867	0.00086	0.01146	1.9802e-08
25	0.933	2.4480e+15	0.02338	0.00565	0.41019	0.35954	0.10302	0.00275	0.02338	1.8270e+15	0.02439	0.08163	0.88158	0.00094	0.01146	1.9263e-08
26	1.069	2.6980e+15	0.02742	0.00554	0.38924	0.37643	0.10058	0.00287	0.02742	2.0940e+15	0.02407	0.07327	0.89036	0.00084	0.01145	2.0061e-08
27	1.111	2.7810e+15	0.02850	0.00551	0.38413	0.38080	0.09964	0.00290	0.02850	2.1760e+15	0.02401	0.06979	0.89394	0.00080	0.01146	2.0278e-08
28	1.087	2.7380e+15	0.02784	0.00552	0.38750	0.37818	0.09995	0.00288	0.02784	2.1290e+15	0.02404	0.07097	0.89271	0.00082	0.01146	2.0166e-08
29	0.985	2.5490e+15	0.02487	0.00559	0.40253	0.36614	0.10228	0.00279	0.02487	1.9300e+15	0.02420	0.07817	0.88529	0.00090	0.01144	1.9639e-08
30	0.923	2.4290e+15	0.02305	0.00565	0.41209	0.35794	0.10316	0.00274	0.02305	1.8080e+15	0.02436	0.08372	0.87952	0.00096	0.01143	1.9224e-08
31	1.043	2.6510e+15	0.02673	0.00556	0.39312	0.37337	0.10031	0.00285	0.02673	2.0420e+15	0.02417	0.07387	0.88964	0.00085	0.01147	1.9886e-08
32	0.939	2.4590e+15	0.02359	0.00565	0.40935	0.36027	0.10275	0.00276	0.02359	1.8390e+15	0.02436	0.08174	0.88150	0.00094	0.01145	1.9302e-08
33	0.910	2.4100e+15	0.02258	0.00566	0.41465	0.35609	0.10347	0.00272	0.02258	1.7820e+15	0.02442	0.08340	0.87978	0.00096	0.01145	1.9139e-08
34	0.968	2.5160e+15	0.02442	0.00561	0.40491	0.36400	0.10216	0.00278	0.02442	1.8950e+15	0.02429	0.07883	0.88452	0.00091	0.01146	1.9489e-08
35	0.916	2.4180e+15	0.02279	0.00566	0.41362	0.35690	0.10320	0.00273	0.02279	1.7930e+15	0.02439	0.08362	0.87959	0.00096	0.01144	1.9173e-08
36	0.898	2.3870e+15	0.02217	0.00567	0.41699	0.35427	0.10359	0.00271	0.02217	1.7580e+15	0.02443	0.08480	0.87837	0.00098	0.01143	1.9064e-08
37	0.896	2.3830e+15	0.02216	0.00567	0.41704	0.35399	0.10340	0.00271	0.02216	1.7550e+15	0.02444	0.08532	0.87782	0.00098	0.01143	1.9040e-08
38	0.891	2.3750e+15	0.02193	0.00567	0.41839	0.35320	0.10364	0.00270	0.02193	1.7450e+15	0.02443	0.08560	0.87755	0.00099	0.01143	1.9031e-08
39	0.886	2.3640e+15	0.02178	0.00567	0.41921	0.35235	0.10352	0.00269	0.02178	1.7340e+15	0.02445	0.08620	0.87692	0.00099	0.01143	1.8974e-08
Assembly total[c]		6.7900e+17	0.02537	0.00559	0.39991	0.36782	0.10169	0.00281	0.02537	5.1700e+17	0.02423	0.07746	0.88597	0.00089	0.01145	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.51. HELIOS results for PWR MOX benchmark Case BOL-6

Total production/total absorption = 1.15648
Multiplication factor (k_{eff}) = 1.15177

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.103	2.8350e+15	0.02695	0.00556	0.39637	0.36990	0.10114	0.00282	0.02695	2.1600e+15	0.02418	0.07417	0.88933	0.00085	0.01147	2.0660e-08
2	1.036	2.7210e+15	0.02484	0.00559	0.40753	0.36151	0.10279	0.00275	0.02484	2.0280e+15	0.02423	0.07831	0.88510	0.00090	0.01145	2.0404e-08
3	1.016	2.6890e+15	0.02415	0.00559	0.41127	0.35870	0.10324	0.00273	0.02415	1.9890e+15	0.02425	0.07955	0.88384	0.00092	0.01144	2.0335e-08
4	1.014	2.6870e+15	0.02408	0.00560	0.41170	0.35841	0.10323	0.00272	0.02408	1.9850e+15	0.02426	0.07947	0.88391	0.00092	0.01144	2.0323e-08
5	1.003	2.6670e+15	0.02375	0.00560	0.41361	0.35691	0.10335	0.00271	0.02375	1.9630e+15	0.02428	0.08039	0.88297	0.00093	0.01144	2.0263e-08
6	0.975	2.6030e+15	0.02316	0.00566	0.41644	0.35411	0.10380	0.00270	0.02316	1.9080e+15	0.02445	0.08238	0.88076	0.00095	0.01146	2.0004e-08
7	1.050	2.7360e+15	0.02542	0.00560	0.40403	0.36386	0.10262	0.00277	0.02542	2.0560e+15	0.02424	0.07819	0.88522	0.00090	0.01145	2.0425e-08
8	1.021	2.6930e+15	0.02438	0.00560	0.40977	0.35963	0.10358	0.00274	0.02438	1.9990e+15	0.02426	0.07951	0.88387	0.00092	0.01144	2.0332e-08
9	1.020	2.6940e+15	0.02429	0.00559	0.41039	0.35943	0.10321	0.00273	0.02429	1.9970e+15	0.02424	0.07935	0.88406	0.00092	0.01144	2.0353e-08
10	1.005	2.6680e+15	0.02384	0.00561	0.41279	0.35732	0.10389	0.00272	0.02384	1.9680e+15	0.02428	0.08059	0.88276	0.00093	0.01144	2.0269e-08
11	1.003	2.6660e+15	0.02377	0.00561	0.41327	0.35703	0.10392	0.00271	0.02377	1.9640e+15	0.02429	0.08038	0.88296	0.00093	0.01144	2.0260e-08
12	1.011	2.6810e+15	0.02399	0.00560	0.41224	0.35807	0.10328	0.00272	0.02399	1.9800e+15	0.02425	0.08006	0.88333	0.00093	0.01144	2.0320e-08
13	0.992	2.6440e+15	0.02348	0.00561	0.41499	0.35562	0.10394	0.00270	0.02348	1.9430e+15	0.02430	0.08173	0.88159	0.00094	0.01143	2.0200e-08
14	0.973	2.5970e+15	0.02310	0.00566	0.41667	0.35388	0.10392	0.00270	0.02310	1.9050e+15	0.02443	0.08336	0.87979	0.00096	0.01145	2.0010e-08
15	1.008	2.6670e+15	0.02406	0.00562	0.41133	0.35804	0.10354	0.00273	0.02406	1.9740e+15	0.02430	0.08095	0.88238	0.00093	0.01144	2.0245e-08
16	1.019	2.6950e+15	0.02424	0.00559	0.41075	0.35918	0.10326	0.00273	0.02424	1.9950e+15	0.02423	0.07934	0.88407	0.00092	0.01144	2.0359e-08
17	1.006	2.6720e+15	0.02388	0.00561	0.41265	0.35744	0.10389	0.00272	0.02388	1.9710e+15	0.02428	0.08039	0.88296	0.00093	0.01144	2.0281e-08
18	1.004	2.6700e+15	0.02381	0.00561	0.41315	0.35713	0.10388	0.00272	0.02381	1.9670e+15	0.02429	0.08021	0.88313	0.00093	0.01144	2.0269e-08
19	1.012	2.6830e+15	0.02401	0.00560	0.41223	0.35808	0.10325	0.00272	0.02401	1.9820e+15	0.02425	0.08011	0.88328	0.00093	0.01143	2.0329e-08
20	0.994	2.6480e+15	0.02350	0.00561	0.41495	0.35565	0.10394	0.00270	0.02350	1.9460e+15	0.02430	0.08161	0.88171	0.00094	0.01143	2.0212e-08
21	0.973	2.5990e+15	0.02311	0.00566	0.41673	0.35383	0.10390	0.00270	0.02311	1.9060e+15	0.02443	0.08334	0.87982	0.00096	0.01145	2.0016e-08
22	1.022	2.7030e+15	0.02427	0.00559	0.41075	0.35926	0.10324	0.00273	0.02427	2.0000e+15	0.02422	0.07911	0.88431	0.00091	0.01144	2.0389e-08
23	1.020	2.7000e+15	0.02423	0.00559	0.41111	0.35907	0.10316	0.00273	0.02423	1.9970e+15	0.02424	0.07894	0.88446	0.00091	0.01145	2.0371e-08
24	1.004	2.6710e+15	0.02377	0.00560	0.41360	0.35705	0.10335	0.00271	0.02377	1.9670e+15	0.02428	0.08018	0.88317	0.00093	0.01144	2.0284e-08
25	0.974	2.6010e+15	0.02311	0.00566	0.41681	0.35388	0.10382	0.00270	0.02311	1.9070e+15	0.02444	0.08283	0.88031	0.00096	0.01146	2.0013e-08
26	1.019	2.7000e+15	0.02415	0.00558	0.41156	0.35838	0.10352	0.00272	0.02415	1.9950e+15	0.02422	0.07976	0.88367	0.00092	0.01143	2.0383e-08
27	1.034	2.7400e+15	0.02440	0.00555	0.41068	0.35976	0.10332	0.00272	0.02440	2.0260e+15	0.02413	0.07790	0.88564	0.00090	0.01143	2.0534e-08
28	1.027	2.7250e+15	0.02420	0.00556	0.41177	0.35889	0.10336	0.00272	0.02420	2.0100e+15	0.02416	0.07848	0.88503	0.00091	0.01142	2.0486e-08
29	0.993	2.6490e+15	0.02346	0.00561	0.41534	0.35539	0.10388	0.00270	0.02346	1.9450e+15	0.02431	0.08172	0.88159	0.00095	0.01143	2.0215e-08
30	0.972	2.5950e+15	0.02305	0.00566	0.41727	0.35336	0.10383	0.00270	0.02305	1.9030e+15	0.02442	0.08423	0.87894	0.00097	0.01144	2.0019e-08
31	1.012	2.6870e+15	0.02394	0.00559	0.41293	0.35764	0.10322	0.00272	0.02394	1.9810e+15	0.02425	0.07992	0.88346	0.00093	0.01144	2.0344e-08
32	0.977	2.6080e+15	0.02318	0.00565	0.41670	0.35396	0.10373	0.00270	0.02318	1.9140e+15	0.02442	0.08324	0.87992	0.00096	0.01145	2.0052e-08
33	0.968	2.5910e+15	0.02290	0.00566	0.41821	0.35275	0.10386	0.00269	0.02290	1.8950e+15	0.02446	0.08366	0.87946	0.00097	0.01145	1.9986e-08
34	0.986	2.6320e+15	0.02332	0.00563	0.41607	0.35459	0.10360	0.00270	0.02332	1.9300e+15	0.02438	0.08199	0.88124	0.00095	0.01145	2.0127e-08
35	0.971	2.5950e+15	0.02299	0.00566	0.41777	0.35306	0.10377	0.00269	0.02299	1.9010e+15	0.02444	0.08397	0.87917	0.00097	0.01145	2.0013e-08
36	0.964	2.5830e+15	0.02280	0.00567	0.41886	0.35220	0.10384	0.00269	0.02280	1.8880e+15	0.02446	0.08441	0.87871	0.00098	0.01145	1.9971e-08
37	0.963	2.5790e+15	0.02279	0.00567	0.41891	0.35190	0.10367	0.00269	0.02279	1.8850e+15	0.02447	0.08496	0.87814	0.00098	0.01145	1.9947e-08
38	0.963	2.5820e+15	0.02276	0.00567	0.41918	0.35193	0.10379	0.00269	0.02276	1.8870e+15	0.02446	0.08485	0.87827	0.00098	0.01144	1.9971e-08
39	0.961	2.5750e+15	0.02271	0.00567	0.41944	0.35149	0.10362	0.00269	0.02271	1.8810e+15	0.02448	0.08539	0.87771	0.00099	0.01144	1.9938e-08
Assembly total[c]		7.0150e+17	0.02373	0.00562	0.41366	0.35665	0.10355	0.00271	0.02373	5.1700e+17	0.02431	0.08110	0.88221	0.00094	0.01144	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.52. HELIOS results for PWR MOX benchmark Case BOL-7

Total production/total absorption = 1.25353
Multiplication factor (k_{eff}) = 1.24851

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.063	2.5920e+15	0.02857	0.00570	0.39659	0.38889	0.10224	0.00298	0.02857	2.0830e+15	0.02415	0.07238	0.89116	0.00083	0.01147	1.9835e-08
2	1.060	2.5850e+15	0.02851	0.00571	0.39690	0.38859	0.10222	0.00298	0.02851	2.0760e+15	0.02417	0.07246	0.89106	0.00083	0.01148	1.9802e-08
3	1.057	2.5810e+15	0.02840	0.00571	0.39749	0.38814	0.10228	0.00297	0.02840	2.0700e+15	0.02417	0.07258	0.89094	0.00083	0.01148	1.9790e-08
4	1.053	2.5750e+15	0.02830	0.00571	0.39804	0.38776	0.10227	0.00297	0.02830	2.0630e+15	0.02419	0.07248	0.89102	0.00083	0.01148	1.9766e-08
5	1.020	2.5210e+15	0.02720	0.00572	0.40347	0.38331	0.10292	0.00293	0.02720	1.9970e+15	0.02421	0.07443	0.88905	0.00086	0.01146	1.9618e-08
6	0.933	2.3690e+15	0.02446	0.00579	0.41698	0.37168	0.10510	0.00285	0.02446	1.8280e+15	0.02439	0.08035	0.88287	0.00093	0.01147	1.9115e-08
7	1.018	2.5120e+15	0.02719	0.00573	0.40295	0.38338	0.10361	0.00293	0.02719	1.9940e+15	0.02419	0.07594	0.88755	0.00087	0.01146	1.9624e-08
8	1.025	2.5290e+15	0.02728	0.00572	0.40253	0.38406	0.10385	0.00293	0.02728	2.0070e+15	0.02416	0.07477	0.88876	0.00086	0.01146	1.9691e-08
9	1.061	2.5870e+15	0.02854	0.00571	0.39671	0.38889	0.10229	0.00298	0.02854	2.0780e+15	0.02417	0.07229	0.89124	0.00083	0.01148	1.9817e-08
10	1.023	2.5250e+15	0.02720	0.00572	0.40300	0.38367	0.10388	0.00293	0.02720	2.0020e+15	0.02416	0.07495	0.88857	0.00086	0.01146	1.9679e-08
11	1.019	2.5210e+15	0.02709	0.00572	0.40360	0.38326	0.10392	0.00293	0.02709	1.9960e+15	0.02417	0.07471	0.88880	0.00086	0.01146	1.9657e-08
12	1.047	2.5640e+15	0.02809	0.00571	0.39910	0.38703	0.10243	0.00296	0.02809	2.0510e+15	0.02418	0.07307	0.89044	0.00084	0.01147	1.9751e-08
13	0.987	2.4650e+15	0.02605	0.00573	0.40889	0.37887	0.10440	0.00289	0.02605	1.9330e+15	0.02420	0.07721	0.88626	0.00089	0.01144	1.9495e-08
14	0.930	2.3610e+15	0.02433	0.00579	0.41747	0.37121	0.10529	0.00284	0.02433	1.8220e+15	0.02436	0.08147	0.88178	0.00094	0.01145	1.9118e-08
15	1.018	2.5120e+15	0.02719	0.00573	0.40300	0.38332	0.10361	0.00293	0.02719	1.9940e+15	0.02419	0.07591	0.88757	0.00087	0.01146	1.9621e-08
16	1.064	2.5930e+15	0.02860	0.00571	0.39644	0.38913	0.10229	0.00298	0.02860	2.0840e+15	0.02416	0.07213	0.89140	0.00083	0.01148	1.9838e-08
17	1.027	2.5330e+15	0.02735	0.00572	0.40234	0.38424	0.10379	0.00294	0.02735	2.0110e+15	0.02416	0.07462	0.88891	0.00086	0.01146	1.9697e-08
18	1.024	2.5280e+15	0.02724	0.00572	0.40295	0.38381	0.10381	0.00293	0.02724	2.0040e+15	0.02418	0.07437	0.88913	0.00085	0.01147	1.9673e-08
19	1.050	2.5690e+15	0.02819	0.00571	0.39869	0.38737	0.10233	0.00297	0.02819	2.0560e+15	0.02417	0.07301	0.89050	0.00084	0.01147	1.9763e-08
20	0.989	2.4700e+15	0.02611	0.00573	0.40864	0.37911	0.10437	0.00289	0.02611	1.9370e+15	0.02419	0.07699	0.88649	0.00088	0.01144	1.9510e-08
21	0.930	2.3620e+15	0.02433	0.00579	0.41753	0.37117	0.10527	0.00284	0.02433	1.8220e+15	0.02437	0.08139	0.88185	0.00094	0.01145	1.9118e-08
22	1.078	2.6160e+15	0.02903	0.00570	0.39453	0.39081	0.10195	0.00299	0.02903	2.1110e+15	0.02415	0.07128	0.89227	0.00082	0.01148	1.9892e-08
23	1.076	2.6140e+15	0.02901	0.00571	0.39476	0.39071	0.10185	0.00299	0.02901	2.1070e+15	0.02418	0.07094	0.89258	0.00081	0.01149	1.9865e-08
24	1.025	2.5300e+15	0.02736	0.00572	0.40268	0.38415	0.10285	0.00294	0.02736	2.0080e+15	0.02421	0.07373	0.88975	0.00085	0.01147	1.9648e-08
25	0.931	2.3650e+15	0.02439	0.00580	0.41741	0.37142	0.10512	0.00284	0.02439	1.8240e+15	0.02440	0.08059	0.88262	0.00093	0.01147	1.9103e-08
26	1.071	2.6090e+15	0.02871	0.00569	0.39594	0.38973	0.10258	0.00298	0.02871	2.0980e+15	0.02409	0.07214	0.89147	0.00083	0.01147	1.9907e-08
27	1.114	2.6890e+15	0.02986	0.00566	0.39080	0.39443	0.10163	0.00301	0.02986	2.1810e+15	0.02404	0.06867	0.89503	0.00079	0.01148	2.0124e-08
28	1.089	2.6470e+15	0.02914	0.00567	0.39427	0.39159	0.10196	0.00299	0.02914	2.1330e+15	0.02406	0.06987	0.89380	0.00080	0.01147	2.0013e-08
29	0.985	2.4630e+15	0.02597	0.00573	0.40950	0.37849	0.10433	0.00289	0.02597	1.9290e+15	0.02421	0.07709	0.88636	0.00089	0.01145	1.9480e-08
30	0.921	2.3450e+15	0.02402	0.00579	0.41935	0.36968	0.10526	0.00283	0.02402	1.8040e+15	0.02437	0.08267	0.88057	0.00095	0.01144	1.9061e-08
31	1.044	2.5610e+15	0.02796	0.00571	0.40006	0.38646	0.10235	0.00296	0.02796	2.0440e+15	0.02419	0.07276	0.89073	0.00084	0.01148	1.9733e-08
32	0.938	2.3740e+15	0.02461	0.00579	0.41653	0.37222	0.10484	0.00285	0.02461	1.8360e+15	0.02437	0.08067	0.88257	0.00093	0.01146	1.9142e-08
33	0.908	2.3270e+15	0.02352	0.00580	0.42197	0.36766	0.10559	0.00281	0.02352	1.7770e+15	0.02442	0.08237	0.88080	0.00095	0.01145	1.8977e-08
34	0.967	2.4300e+15	0.02549	0.00576	0.41202	0.37626	0.10423	0.00288	0.02549	1.8930e+15	0.02430	0.07775	0.88559	0.00090	0.01146	1.9329e-08
35	0.913	2.3340e+15	0.02375	0.00580	0.42092	0.36855	0.10531	0.00282	0.02375	1.7890e+15	0.02440	0.08257	0.88063	0.00095	0.01145	1.9010e-08
36	0.895	2.3040e+15	0.02308	0.00581	0.42438	0.36567	0.10572	0.00280	0.02308	1.7530e+15	0.02443	0.08378	0.87939	0.00097	0.01144	1.8899e-08
37	0.893	2.3000e+15	0.02307	0.00581	0.42447	0.36542	0.10553	0.00280	0.02307	1.7500e+15	0.02444	0.08430	0.87885	0.00097	0.01144	1.8874e-08
38	0.888	2.2930e+15	0.02282	0.00581	0.42583	0.36450	0.10577	0.00279	0.02282	1.7390e+15	0.02443	0.08459	0.87857	0.00098	0.01143	1.8862e-08
39	0.882	2.2810e+15	0.02266	0.00581	0.42671	0.36363	0.10567	0.00278	0.02266	1.7280e+15	0.02445	0.08519	0.87794	0.00098	0.01143	1.8808e-08
Assembly total[c]		6.5600e+17	0.02651	0.00574	0.40692	0.38040	0.10374	0.00291	0.02651	5.1700e+17	0.02424	0.07638	0.88704	0.00088	0.01146	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.53. HELIOS results for PWR MOX benchmark Case BOL-8

Total production/total absorption = 1.17915
Multiplication factor (k_{eff}) = 1.17434

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.106	2.7470e+15	0.02819	0.00571	0.40338	0.38266	0.10324	0.00292	0.02819	2.1660e+15	0.02419	0.07308	0.89041	0.00084	0.01148	2.0525e-08
2	1.037	2.6360e+15	0.02593	0.00573	0.41467	0.37347	0.10491	0.00285	0.02593	2.0310e+15	0.02424	0.07727	0.88614	0.00089	0.01146	2.0266e-08
3	1.016	2.6040e+15	0.02518	0.00573	0.41851	0.37037	0.10537	0.00282	0.02518	1.9900e+15	0.02425	0.07854	0.88485	0.00091	0.01145	2.0194e-08
4	1.014	2.6010e+15	0.02511	0.00573	0.41896	0.37005	0.10537	0.00282	0.02511	1.9850e+15	0.02426	0.07847	0.88491	0.00091	0.01145	2.0182e-08
5	1.003	2.5820e+15	0.02476	0.00574	0.42090	0.36844	0.10549	0.00280	0.02476	1.9630e+15	0.02428	0.07939	0.88397	0.00092	0.01144	2.0118e-08
6	0.974	2.5200e+15	0.02413	0.00580	0.42379	0.36547	0.10596	0.00279	0.02413	1.9080e+15	0.02445	0.08137	0.88177	0.00094	0.01147	1.9862e-08
7	1.052	2.6500e+15	0.02656	0.00574	0.41107	0.37605	0.10472	0.00287	0.02656	2.0600e+15	0.02425	0.07711	0.88630	0.00089	0.01146	2.0287e-08
8	1.022	2.6090e+15	0.02545	0.00574	0.41688	0.37139	0.10570	0.00283	0.02545	2.0010e+15	0.02426	0.07847	0.88491	0.00091	0.01145	2.0194e-08
9	1.020	2.6090e+15	0.02533	0.00573	0.41759	0.37116	0.10535	0.00283	0.02533	1.9980e+15	0.02424	0.07833	0.88508	0.00091	0.01145	2.0215e-08
10	1.005	2.5830e+15	0.02486	0.00575	0.41999	0.36886	0.10603	0.00281	0.02486	1.9680e+15	0.02428	0.07957	0.88378	0.00092	0.01144	2.0127e-08
11	1.003	2.5820e+15	0.02478	0.00575	0.42047	0.36853	0.10605	0.00281	0.02478	1.9640e+15	0.02429	0.07937	0.88397	0.00092	0.01145	2.0118e-08
12	1.011	2.5960e+15	0.02501	0.00574	0.41950	0.36966	0.10542	0.00281	0.02501	1.9800e+15	0.02425	0.07905	0.88434	0.00091	0.01144	2.0179e-08
13	0.992	2.5610e+15	0.02446	0.00575	0.42224	0.36702	0.10608	0.00279	0.02446	1.9430e+15	0.02431	0.08072	0.88261	0.00093	0.01144	2.0055e-08
14	0.972	2.5140e+15	0.02407	0.00580	0.42400	0.36521	0.10607	0.00279	0.02407	1.9040e+15	0.02443	0.08235	0.88081	0.00095	0.01146	1.9868e-08
15	1.009	2.5830e+15	0.02510	0.00576	0.41855	0.36973	0.10568	0.00282	0.02510	1.9750e+15	0.02430	0.07991	0.88342	0.00092	0.01145	2.0106e-08
16	1.020	2.6100e+15	0.02528	0.00573	0.41795	0.37088	0.10539	0.00282	0.02528	1.9960e+15	0.02424	0.07833	0.88508	0.00091	0.01145	2.0221e-08
17	1.007	2.5870e+15	0.02490	0.00574	0.41984	0.36898	0.10602	0.00281	0.02490	1.9710e+15	0.02428	0.07938	0.88398	0.00092	0.01145	2.0139e-08
18	1.005	2.5850e+15	0.02482	0.00575	0.42035	0.36864	0.10601	0.00281	0.02482	1.9670e+15	0.02429	0.07920	0.88414	0.00092	0.01145	2.0127e-08
19	1.012	2.5980e+15	0.02503	0.00573	0.41948	0.36968	0.10539	0.00281	0.02503	1.9820e+15	0.02425	0.07910	0.88429	0.00091	0.01144	2.0188e-08
20	0.994	2.5640e+15	0.02448	0.00575	0.42220	0.36706	0.10608	0.00279	0.02448	1.9460e+15	0.02430	0.08060	0.88272	0.00093	0.01144	2.0067e-08
21	0.973	2.5160e+15	0.02407	0.00580	0.42406	0.36516	0.10605	0.00279	0.02407	1.9050e+15	0.02443	0.08233	0.88084	0.00095	0.01146	1.9874e-08
22	1.022	2.6170e+15	0.02530	0.00573	0.41796	0.37094	0.10537	0.00282	0.02530	2.0010e+15	0.02423	0.07810	0.88532	0.00090	0.01145	2.0248e-08
23	1.020	2.6150e+15	0.02526	0.00573	0.41833	0.37074	0.10529	0.00282	0.02526	1.9980e+15	0.02425	0.07794	0.88546	0.00090	0.01145	2.0230e-08
24	1.004	2.5860e+15	0.02477	0.00574	0.42088	0.36856	0.10549	0.00280	0.02477	1.9660e+15	0.02428	0.07918	0.88418	0.00092	0.01145	2.0139e-08
25	0.973	2.5180e+15	0.02408	0.00580	0.42415	0.36521	0.10596	0.00279	0.02408	1.9060e+15	0.02444	0.08182	0.88132	0.00095	0.01146	1.9868e-08
26	1.019	2.6150e+15	0.02518	0.00572	0.41877	0.37001	0.10566	0.00281	0.02518	1.9960e+15	0.02422	0.07875	0.88468	0.00091	0.01144	2.0239e-08
27	1.035	2.6540e+15	0.02544	0.00569	0.41783	0.37142	0.10544	0.00282	0.02544	2.0260e+15	0.02414	0.07690	0.88664	0.00089	0.01143	2.0392e-08
28	1.027	2.6380e+15	0.02522	0.00570	0.41895	0.37049	0.10548	0.00281	0.02522	2.0110e+15	0.02416	0.07749	0.88602	0.00090	0.01143	2.0341e-08
29	0.993	2.5650e+15	0.02445	0.00575	0.42260	0.36677	0.10602	0.00279	0.02445	1.9450e+15	0.02431	0.08071	0.88260	0.00093	0.01144	2.0070e-08
30	0.971	2.5120e+15	0.02401	0.00580	0.42462	0.36465	0.10598	0.00279	0.02401	1.9020e+15	0.02442	0.08321	0.87996	0.00096	0.01145	1.9874e-08
31	1.012	2.6010e+15	0.02495	0.00573	0.42019	0.36920	0.10535	0.00281	0.02495	1.9810e+15	0.02425	0.07893	0.88446	0.00091	0.01144	2.0200e-08
32	0.977	2.5250e+15	0.02415	0.00579	0.42404	0.36530	0.10588	0.00279	0.02415	1.9130e+15	0.02442	0.08223	0.88094	0.00095	0.01146	1.9907e-08
33	0.967	2.5080e+15	0.02385	0.00580	0.42558	0.36399	0.10601	0.00278	0.02385	1.8930e+15	0.02446	0.08266	0.88047	0.00096	0.01146	1.9838e-08
34	0.985	2.5480e+15	0.02430	0.00577	0.42341	0.36599	0.10575	0.00279	0.02430	1.9290e+15	0.02438	0.08098	0.88225	0.00094	0.01145	1.9983e-08
35	0.970	2.5120e+15	0.02395	0.00580	0.42514	0.36433	0.10592	0.00278	0.02395	1.9000e+15	0.02444	0.08296	0.88019	0.00096	0.01145	1.9865e-08
36	0.963	2.5000e+15	0.02374	0.00580	0.42624	0.36341	0.10599	0.00278	0.02374	1.8870e+15	0.02446	0.08340	0.87972	0.00097	0.01145	1.9823e-08
37	0.962	2.4960e+15	0.02373	0.00581	0.42634	0.36315	0.10583	0.00278	0.02373	1.8840e+15	0.02447	0.08395	0.87916	0.00097	0.01145	1.9799e-08
38	0.962	2.4990e+15	0.02370	0.00580	0.42657	0.36312	0.10594	0.00278	0.02370	1.8850e+15	0.02446	0.08384	0.87928	0.00097	0.01145	1.9823e-08
39	0.960	2.4920e+15	0.02365	0.00581	0.42689	0.36270	0.10578	0.00277	0.02365	1.8790e+15	0.02448	0.08437	0.87873	0.00098	0.01145	1.9790e-08
Assembly total[c]		6.7920e+17	0.02474	0.00576	0.42092	0.36816	0.10569	0.00281	0.02474	5.1700e+17	0.02432	0.08008	0.88322	0.00093	0.01145	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.54. HELIOS results for PWR MOX benchmark Case BOL-9

Total production/total absorption = 1.28326
Multiplication factor (k_{eff}) = 1.27811

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.065	2.5010e+15	0.02997	0.00587	0.40411	0.40334	0.10443	0.00309	0.02997	2.0860e+15	0.02417	0.07128	0.89225	0.00082	0.01149	1.9682e-08
2	1.062	2.4950e+15	0.02990	0.00588	0.40445	0.40304	0.10441	0.00309	0.02990	2.0790e+15	0.02419	0.07135	0.89215	0.00082	0.01149	1.9648e-08
3	1.059	2.4900e+15	0.02978	0.00588	0.40505	0.40254	0.10448	0.00309	0.02978	2.0730e+15	0.02420	0.07147	0.89203	0.00082	0.01149	1.9636e-08
4	1.055	2.4840e+15	0.02967	0.00588	0.40562	0.40211	0.10447	0.00309	0.02967	2.0650e+15	0.02421	0.07137	0.89210	0.00082	0.01149	1.9609e-08
5	1.020	2.4310e+15	0.02848	0.00588	0.41117	0.39723	0.10515	0.00304	0.02848	1.9980e+15	0.02422	0.07335	0.89011	0.00084	0.01148	1.9462e-08
6	0.932	2.2840e+15	0.02555	0.00595	0.42478	0.38456	0.10734	0.00295	0.02555	1.8250e+15	0.02440	0.07930	0.88391	0.00091	0.01147	1.8953e-08
7	1.020	2.4250e+15	0.02850	0.00589	0.41041	0.39733	0.10578	0.00305	0.02850	1.9970e+15	0.02420	0.07481	0.88866	0.00086	0.01147	1.9471e-08
8	1.026	2.4410e+15	0.02859	0.00588	0.40989	0.39797	0.10600	0.00305	0.02859	2.0100e+15	0.02417	0.07365	0.88986	0.00084	0.01147	1.9537e-08
9	1.063	2.4960e+15	0.02993	0.00588	0.40422	0.40331	0.10448	0.00310	0.02993	2.0820e+15	0.02419	0.07118	0.89232	0.00082	0.01149	1.9664e-08
10	1.024	2.4370e+15	0.02850	0.00588	0.41037	0.39755	0.10604	0.00304	0.02850	2.0040e+15	0.02418	0.07384	0.88967	0.00085	0.01147	1.9525e-08
11	1.020	2.4330e+15	0.02838	0.00588	0.41099	0.39709	0.10608	0.00304	0.02838	1.9970e+15	0.02419	0.07360	0.88989	0.00085	0.01147	1.9501e-08
12	1.048	2.4740e+15	0.02944	0.00588	0.40667	0.40126	0.10463	0.00308	0.02944	2.0530e+15	0.02420	0.07197	0.89152	0.00083	0.01148	1.9594e-08
13	0.987	2.3790e+15	0.02725	0.00589	0.41641	0.39228	0.10659	0.00300	0.02725	1.9320e+15	0.02421	0.07612	0.88734	0.00087	0.01145	1.9338e-08
14	0.929	2.2770e+15	0.02541	0.00595	0.42524	0.38403	0.10752	0.00294	0.02541	1.8190e+15	0.02437	0.08042	0.88283	0.00092	0.01146	1.8956e-08
15	1.019	2.4240e+15	0.02849	0.00589	0.41046	0.39728	0.10578	0.00305	0.02849	1.9960e+15	0.02421	0.07479	0.88868	0.00086	0.01147	1.9468e-08
16	1.066	2.5020e+15	0.03000	0.00587	0.40393	0.40358	0.10447	0.00310	0.03000	2.0880e+15	0.02418	0.07102	0.89249	0.00081	0.01149	1.9685e-08
17	1.028	2.4450e+15	0.02866	0.00588	0.40968	0.39818	0.10594	0.00305	0.02866	2.0130e+15	0.02418	0.07350	0.89001	0.00084	0.01147	1.9543e-08
18	1.024	2.4400e+15	0.02854	0.00588	0.41032	0.39770	0.10597	0.00305	0.02854	2.0060e+15	0.02419	0.07326	0.89023	0.00084	0.01148	1.9519e-08
19	1.051	2.4780e+15	0.02954	0.00588	0.40624	0.40165	0.10453	0.00308	0.02954	2.0580e+15	0.02420	0.07191	0.89159	0.00082	0.01149	1.9606e-08
20	0.989	2.3830e+15	0.02732	0.00589	0.41614	0.39255	0.10655	0.00300	0.02732	1.9360e+15	0.02421	0.07589	0.88757	0.00087	0.01145	1.9350e-08
21	0.929	2.2780e+15	0.02541	0.00594	0.42531	0.38399	0.10750	0.00294	0.02541	1.8190e+15	0.02437	0.08034	0.88291	0.00092	0.01146	1.8956e-08
22	1.080	2.5250e+15	0.03045	0.00587	0.40196	0.40542	0.10413	0.00311	0.03045	2.1150e+15	0.02417	0.07016	0.89337	0.00080	0.01150	1.9739e-08
23	1.078	2.5220e+15	0.03043	0.00587	0.40222	0.40530	0.10402	0.00311	0.03043	2.1110e+15	0.02420	0.06982	0.89367	0.00080	0.01151	1.9712e-08
24	1.025	2.4400e+15	0.02866	0.00588	0.41032	0.39812	0.10506	0.00305	0.02866	2.0080e+15	0.02423	0.07264	0.89081	0.00084	0.01148	1.9489e-08
25	0.930	2.2800e+15	0.02548	0.00595	0.42519	0.38426	0.10735	0.00295	0.02548	1.8200e+15	0.02440	0.07953	0.88367	0.00092	0.01147	1.8941e-08
26	1.073	2.5180e+15	0.03012	0.00585	0.40322	0.40420	0.10472	0.00310	0.03012	2.1020e+15	0.02411	0.07100	0.89260	0.00081	0.01148	1.9754e-08
27	1.116	2.5950e+15	0.03133	0.00582	0.39808	0.40925	0.10378	0.00313	0.03133	2.1860e+15	0.02406	0.06756	0.89612	0.00078	0.01149	1.9971e-08
28	1.091	2.5540e+15	0.03055	0.00583	0.40165	0.40613	0.10413	0.00311	0.03055	2.1360e+15	0.02409	0.06876	0.89488	0.00079	0.01148	1.9856e-08
29	0.984	2.3760e+15	0.02717	0.00589	0.41702	0.39187	0.10652	0.00300	0.02717	1.9280e+15	0.02422	0.07600	0.88745	0.00087	0.01146	1.9320e-08
30	0.919	2.2610e+15	0.02508	0.00595	0.42718	0.38237	0.10750	0.00293	0.02508	1.8000e+15	0.02438	0.08162	0.88162	0.00094	0.01145	1.8899e-08
31	1.044	2.4700e+15	0.02929	0.00588	0.40763	0.40064	0.10455	0.00307	0.02929	2.0450e+15	0.02421	0.07166	0.89182	0.00082	0.01149	1.9573e-08
32	0.936	2.2890e+15	0.02571	0.00594	0.42429	0.38514	0.10706	0.00295	0.02571	1.8330e+15	0.02438	0.07960	0.88363	0.00092	0.01147	1.8980e-08
33	0.905	2.2430e+15	0.02454	0.00595	0.42985	0.38014	0.10784	0.00291	0.02454	1.7730e+15	0.02443	0.08134	0.88183	0.00094	0.01146	1.8811e-08
34	0.966	2.3430e+15	0.02666	0.00591	0.41969	0.38954	0.10645	0.00298	0.02666	1.8910e+15	0.02431	0.07667	0.88667	0.00088	0.01147	1.9170e-08
35	0.911	2.2500e+15	0.02478	0.00595	0.42879	0.38112	0.10756	0.00292	0.02478	1.7840e+15	0.02440	0.08153	0.88167	0.00094	0.01145	1.8844e-08
36	0.892	2.2210e+15	0.02406	0.00596	0.43233	0.37795	0.10799	0.00290	0.02406	1.7470e+15	0.02443	0.08276	0.88040	0.00095	0.01145	1.8733e-08
37	0.890	2.2160e+15	0.02405	0.00596	0.43248	0.37776	0.10781	0.00290	0.02405	1.7440e+15	0.02444	0.08327	0.87988	0.00096	0.01145	1.8709e-08
38	0.885	2.2090e+15	0.02378	0.00596	0.43383	0.37666	0.10805	0.00288	0.02378	1.7330e+15	0.02443	0.08359	0.87958	0.00096	0.01144	1.8694e-08
39	0.879	2.1980e+15	0.02360	0.00596	0.43479	0.37577	0.10795	0.00288	0.02360	1.7210e+15	0.02446	0.08418	0.87895	0.00097	0.01144	1.8640e-08
Assembly total[c]		6.3280e+17	0.02775	0.00590	0.41451	0.39403	0.10595	0.00302	0.02775	5.1700e+17	0.02426	0.07529	0.88811	0.00087	0.01147	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.55. HELIOS results for PWR MOX benchmark Case BOL-10

Total production/total absorption = 1.20300
Multiplication factor (k_{eff}) = 1.19808

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	concentration (a/b-cm)[b]
1	1.109	2.6570e+15	0.02954	0.00587	0.41103	0.39644	0.10550	0.00303	0.02954	2.1720e+15	0.02421	0.07201	0.89147	0.00083	0.01149	2.0383e-08
2	1.038	2.5490e+15	0.02711	0.00588	0.42241	0.38636	0.10717	0.00295	0.02711	2.0330e+15	0.02425	0.07624	0.88717	0.00088	0.01146	2.0124e-08
3	1.016	2.5180e+15	0.02630	0.00588	0.42634	0.38294	0.10766	0.00292	0.02630	1.9910e+15	0.02426	0.07753	0.88586	0.00090	0.01145	2.0049e-08
4	1.014	2.5150e+15	0.02621	0.00589	0.42680	0.38259	0.10765	0.00292	0.02621	1.9860e+15	0.02427	0.07747	0.88592	0.00090	0.01146	2.0037e-08
5	1.002	2.4960e+15	0.02584	0.00589	0.42878	0.38084	0.10778	0.00290	0.02584	1.9630e+15	0.02429	0.07838	0.88497	0.00091	0.01145	1.9974e-08
6	0.974	2.4360e+15	0.02518	0.00595	0.43171	0.37771	0.10825	0.00289	0.02518	1.9070e+15	0.02445	0.08036	0.88279	0.00093	0.01147	1.9718e-08
7	1.054	2.5640e+15	0.02780	0.00590	0.41869	0.38924	0.10697	0.00298	0.02780	2.0640e+15	0.02426	0.07602	0.88737	0.00088	0.01147	2.0148e-08
8	1.023	2.5240e+15	0.02659	0.00589	0.42455	0.38408	0.10795	0.00293	0.02659	2.0030e+15	0.02427	0.07743	0.88594	0.00089	0.01146	2.0055e-08
9	1.021	2.5230e+15	0.02646	0.00588	0.42538	0.38378	0.10762	0.00293	0.02646	1.9990e+15	0.02425	0.07732	0.88609	0.00089	0.01145	2.0070e-08
10	1.005	2.4990e+15	0.02596	0.00589	0.42774	0.38130	0.10830	0.00291	0.02596	1.9690e+15	0.02428	0.07855	0.88480	0.00091	0.01145	1.9986e-08
11	1.003	2.4970e+15	0.02587	0.00590	0.42824	0.38093	0.10832	0.00290	0.02587	1.9640e+15	0.02429	0.07836	0.88499	0.00091	0.01145	1.9974e-08
12	1.011	2.5100e+15	0.02610	0.00589	0.42733	0.38213	0.10770	0.00291	0.02610	1.9800e+15	0.02426	0.07805	0.88535	0.00090	0.01145	2.0034e-08
13	0.992	2.4760e+15	0.02553	0.00590	0.43004	0.37930	0.10836	0.00289	0.02553	1.9430e+15	0.02431	0.07970	0.88362	0.00092	0.01144	1.9910e-08
14	0.972	2.4310e+15	0.02512	0.00595	0.43190	0.37741	0.10836	0.00289	0.02512	1.9040e+15	0.02443	0.08133	0.88184	0.00094	0.01146	1.9724e-08
15	1.009	2.4980e+15	0.02623	0.00591	0.42635	0.38234	0.10796	0.00292	0.02623	1.9760e+15	0.02430	0.07887	0.88446	0.00091	0.01146	1.9965e-08
16	1.020	2.5240e+15	0.02640	0.00588	0.42574	0.38347	0.10767	0.00292	0.02640	1.9970e+15	0.02424	0.07732	0.88609	0.00089	0.01145	2.0076e-08
17	1.007	2.5020e+15	0.02599	0.00589	0.42760	0.38143	0.10829	0.00291	0.02599	1.9720e+15	0.02428	0.07836	0.88500	0.00091	0.01145	1.9998e-08
18	1.005	2.5000e+15	0.02591	0.00589	0.42812	0.38106	0.10829	0.00291	0.02591	1.9680e+15	0.02430	0.07819	0.88515	0.00090	0.01146	1.9983e-08
19	1.012	2.5110e+15	0.02612	0.00588	0.42731	0.38215	0.10767	0.00291	0.02612	1.9820e+15	0.02425	0.07810	0.88530	0.00090	0.01145	2.0040e-08
20	0.993	2.4790e+15	0.02555	0.00590	0.43000	0.37934	0.10835	0.00289	0.02555	1.9450e+15	0.02431	0.07959	0.88374	0.00092	0.01144	1.9923e-08
21	0.973	2.4320e+15	0.02512	0.00595	0.43196	0.37736	0.10834	0.00289	0.02512	1.9050e+15	0.02443	0.08131	0.88186	0.00094	0.01146	1.9727e-08
22	1.022	2.5310e+15	0.02642	0.00588	0.42576	0.38352	0.10765	0.00292	0.02642	2.0020e+15	0.02423	0.07710	0.88633	0.00089	0.01145	2.0103e-08
23	1.020	2.5280e+15	0.02637	0.00588	0.42614	0.38330	0.10757	0.00292	0.02637	1.9980e+15	0.02425	0.07694	0.88646	0.00089	0.01146	2.0085e-08
24	1.004	2.5000e+15	0.02585	0.00589	0.42873	0.38095	0.10777	0.00290	0.02585	1.9660e+15	0.02428	0.07818	0.88518	0.00091	0.01145	1.9992e-08
25	0.973	2.4340e+15	0.02513	0.00595	0.43206	0.37741	0.10826	0.00289	0.02513	1.9050e+15	0.02445	0.08081	0.88234	0.00094	0.01147	1.9724e-08
26	1.020	2.5290e+15	0.02629	0.00587	0.42654	0.38256	0.10794	0.00291	0.02629	1.9960e+15	0.02423	0.07773	0.88570	0.00090	0.01145	2.0094e-08
27	1.035	2.5660e+15	0.02656	0.00584	0.42556	0.38398	0.10771	0.00292	0.02656	2.0270e+15	0.02414	0.07591	0.88763	0.00088	0.01144	2.0245e-08
28	1.027	2.5510e+15	0.02632	0.00584	0.42671	0.38297	0.10775	0.00291	0.02632	2.0110e+15	0.02417	0.07649	0.88702	0.00089	0.01144	2.0194e-08
29	0.993	2.4800e+15	0.02551	0.00590	0.43040	0.37903	0.10830	0.00289	0.02551	1.9440e+15	0.02431	0.07970	0.88362	0.00092	0.01144	1.9926e-08
30	0.971	2.4290e+15	0.02505	0.00595	0.43253	0.37681	0.10828	0.00288	0.02505	1.9010e+15	0.02443	0.08218	0.88099	0.00095	0.01145	1.9727e-08
31	1.011	2.5150e+15	0.02604	0.00588	0.42802	0.38163	0.10763	0.00291	0.02604	1.9810e+15	0.02426	0.07792	0.88547	0.00090	0.01145	2.0052e-08
32	0.976	2.4410e+15	0.02520	0.00594	0.43193	0.37750	0.10817	0.00289	0.02520	1.9120e+15	0.02443	0.08121	0.88196	0.00094	0.01146	1.9763e-08
33	0.966	2.4240e+15	0.02488	0.00595	0.43350	0.37610	0.10830	0.00288	0.02488	1.8920e+15	0.02446	0.08164	0.88149	0.00095	0.01146	1.9694e-08
34	0.985	2.4630e+15	0.02536	0.00592	0.43131	0.37827	0.10804	0.00289	0.02536	1.9290e+15	0.02438	0.07997	0.88327	0.00093	0.01146	1.9838e-08
35	0.969	2.4290e+15	0.02498	0.00595	0.43306	0.37646	0.10821	0.00288	0.02498	1.8980e+15	0.02444	0.08194	0.88121	0.00095	0.01146	1.9721e-08
36	0.963	2.4170e+15	0.02476	0.00595	0.43419	0.37547	0.10828	0.00287	0.02476	1.8850e+15	0.02446	0.08238	0.88074	0.00095	0.01146	1.9676e-08
37	0.961	2.4120e+15	0.02476	0.00596	0.43433	0.37525	0.10813	0.00287	0.02476	1.8820e+15	0.02447	0.08292	0.88019	0.00096	0.01146	1.9654e-08
38	0.962	2.4150e+15	0.02472	0.00595	0.43453	0.37516	0.10823	0.00287	0.02472	1.8830e+15	0.02446	0.08283	0.88031	0.00096	0.01145	1.9676e-08
39	0.959	2.4080e+15	0.02467	0.00596	0.43490	0.37476	0.10808	0.00287	0.02467	1.8770e+15	0.02448	0.08335	0.87976	0.00096	0.01145	1.9642e-08
Assembly total[c]		6.5670e+17	0.02582	0.00591	0.42875	0.38057	0.10797	0.00290	0.02582	5.1700e+17	0.02432	0.07907	0.88424	0.00091	0.01145	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.56. HELIOS multiplication factors and total fuel pin reaction rate results for PWR MOX benchmark multicycle case

Burnup			Total capture	Fraction of total capture rate							Total fission	Fraction of total fission rate				
(MWd/kg)	k_{eff}	k_0[a]	rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
0.0	1.17433	1.17914	6.7920e+17	0.02474	0.00576	0.42092	0.36816	0.10569	0.00281	0.02474	5.1700e+17	0.02432	0.08009	0.88322	0.00093	0.01145
1.5	1.15192	1.15664	7.0790e+17	0.02443	0.00549	0.41104	0.35088	0.11655	0.00414	0.04079	5.1670e+17	0.02418	0.08104	0.87596	0.00117	0.01760
3.0	1.13874	1.14341	7.2680e+17	0.02414	0.00529	0.40488	0.33917	0.12535	0.00560	0.04900	5.1660e+17	0.02402	0.08158	0.86851	0.00140	0.02443
4.5	1.12816	1.13278	7.4320e+17	0.02396	0.00512	0.39976	0.32898	0.13264	0.00714	0.05574	5.1660e+17	0.02384	0.08201	0.86066	0.00161	0.03179
6.0	1.11877	1.12336	7.5830e+17	0.02384	0.00495	0.39521	0.31957	0.13881	0.00871	0.06199	5.1650e+17	0.02365	0.08238	0.85244	0.00182	0.03959
7.5	1.11007	1.11462	7.7260e+17	0.02375	0.00480	0.39108	0.31071	0.14411	0.01032	0.06792	5.1650e+17	0.02346	0.08273	0.84391	0.00201	0.04774
9.0	1.10182	1.10634	7.8640e+17	0.02367	0.00465	0.38732	0.30229	0.14872	0.01194	0.07359	5.1640e+17	0.02325	0.08306	0.83511	0.00219	0.05619
10.5	1.09385	1.09833	7.9970e+17	0.02361	0.00451	0.38385	0.29422	0.15276	0.01357	0.07903	5.1630e+17	0.02304	0.08338	0.82608	0.00237	0.06488
12.0	1.08602	1.09048	8.1270e+17	0.02356	0.00437	0.38065	0.28645	0.15634	0.01519	0.08427	5.1630e+17	0.02281	0.08370	0.81688	0.00253	0.07376
13.5	1.07827	1.08270	8.2550e+17	0.02351	0.00424	0.37768	0.27895	0.15950	0.01679	0.08932	5.1620e+17	0.02258	0.08401	0.80753	0.00269	0.08280
15.0	1.07055	1.07495	8.3800e+17	0.02346	0.00411	0.37489	0.27170	0.16230	0.01838	0.09423	5.1620e+17	0.02235	0.08433	0.79807	0.00284	0.09196
15.0	1.09508	1.09948	8.2040e+17	0.02423	0.00412	0.36783	0.27730	0.16121	0.01883	0.09522	5.1640e+17	0.02233	0.08224	0.80008	0.00275	0.09214
16.5	1.08465	1.08901	8.3340e+17	0.02430	0.00400	0.36564	0.26981	0.16411	0.02036	0.09967	5.1610e+17	0.02212	0.08271	0.79057	0.00289	0.10116
18.0	1.07416	1.07848	8.4670e+17	0.02422	0.00388	0.36350	0.26254	0.16657	0.02186	0.10421	5.1610e+17	0.02190	0.08316	0.78097	0.00303	0.11030
19.5	1.06394	1.06821	8.5990e+17	0.02415	0.00376	0.36144	0.25549	0.16874	0.02334	0.10869	5.1600e+17	0.02168	0.08361	0.77130	0.00315	0.11952
21.0	1.05398	1.05822	8.7290e+17	0.02407	0.00365	0.35949	0.24866	0.17065	0.02479	0.11308	5.1590e+17	0.02144	0.08404	0.76161	0.00327	0.12878
22.5	1.04428	1.04848	8.8590e+17	0.02400	0.00354	0.35762	0.24203	0.17232	0.02620	0.11739	5.1590e+17	0.02119	0.08448	0.75191	0.00338	0.13806
24.0	1.03481	1.03897	8.9890e+17	0.02393	0.00343	0.35583	0.23562	0.17377	0.02757	0.12161	5.1580e+17	0.02093	0.08491	0.74224	0.00349	0.14732
25.5	1.02554	1.02966	9.1180e+17	0.02387	0.00332	0.35412	0.22941	0.17500	0.02889	0.12576	5.1570e+17	0.02066	0.08534	0.73263	0.00358	0.15653
27.0	1.01647	1.02057	9.2460e+17	0.02380	0.00322	0.35247	0.22341	0.17604	0.03017	0.12983	5.1570e+17	0.02038	0.08577	0.72311	0.00367	0.16566
28.5	1.00758	1.01164	9.3740e+17	0.02373	0.00311	0.35090	0.21760	0.17688	0.03140	0.13384	5.1560e+17	0.02009	0.08619	0.71372	0.00375	0.17468
30.0	0.99889	1.00291	9.5020e+17	0.02366	0.00301	0.34937	0.21200	0.17756	0.03257	0.13779	5.1550e+17	0.01979	0.08661	0.70447	0.00382	0.18356
31.5	0.99037	0.99436	9.6290e+17	0.02360	0.00291	0.34788	0.20659	0.17807	0.03368	0.14167	5.1550e+17	0.01948	0.08704	0.69540	0.00389	0.19227
33.0	0.98202	0.98597	9.7560e+17	0.02353	0.00282	0.34645	0.20139	0.17841	0.03473	0.14550	5.1540e+17	0.01916	0.08746	0.68654	0.00395	0.20078
34.5	0.97380	0.97773	9.8830e+17	0.02346	0.00272	0.34508	0.19638	0.17861	0.03572	0.14926	5.1540e+17	0.01883	0.08788	0.67790	0.00400	0.20907
36.0	0.96578	0.96967	1.0010e+18	0.02340	0.00263	0.34374	0.19158	0.17866	0.03665	0.15297	5.1530e+17	0.01850	0.08830	0.66952	0.00404	0.21711
37.5	0.95790	0.96176	1.0130e+18	0.02333	0.00253	0.34245	0.18698	0.17857	0.03751	0.15662	5.1530e+17	0.01815	0.08871	0.66142	0.00408	0.22489
9.0	0.95016	0.95400	1.0260e+18	0.02326	0.00244	0.34120	0.18257	0.17835	0.03830	0.16021	5.1520e+17	0.01779	0.08913	0.65362	0.00411	0.23236
0.5	0.94258	0.94638	1.0380e+18	0.02319	0.00235	0.34000	0.17835	0.17800	0.03903	0.16374	5.1520e+17	0.01742	0.08954	0.64613	0.00413	0.23952
2.0	0.93512	0.93890	1.0510e+18	0.02312	0.00227	0.33883	0.17433	0.17756	0.03969	0.16722	5.1510e+17	0.01705	0.08996	0.63899	0.00415	0.24634
43.5	0.92783	0.93158	1.0630e+18	0.02305	0.00218	0.33771	0.17050	0.17698	0.04028	0.17063	5.1510e+17	0.01667	0.09037	0.63220	0.00416	0.25282
45.0	0.92069	0.92441	1.0760e+18	0.02298	0.00210	0.33660	0.16687	0.17633	0.04080	0.17399	5.1510e+17	0.01628	0.09078	0.62577	0.00417	0.25893

[a]Ratio of total production to total absorption.

Table 4.57. HELIOS results for PWR MOX benchmark multicycle depletion at BOC 1 (0.0 MWd/kg)

Total production/total absorption = 1.17914
Multiplication factor (k_{eff}) = 1.17433

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.106	2.7470e+15	0.02820	0.00571	0.40339	0.38265	0.10324	0.00292	0.02820	2.1660e+15	0.02419	0.07308	0.89041	0.00084	0.01148	2.0528e-08
2	1.037	2.6360e+15	0.02594	0.00573	0.41467	0.37347	0.10491	0.00285	0.02594	2.0310e+15	0.02424	0.07727	0.88614	0.00089	0.01146	2.0269e-08
3	1.016	2.6040e+15	0.02519	0.00573	0.41851	0.37037	0.10537	0.00282	0.02519	1.9900e+15	0.02425	0.07854	0.88485	0.00091	0.01145	2.0194e-08
4	1.014	2.6010e+15	0.02511	0.00574	0.41896	0.37005	0.10537	0.00282	0.02511	1.9850e+15	0.02426	0.07847	0.88491	0.00091	0.01145	2.0182e-08
5	1.003	2.5820e+15	0.02476	0.00574	0.42091	0.36843	0.10549	0.00280	0.02476	1.9630e+15	0.02428	0.07939	0.88397	0.00092	0.01144	2.0118e-08
6	0.974	2.5200e+15	0.02413	0.00580	0.42379	0.36547	0.10596	0.00279	0.02413	1.9080e+15	0.02445	0.08137	0.88177	0.00094	0.01147	1.9862e-08
7	1.052	2.6510e+15	0.02657	0.00574	0.41106	0.37606	0.10472	0.00287	0.02657	2.0600e+15	0.02425	0.07710	0.88630	0.00089	0.01146	2.0293e-08
8	1.022	2.6090e+15	0.02545	0.00574	0.41687	0.37140	0.10570	0.00283	0.02545	2.0010e+15	0.02426	0.07847	0.88491	0.00091	0.01145	2.0197e-08
9	1.020	2.6090e+15	0.02533	0.00573	0.41760	0.37115	0.10535	0.00282	0.02533	1.9980e+15	0.02424	0.07833	0.88508	0.00091	0.01145	2.0215e-08
10	1.005	2.5840e+15	0.02486	0.00575	0.41998	0.36886	0.10603	0.00281	0.02486	1.9680e+15	0.02428	0.07957	0.88379	0.00092	0.01144	2.0130e-08
11	1.003	2.5820e+15	0.02478	0.00575	0.42047	0.36853	0.10605	0.00281	0.02478	1.9640e+15	0.02429	0.07937	0.88398	0.00092	0.01145	2.0118e-08
12	1.011	2.5960e+15	0.02501	0.00574	0.41950	0.36965	0.10542	0.00281	0.02501	1.9800e+15	0.02425	0.07906	0.88434	0.00091	0.01144	2.0179e-08
13	0.992	2.5610e+15	0.02446	0.00575	0.42223	0.36702	0.10608	0.00279	0.02446	1.9430e+15	0.02431	0.08072	0.88261	0.00093	0.01144	2.0055e-08
14	0.973	2.5140e+15	0.02407	0.00580	0.42400	0.36521	0.10607	0.00279	0.02407	1.9040e+15	0.02443	0.08235	0.88081	0.00095	0.01146	1.9868e-08
15	1.009	2.5830e+15	0.02511	0.00576	0.41855	0.36973	0.10568	0.00282	0.02511	1.9750e+15	0.02430	0.07991	0.88342	0.00092	0.01145	2.0109e-08
16	1.020	2.6100e+15	0.02528	0.00573	0.41796	0.37087	0.10539	0.00282	0.02528	1.9960e+15	0.02424	0.07833	0.88508	0.00091	0.01145	2.0221e-08
17	1.007	2.5880e+15	0.02490	0.00574	0.41984	0.36899	0.10602	0.00281	0.02490	1.9720e+15	0.02428	0.07938	0.88398	0.00092	0.01145	2.0142e-08
18	1.005	2.5850e+15	0.02482	0.00575	0.42035	0.36865	0.10602	0.00281	0.02482	1.9670e+15	0.02429	0.07920	0.88414	0.00092	0.01145	2.0127e-08
19	1.012	2.5980e+15	0.02503	0.00573	0.41948	0.36967	0.10539	0.00281	0.02503	1.9820e+15	0.02425	0.07911	0.88429	0.00091	0.01144	2.0188e-08
20	0.994	2.5640e+15	0.02448	0.00575	0.42219	0.36706	0.10608	0.00279	0.02448	1.9460e+15	0.02430	0.08060	0.88272	0.00093	0.01144	2.0067e-08
21	0.973	2.5160e+15	0.02407	0.00580	0.42406	0.36516	0.10605	0.00279	0.02407	1.9050e+15	0.02443	0.08233	0.88084	0.00095	0.01146	1.9874e-08
22	1.022	2.6170e+15	0.02530	0.00573	0.41797	0.37094	0.10537	0.00282	0.02530	2.0010e+15	0.02423	0.07810	0.88532	0.00090	0.01145	2.0248e-08
23	1.020	2.6150e+15	0.02526	0.00573	0.41834	0.37073	0.10529	0.00282	0.02526	1.9980e+15	0.02425	0.07794	0.88546	0.00090	0.01145	2.0230e-08
24	1.004	2.5860e+15	0.02477	0.00574	0.42089	0.36856	0.10549	0.00280	0.02477	1.9660e+15	0.02428	0.07919	0.88417	0.00092	0.01145	2.0139e-08
25	0.973	2.5180e+15	0.02408	0.00580	0.42415	0.36521	0.10597	0.00279	0.02408	1.9060e+15	0.02444	0.08183	0.88132	0.00095	0.01146	1.9868e-08
26	1.019	2.6150e+15	0.02518	0.00572	0.41877	0.37002	0.10566	0.00281	0.02518	1.9960e+15	0.02422	0.07875	0.88468	0.00091	0.01144	2.0239e-08
27	1.035	2.6540e+15	0.02544	0.00569	0.41784	0.37142	0.10545	0.00282	0.02544	2.0260e+15	0.02414	0.07691	0.88663	0.00089	0.01143	2.0389e-08
28	1.027	2.6380e+15	0.02522	0.00570	0.41896	0.37049	0.10549	0.00281	0.02522	2.0110e+15	0.02416	0.07749	0.88602	0.00090	0.01143	2.0341e-08
29	0.993	2.5650e+15	0.02445	0.00575	0.42259	0.36677	0.10602	0.00279	0.02445	1.9450e+15	0.02431	0.08072	0.88260	0.00093	0.01144	2.0070e-08
30	0.971	2.5120e+15	0.02401	0.00580	0.42462	0.36465	0.10599	0.00279	0.02401	1.9020e+15	0.02442	0.08321	0.87996	0.00096	0.01145	1.9874e-08
31	1.012	2.6010e+15	0.02495	0.00573	0.42019	0.36919	0.10535	0.00281	0.02495	1.9810e+15	0.02425	0.07893	0.88446	0.00091	0.01144	2.0197e-08
32	0.977	2.5250e+15	0.02415	0.00579	0.42403	0.36530	0.10588	0.00279	0.02415	1.9130e+15	0.02442	0.08224	0.88093	0.00095	0.01146	1.9907e-08
33	0.967	2.5070e+15	0.02385	0.00580	0.42557	0.36400	0.10601	0.00278	0.02385	1.8930e+15	0.02446	0.08266	0.88046	0.00096	0.01146	1.9838e-08
34	0.985	2.5480e+15	0.02430	0.00577	0.42340	0.36599	0.10575	0.00279	0.02430	1.9290e+15	0.02438	0.08099	0.88225	0.00094	0.01145	1.9983e-08
35	0.970	2.5120e+15	0.02395	0.00580	0.42513	0.36433	0.10592	0.00278	0.02395	1.9000e+15	0.02444	0.08297	0.88018	0.00096	0.01145	1.9865e-08
36	0.963	2.5000e+15	0.02374	0.00580	0.42624	0.36341	0.10599	0.00278	0.02374	1.8860e+15	0.02446	0.08341	0.87972	0.00097	0.01145	1.9820e-08
37	0.962	2.4960e+15	0.02373	0.00581	0.42633	0.36315	0.10583	0.00278	0.02373	1.8840e+15	0.02447	0.08395	0.87915	0.00097	0.01145	1.9799e-08
38	0.962	2.4980e+15	0.02370	0.00580	0.42657	0.36312	0.10594	0.00278	0.02370	1.8850e+15	0.02446	0.08385	0.87928	0.00097	0.01145	1.9823e-08
39	0.959	2.4910e+15	0.02365	0.00581	0.42689	0.36270	0.10578	0.00277	0.02365	1.8790e+15	0.02448	0.08438	0.87872	0.00098	0.01145	1.9787e-08
Assembly total[c]		6.7920e+17	0.02474	0.00576	0.42092	0.36816	0.10569	0.00281	0.02474	5.1700e+17	0.02432	0.08009	0.88322	0.00093	0.01145	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.58. HELIOS results for PWR MOX benchmark multicycle depletion at MOC 1 (7.5 MWd/kg)

Total production/total absorption = 1.11462
Multiplication factor (k_{eff}) = 1.11007

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.083	3.1160e+15	0.02639	0.00472	0.37601	0.31574	0.14625	0.01122	0.07308	2.1180e+15	0.02358	0.07691	0.84650	0.00197	0.05087	1.9155e-08
2	1.040	3.0170e+15	0.02502	0.00476	0.38376	0.31371	0.14494	0.01072	0.07025	2.0350e+15	0.02348	0.07963	0.84569	0.00198	0.04906	1.9206e-08
3	1.025	2.9860e+15	0.02449	0.00477	0.38674	0.31265	0.14463	0.01055	0.06920	2.0060e+15	0.02344	0.08058	0.84533	0.00198	0.04851	1.9230e-08
4	1.022	2.9800e+15	0.02439	0.00477	0.38735	0.31239	0.14457	0.01052	0.06901	2.0000e+15	0.02344	0.08056	0.84542	0.00198	0.04844	1.9221e-08
5	1.006	2.9440e+15	0.02388	0.00478	0.39034	0.31110	0.14421	0.01037	0.06808	1.9680e+15	0.02343	0.08179	0.84469	0.00200	0.04793	1.9194e-08
6	0.967	2.8450e+15	0.02291	0.00485	0.39585	0.30881	0.14309	0.01002	0.06646	1.8920e+15	0.02354	0.08461	0.84301	0.00203	0.04666	1.9001e-08
7	1.040	3.0100e+15	0.02516	0.00477	0.38264	0.31380	0.14527	0.01077	0.07068	2.0350e+15	0.02351	0.08044	0.84469	0.00200	0.04921	1.9146e-08
8	1.023	2.9780e+15	0.02448	0.00478	0.38660	0.31258	0.14501	0.01057	0.06928	2.0010e+15	0.02345	0.08099	0.84483	0.00199	0.04859	1.9203e-08
9	1.029	2.9920e+15	0.02462	0.00477	0.38590	0.31310	0.14473	0.01059	0.06944	2.0130e+15	0.02344	0.08037	0.84544	0.00198	0.04861	1.9230e-08
10	1.011	2.9530e+15	0.02405	0.00478	0.38906	0.31168	0.14470	0.01043	0.06844	1.9780e+15	0.02342	0.08185	0.84445	0.00200	0.04813	1.9215e-08
11	1.008	2.9490e+15	0.02395	0.00479	0.38968	0.31141	0.14467	0.01041	0.06826	1.9730e+15	0.02343	0.08168	0.84465	0.00199	0.04809	1.9209e-08
12	1.018	2.9700e+15	0.02425	0.00477	0.38818	0.31213	0.14444	0.01048	0.06875	1.9920e+15	0.02343	0.08122	0.84496	0.00199	0.04825	1.9227e-08
13	0.992	2.9110e+15	0.02347	0.00480	0.39250	0.31012	0.14429	0.01025	0.06738	1.9410e+15	0.02342	0.08339	0.84350	0.00202	0.04753	1.9173e-08
14	0.965	2.8370e+15	0.02284	0.00485	0.39614	0.30871	0.14307	0.00999	0.06633	1.8880e+15	0.02351	0.08563	0.84216	0.00204	0.04650	1.9016e-08
15	1.013	2.9500e+15	0.02424	0.00479	0.38792	0.31211	0.14440	0.01045	0.06880	1.9820e+15	0.02346	0.08231	0.84400	0.00201	0.04808	1.9170e-08
16	1.029	2.9950e+15	0.02461	0.00477	0.38605	0.31304	0.14475	0.01059	0.06940	2.0140e+15	0.02343	0.08030	0.84550	0.00198	0.04863	1.9245e-08
17	1.013	2.9580e+15	0.02410	0.00478	0.38883	0.31173	0.14476	0.01045	0.06853	1.9820e+15	0.02342	0.08163	0.84458	0.00199	0.04822	1.9221e-08
18	1.011	2.9540e+15	0.02401	0.00478	0.38940	0.31153	0.14469	0.01043	0.06837	1.9770e+15	0.02343	0.08146	0.84480	0.00199	0.04817	1.9215e-08
19	1.019	2.9730e+15	0.02429	0.00477	0.38803	0.31217	0.14445	0.01049	0.06882	1.9940e+15	0.02342	0.08123	0.84491	0.00199	0.04829	1.9233e-08
20	0.994	2.9150e+15	0.02349	0.00480	0.39239	0.31012	0.14435	0.01026	0.06743	1.9440e+15	0.02341	0.08325	0.84357	0.00201	0.04760	1.9182e-08
21	0.965	2.8390e+15	0.02284	0.00485	0.39619	0.30865	0.14307	0.00999	0.06634	1.8890e+15	0.02351	0.08560	0.84217	0.00204	0.04652	1.9019e-08
22	1.033	3.0060e+15	0.02468	0.00476	0.38572	0.31307	0.14492	0.01063	0.06954	2.0210e+15	0.02343	0.07999	0.84565	0.00198	0.04880	1.9263e-08
23	1.032	3.0030e+15	0.02464	0.00476	0.38606	0.31303	0.14474	0.01061	0.06946	2.0180e+15	0.02344	0.07979	0.84591	0.00197	0.04873	1.9251e-08
24	1.008	2.9490e+15	0.02391	0.00478	0.39018	0.31123	0.14424	0.01038	0.06816	1.9710e+15	0.02343	0.08151	0.84492	0.00200	0.04800	1.9206e-08
25	0.966	2.8410e+15	0.02285	0.00485	0.39627	0.30868	0.14299	0.00999	0.06636	1.8890e+15	0.02353	0.08505	0.84267	0.00204	0.04656	1.9010e-08
26	1.031	3.0050e+15	0.02456	0.00475	0.38630	0.31258	0.14526	0.01062	0.06930	2.0180e+15	0.02339	0.08059	0.84505	0.00198	0.04883	1.9290e-08
27	1.050	3.0600e+15	0.02492	0.00472	0.38449	0.31329	0.14585	0.01079	0.06993	2.0540e+15	0.02335	0.07845	0.84651	0.00196	0.04958	1.9386e-08
28	1.038	3.0310e+15	0.02458	0.00473	0.38641	0.31250	0.14554	0.01068	0.06933	2.0300e+15	0.02335	0.07927	0.84607	0.00197	0.04918	1.9356e-08
29	0.992	2.9120e+15	0.02342	0.00480	0.39293	0.30986	0.14424	0.01024	0.06732	1.9400e+15	0.02342	0.08339	0.84347	0.00202	0.04755	1.9182e-08
30	0.962	2.8290e+15	0.02271	0.00485	0.39715	0.30814	0.14285	0.00994	0.06611	1.8810e+15	0.02350	0.08663	0.84132	0.00206	0.04634	1.9013e-08
31	1.017	2.9720e+15	0.02415	0.00477	0.38902	0.31164	0.14442	0.01046	0.06859	1.9890e+15	0.02342	0.08111	0.84504	0.00199	0.04829	1.9239e-08
32	0.969	2.8490e+15	0.02293	0.00484	0.39598	0.30870	0.14303	0.01002	0.06650	1.8960e+15	0.02351	0.08541	0.84225	0.00204	0.04664	1.9034e-08
33	0.955	2.8180e+15	0.02248	0.00486	0.39856	0.30754	0.14272	0.00989	0.06572	1.8680e+15	0.02352	0.08616	0.84187	0.00205	0.04625	1.8989e-08
34	0.981	2.8860e+15	0.02321	0.00482	0.39428	0.30926	0.14363	0.01014	0.06695	1.9200e+15	0.02347	0.08379	0.84337	0.00202	0.04718	1.9100e-08
35	0.958	2.8240e+15	0.02258	0.00485	0.39800	0.30774	0.14274	0.00991	0.06590	1.8740e+15	0.02351	0.08646	0.84153	0.00206	0.04629	1.9004e-08
36	0.949	2.8030e+15	0.02229	0.00486	0.39974	0.30697	0.14251	0.00983	0.06537	1.8560e+15	0.02351	0.08710	0.84115	0.00207	0.04601	1.8971e-08
37	0.947	2.7980e+15	0.02228	0.00487	0.39980	0.30682	0.14233	0.00981	0.06535	1.8530e+15	0.02352	0.08764	0.84070	0.00207	0.04591	1.8956e-08
38	0.946	2.7970e+15	0.02219	0.00486	0.40043	0.30660	0.14239	0.00979	0.06521	1.8500e+15	0.02351	0.08767	0.84069	0.00207	0.04590	1.8971e-08
39	0.942	2.7870e+15	0.02211	0.00487	0.40087	0.30630	0.14216	0.00976	0.06507	1.8430e+15	0.02352	0.08823	0.84027	0.00208	0.04575	1.8944e-08
Assembly total[c]		7.7260e+17	0.02375	0.00480	0.39108	0.31071	0.14411	0.01032	0.06792	5.1650e+17	0.02346	0.08273	0.84391	0.00201	0.04774	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.59. HELIOS results for PWR MOX benchmark multicycle depletion at EOC 1 (15.0 MWd/kg)

Total production/total absorption = 1.07495
Multiplication factor (k_{eff}) = 1.07055

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.064	3.3630e+15	0.02552	0.00402	0.36240	0.27086	0.16587	0.02011	0.09992	2.0800e+15	0.02260	0.07957	0.79467	0.00282	0.09985	1.7450e-08
2	1.041	3.2840e+15	0.02476	0.00407	0.36727	0.27261	0.16383	0.01927	0.09724	2.0350e+15	0.02246	0.08112	0.79749	0.00280	0.09566	1.7688e-08
3	1.031	3.2560e+15	0.02438	0.00408	0.36956	0.27275	0.16326	0.01897	0.09614	2.0150e+15	0.02240	0.08181	0.79821	0.00280	0.09432	1.7781e-08
4	1.026	3.2470e+15	0.02425	0.00408	0.37035	0.27255	0.16317	0.01890	0.09585	2.0070e+15	0.02239	0.08186	0.79841	0.00280	0.09407	1.7787e-08
5	1.007	3.1970e+15	0.02365	0.00410	0.37380	0.27185	0.16262	0.01851	0.09450	1.9690e+15	0.02234	0.08329	0.79852	0.00282	0.09257	1.7832e-08
6	0.964	3.0720e+15	0.02252	0.00417	0.38036	0.27110	0.16068	0.01766	0.09216	1.8850e+15	0.02235	0.08649	0.79896	0.00286	0.08889	1.7805e-08
7	1.032	3.2590e+15	0.02462	0.00408	0.36766	0.27194	0.16410	0.01924	0.09733	2.0180e+15	0.02247	0.08254	0.79604	0.00284	0.09563	1.7631e-08
8	1.024	3.2380e+15	0.02422	0.00409	0.37021	0.27247	0.16356	0.01892	0.09602	2.0020e+15	0.02238	0.08248	0.79764	0.00281	0.09422	1.7778e-08
9	1.034	3.2630e+15	0.02450	0.00408	0.36878	0.27292	0.16346	0.01905	0.09643	2.0210e+15	0.02241	0.08160	0.79811	0.00280	0.09461	1.7763e-08
10	1.016	3.2150e+15	0.02391	0.00410	0.37213	0.27252	0.16306	0.01868	0.09513	1.9860e+15	0.02234	0.08315	0.79813	0.00281	0.09311	1.7844e-08
11	1.012	3.2080e+15	0.02378	0.00410	0.37285	0.27231	0.16304	0.01862	0.09485	1.9790e+15	0.02233	0.08303	0.79841	0.00281	0.09295	1.7853e-08
12	1.021	3.2330e+15	0.02409	0.00409	0.37129	0.27247	0.16299	0.01878	0.09549	1.9970e+15	0.02237	0.08256	0.79824	0.00281	0.09356	1.7814e-08
13	0.993	3.1550e+15	0.02320	0.00411	0.37630	0.27156	0.16236	0.01823	0.09355	1.9410e+15	0.02229	0.08498	0.79808	0.00284	0.09135	1.7884e-08
14	0.962	3.0640e+15	0.02246	0.00417	0.38069	0.27112	0.16061	0.01760	0.09199	1.8810e+15	0.02233	0.08753	0.79829	0.00288	0.08852	1.7829e-08
15	1.016	3.2090e+15	0.02406	0.00410	0.37118	0.27268	0.16279	0.01870	0.09550	1.9870e+15	0.02238	0.08370	0.79760	0.00283	0.09303	1.7781e-08
16	1.035	3.2670e+15	0.02450	0.00408	0.36880	0.27291	0.16351	0.01906	0.09642	2.0230e+15	0.02240	0.08150	0.79815	0.00280	0.09468	1.7778e-08
17	1.018	3.2220e+15	0.02396	0.00409	0.37179	0.27252	0.16319	0.01873	0.09526	1.9900e+15	0.02234	0.08291	0.79814	0.00281	0.09334	1.7844e-08
18	1.015	3.2150e+15	0.02385	0.00410	0.37249	0.27239	0.16305	0.01866	0.09503	1.9840e+15	0.02234	0.08278	0.79847	0.00280	0.09315	1.7850e-08
19	1.023	3.2370e+15	0.02414	0.00409	0.37105	0.27251	0.16302	0.01881	0.09559	2.0010e+15	0.02237	0.08255	0.79815	0.00281	0.09366	1.7814e-08
20	0.994	3.1600e+15	0.02322	0.00411	0.37618	0.27152	0.16243	0.01825	0.09362	1.9430e+15	0.02228	0.08484	0.79808	0.00284	0.09150	1.7887e-08
21	0.963	3.0650e+15	0.02246	0.00417	0.38074	0.27106	0.16061	0.01761	0.09199	1.8820e+15	0.02232	0.08750	0.79829	0.00288	0.08856	1.7832e-08
22	1.040	3.2820e+15	0.02460	0.00407	0.36829	0.27289	0.16371	0.01915	0.09665	2.0320e+15	0.02240	0.08113	0.79809	0.00279	0.09512	1.7781e-08
23	1.037	3.2770e+15	0.02455	0.00407	0.36867	0.27289	0.16354	0.01911	0.09654	2.0280e+15	0.02241	0.08094	0.79845	0.00278	0.09494	1.7778e-08
24	1.009	3.2030e+15	0.02369	0.00410	0.37363	0.27189	0.16269	0.01855	0.09462	1.9720e+15	0.02235	0.08297	0.79866	0.00281	0.09275	1.7835e-08
25	0.962	3.0670e+15	0.02246	0.00417	0.38082	0.27107	0.16054	0.01761	0.09202	1.8820e+15	0.02234	0.08692	0.79878	0.00287	0.08863	1.7817e-08
26	1.038	3.2800e+15	0.02449	0.00407	0.36891	0.27266	0.16389	0.01913	0.09639	2.0300e+15	0.02234	0.08173	0.79754	0.00280	0.09512	1.7829e-08
27	1.057	3.3440e+15	0.02484	0.00403	0.36688	0.27243	0.16499	0.01953	0.09723	2.0660e+15	0.02234	0.07953	0.79779	0.00276	0.09711	1.7847e-08
28	1.042	3.3050e+15	0.02445	0.00404	0.36918	0.27208	0.16446	0.01925	0.09634	2.0380e+15	0.02232	0.08047	0.79803	0.00277	0.09594	1.7866e-08
29	0.991	3.1540e+15	0.02312	0.00411	0.37686	0.27131	0.16229	0.01820	0.09343	1.9380e+15	0.02228	0.08502	0.79809	0.00284	0.09131	1.7890e-08
30	0.957	3.0490e+15	0.02228	0.00417	0.38196	0.27070	0.16029	0.01748	0.09162	1.8710e+15	0.02230	0.08863	0.79770	0.00290	0.08802	1.7841e-08
31	1.019	3.2300e+15	0.02395	0.00408	0.37223	0.27207	0.16296	0.01873	0.09523	1.9920e+15	0.02235	0.08247	0.79839	0.00281	0.09352	1.7832e-08
32	0.966	3.0750e+15	0.02254	0.00416	0.38047	0.27101	0.16063	0.01766	0.09220	1.8880e+15	0.02233	0.08727	0.79823	0.00288	0.08883	1.7829e-08
33	0.949	3.0330e+15	0.02199	0.00418	0.38364	0.27026	0.16008	0.01734	0.09105	1.8550e+15	0.02231	0.08824	0.79848	0.00289	0.08764	1.7841e-08
34	0.980	3.1210e+15	0.02287	0.00413	0.37838	0.27111	0.16153	0.01797	0.09288	1.9150e+15	0.02231	0.08549	0.79858	0.00285	0.09032	1.7847e-08
35	0.952	3.0390e+15	0.02209	0.00417	0.38307	0.27035	0.16014	0.01739	0.09127	1.8610e+15	0.02230	0.08855	0.79801	0.00290	0.08778	1.7841e-08
36	0.941	3.0110e+15	0.02173	0.00418	0.38517	0.26982	0.15982	0.01718	0.09048	1.8390e+15	0.02229	0.08933	0.79805	0.00291	0.08697	1.7847e-08
37	0.939	3.0050e+15	0.02172	0.00419	0.38527	0.26973	0.15959	0.01714	0.09045	1.8360e+15	0.02230	0.08989	0.79769	0.00292	0.08675	1.7832e-08
38	0.936	3.0000e+15	0.02157	0.00419	0.38615	0.26944	0.15966	0.01710	0.09019	1.8300e+15	0.02228	0.09003	0.79766	0.00292	0.08665	1.7853e-08
39	0.932	2.9880e+15	0.02148	0.00419	0.38671	0.26928	0.15933	0.01701	0.08998	1.8220e+15	0.02228	0.09063	0.79746	0.00293	0.08625	1.7838e-08
Assembly total[c]		8.3800e+17	0.02346	0.00411	0.37489	0.27170	0.16230	0.01838	0.09423	5.1620e+17	0.02235	0.08433	0.79807	0.00284	0.09196	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.60. HELIOS results for PWR MOX benchmark multicycle depletion at BOC 2 (15.0 MWd/kg)

Total production/total absorption = 1.09948
Multiplication factor (k_{eff}) = 1.09508

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.041	3.2480e+15	0.02562	0.00403	0.35855	0.27405	0.16517	0.02040	0.10020	2.0360e+15	0.02259	0.07929	0.79495	0.00280	0.09989	1.6977e-08
2	1.052	3.2390e+15	0.02584	0.00407	0.35859	0.27936	0.16238	0.01984	0.09854	2.0590e+15	0.02246	0.07843	0.80003	0.00269	0.09592	1.7284e-08
3	1.052	3.2310e+15	0.02577	0.00409	0.35937	0.28060	0.16160	0.01962	0.09781	2.0580e+15	0.02240	0.07844	0.80139	0.00266	0.09465	1.7399e-08
4	1.048	3.2210e+15	0.02566	0.00409	0.36004	0.28049	0.16146	0.01956	0.09756	2.0510e+15	0.02240	0.07837	0.80170	0.00266	0.09442	1.7402e-08
5	1.016	3.1470e+15	0.02469	0.00410	0.36530	0.27846	0.16127	0.01905	0.09578	1.9870e+15	0.02233	0.08051	0.80119	0.00271	0.09281	1.7432e-08
6	0.942	2.9630e+15	0.02268	0.00417	0.37643	0.27429	0.16008	0.01791	0.09253	1.8420e+15	0.02233	0.08595	0.79952	0.00282	0.08893	1.7344e-08
7	1.014	3.1550e+15	0.02486	0.00408	0.36314	0.27563	0.16336	0.01955	0.09777	1.9830e+15	0.02245	0.08198	0.79661	0.00281	0.09568	1.7176e-08
8	1.025	3.1740e+15	0.02501	0.00409	0.36293	0.27829	0.16254	0.01939	0.09703	2.0060e+15	0.02236	0.08039	0.79969	0.00272	0.09438	1.7375e-08
9	1.056	3.2380e+15	0.02588	0.00408	0.35864	0.28078	0.16182	0.01970	0.09809	2.0650e+15	0.02242	0.07814	0.80138	0.00266	0.09494	1.7381e-08
10	1.025	3.1660e+15	0.02495	0.00410	0.36359	0.27924	0.16189	0.01921	0.09643	2.0050e+15	0.02231	0.08051	0.80069	0.00270	0.09333	1.7462e-08
11	1.021	3.1590e+15	0.02482	0.00410	0.36428	0.27909	0.16185	0.01915	0.09617	1.9980e+15	0.02230	0.08028	0.80108	0.00270	0.09318	1.7468e-08
12	1.041	3.2040e+15	0.02544	0.00409	0.36129	0.28023	0.16139	0.01942	0.09712	2.0370e+15	0.02237	0.07910	0.80152	0.00268	0.09388	1.7432e-08
13	0.989	3.0830e+15	0.02390	0.00412	0.36953	0.27698	0.16147	0.01864	0.09446	1.9350e+15	0.02226	0.08304	0.80001	0.00276	0.09148	1.7474e-08
14	0.939	2.9530e+15	0.02258	0.00417	0.37691	0.27421	0.16006	0.01784	0.09230	1.8370e+15	0.02230	0.08712	0.79875	0.00285	0.08853	1.7372e-08
15	1.022	3.1520e+15	0.02498	0.00411	0.36330	0.27892	0.16165	0.01920	0.09666	1.9980e+15	0.02235	0.08145	0.79978	0.00274	0.09321	1.7384e-08
16	1.059	3.2460e+15	0.02593	0.00408	0.35839	0.28096	0.16185	0.01973	0.09814	2.0710e+15	0.02241	0.07796	0.80149	0.00265	0.09502	1.7399e-08
17	1.030	3.1770e+15	0.02507	0.00410	0.36294	0.27950	0.16194	0.01928	0.09664	2.0140e+15	0.02231	0.08013	0.80083	0.00269	0.09357	1.7462e-08
18	1.026	3.1700e+15	0.02495	0.00410	0.36366	0.27935	0.16181	0.01921	0.09641	2.0070e+15	0.02231	0.07992	0.80123	0.00269	0.09340	1.7465e-08
19	1.044	3.2100e+15	0.02552	0.00409	0.36089	0.28039	0.16137	0.01945	0.09726	2.0430e+15	0.02237	0.07903	0.80148	0.00267	0.09399	1.7429e-08
20	0.991	3.0880e+15	0.02394	0.00411	0.36929	0.27704	0.16150	0.01868	0.09456	1.9390e+15	0.02225	0.08282	0.80008	0.00275	0.09164	1.7480e-08
21	0.939	2.9540e+15	0.02258	0.00417	0.37697	0.27415	0.16006	0.01784	0.09231	1.8370e+15	0.02230	0.08705	0.79877	0.00285	0.08858	1.7372e-08
22	1.071	3.2750e+15	0.02625	0.00408	0.35679	0.28178	0.16183	0.01989	0.09862	2.0960e+15	0.02241	0.07711	0.80188	0.00263	0.09551	1.7411e-08
23	1.069	3.2710e+15	0.02621	0.00408	0.35714	0.28179	0.16164	0.01985	0.09854	2.0910e+15	0.02243	0.07679	0.80234	0.00262	0.09536	1.7402e-08
24	1.020	3.1580e+15	0.02481	0.00410	0.36473	0.27884	0.16128	0.01911	0.09600	1.9950e+15	0.02234	0.07981	0.80167	0.00269	0.09303	1.7438e-08
25	0.940	2.9570e+15	0.02261	0.00417	0.37693	0.27426	0.15994	0.01785	0.09239	1.8380e+15	0.02232	0.08624	0.79947	0.00283	0.08869	1.7351e-08
26	1.068	3.2690e+15	0.02605	0.00407	0.35774	0.28141	0.16226	0.01984	0.09824	2.0880e+15	0.02233	0.07787	0.80123	0.00264	0.09547	1.7471e-08
27	1.099	3.3600e+15	0.02672	0.00404	0.35415	0.28228	0.16305	0.02036	0.09941	2.1510e+15	0.02235	0.07475	0.80228	0.00257	0.09758	1.7492e-08
28	1.076	3.3030e+15	0.02612	0.00405	0.35750	0.28118	0.16267	0.02000	0.09828	2.1050e+15	0.02232	0.07605	0.80221	0.00260	0.09635	1.7501e-08
29	0.987	3.0790e+15	0.02380	0.00412	0.37020	0.27669	0.16137	0.01861	0.09432	1.9300e+15	0.02225	0.08298	0.80010	0.00276	0.09146	1.7477e-08
30	0.930	2.9300e+15	0.02229	0.00417	0.37884	0.27333	0.15978	0.01768	0.09180	1.8180e+15	0.02228	0.08848	0.79790	0.00288	0.08801	1.7363e-08
31	1.037	3.1980e+15	0.02527	0.00409	0.36242	0.27975	0.16133	0.01936	0.09683	2.0280e+15	0.02235	0.07887	0.80179	0.00267	0.09386	1.7438e-08
32	0.945	2.9680e+15	0.02276	0.00417	0.37628	0.27448	0.15992	0.01793	0.09264	1.8480e+15	0.02231	0.08643	0.79907	0.00284	0.08890	1.7363e-08
33	0.916	2.9050e+15	0.02183	0.00418	0.38137	0.27225	0.15973	0.01749	0.09105	1.7920e+15	0.02229	0.08819	0.79857	0.00287	0.08763	1.7348e-08
34	0.970	3.0360e+15	0.02340	0.00414	0.37252	0.27589	0.16066	0.01833	0.09362	1.8970e+15	0.02229	0.08362	0.80040	0.00277	0.09046	1.7417e-08
35	0.921	2.9140e+15	0.02200	0.00418	0.38056	0.27256	0.15970	0.01756	0.09132	1.8010e+15	0.02228	0.08848	0.79813	0.00288	0.08778	1.7351e-08
36	0.903	2.8730e+15	0.02141	0.00419	0.38386	0.27111	0.15958	0.01728	0.09026	1.7660e+15	0.02227	0.08976	0.79769	0.00291	0.08692	1.7335e-08
37	0.901	2.8670e+15	0.02139	0.00419	0.38400	0.27100	0.15934	0.01724	0.09023	1.7630e+15	0.02227	0.09033	0.79732	0.00292	0.08670	1.7320e-08
38	0.895	2.8560e+15	0.02113	0.00419	0.38549	0.27026	0.15950	0.01716	0.08982	1.7500e+15	0.02225	0.09076	0.79703	0.00294	0.08657	1.7332e-08
39	0.889	2.8400e+15	0.02098	0.00420	0.38639	0.26986	0.15921	0.01705	0.08953	1.7390e+15	0.02226	0.09143	0.79675	0.00295	0.08616	1.7308e-08
Assembly total[c]		8.2040e+17	0.02423	0.00412	0.36783	0.27730	0.16121	0.01883	0.09522	5.1640e+17	0.02233	0.08224	0.80008	0.00275	0.09214	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.61. HELIOS results for PWR MOX benchmark multicycle depletion at MOC 2 (22.5 MWd/kg)

Total production/total absorption = 1.04848
Multiplication factor (k_{eff}) = 1.04428

			Fraction of total capture rate								Fraction of total fission rate					^{135}Xe concentration
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	(a/b-cm)[b]
1	1.036	3.5050e+15	0.02526	0.00344	0.34926	0.23661	0.17581	0.02829	0.12289	2.0230e+15	0.02145	0.08174	0.74247	0.00340	0.14989	1.5628e-08
2	1.046	3.4980e+15	0.02546	0.00348	0.34899	0.24102	0.17431	0.02769	0.12132	2.0430e+15	0.02140	0.08095	0.74820	0.00333	0.14511	1.5884e-08
3	1.046	3.4890e+15	0.02539	0.00349	0.34969	0.24226	0.17379	0.02742	0.12055	2.0430e+15	0.02135	0.08098	0.75000	0.00332	0.14336	1.6001e-08
4	1.042	3.4780e+15	0.02527	0.00350	0.35043	0.24232	0.17360	0.02730	0.12022	2.0350e+15	0.02134	0.08096	0.75055	0.00331	0.14285	1.6022e-08
5	1.012	3.3930e+15	0.02435	0.00352	0.35562	0.24207	0.17283	0.02650	0.11797	1.9770e+15	0.02121	0.08305	0.75197	0.00335	0.13944	1.6191e-08
6	0.951	3.2030e+15	0.02267	0.00360	0.36525	0.24260	0.17005	0.02481	0.11416	1.8580e+15	0.02109	0.08763	0.75528	0.00344	0.13162	1.6387e-08
7	1.016	3.4130e+15	0.02471	0.00350	0.35277	0.23998	0.17396	0.02720	0.12031	1.9850e+15	0.02131	0.08398	0.74694	0.00342	0.14333	1.5929e-08
8	1.026	3.4340e+15	0.02482	0.00351	0.35253	0.24187	0.17383	0.02707	0.11968	2.0040e+15	0.02126	0.08248	0.74976	0.00335	0.14216	1.6083e-08
9	1.049	3.4980e+15	0.02549	0.00349	0.34900	0.24221	0.17405	0.02754	0.12089	2.0490e+15	0.02138	0.08069	0.74967	0.00331	0.14396	1.5971e-08
10	1.026	3.4260e+15	0.02476	0.00352	0.35310	0.24283	0.17341	0.02685	0.11904	2.0040e+15	0.02122	0.08261	0.75112	0.00334	0.14072	1.6173e-08
11	1.022	3.4170e+15	0.02463	0.00352	0.35388	0.24282	0.17330	0.02675	0.11870	1.9960e+15	0.02121	0.08243	0.75169	0.00333	0.14036	1.6197e-08
12	1.034	3.4570e+15	0.02504	0.00350	0.35176	0.24233	0.17351	0.02708	0.11964	2.0210e+15	0.02130	0.08175	0.75075	0.00333	0.14188	1.6083e-08
13	0.992	3.3290e+15	0.02372	0.00354	0.35912	0.24245	0.17234	0.02593	0.11652	1.9380e+15	0.02110	0.08518	0.75258	0.00339	0.13678	1.6339e-08
14	0.948	3.1920e+15	0.02259	0.00360	0.36569	0.24269	0.16998	0.02471	0.11390	1.8530e+15	0.02106	0.08879	0.75474	0.00347	0.13100	1.6423e-08
15	1.023	3.4120e+15	0.02482	0.00352	0.35273	0.24275	0.17300	0.02682	0.11927	1.9990e+15	0.02126	0.08350	0.75049	0.00337	0.14039	1.6107e-08
16	1.051	3.5070e+15	0.02554	0.00349	0.34876	0.24225	0.17411	0.02760	0.12098	2.0540e+15	0.02137	0.08052	0.74963	0.00331	0.14418	1.5977e-08
17	1.030	3.4380e+15	0.02487	0.00351	0.35249	0.24283	0.17351	0.02696	0.11931	2.0120e+15	0.02124	0.08226	0.75098	0.00333	0.14120	1.6155e-08
18	1.026	3.4290e+15	0.02474	0.00352	0.35325	0.24281	0.17341	0.02685	0.11900	2.0040e+15	0.02123	0.08208	0.75157	0.00332	0.14082	1.6176e-08
19	1.037	3.4640e+15	0.02511	0.00350	0.35138	0.24234	0.17355	0.02714	0.11982	2.0260e+15	0.02131	0.08169	0.75056	0.00333	0.14212	1.6071e-08
20	0.993	3.3350e+15	0.02376	0.00354	0.35891	0.24240	0.17241	0.02598	0.11663	1.9410e+15	0.02110	0.08498	0.75252	0.00339	0.13705	1.6339e-08
21	0.949	3.1930e+15	0.02258	0.00360	0.36576	0.24263	0.16997	0.02471	0.11390	1.8540e+15	0.02106	0.08874	0.75474	0.00347	0.13104	1.6426e-08
22	1.062	3.5370e+15	0.02581	0.00348	0.34738	0.24229	0.17439	0.02784	0.12156	2.0740e+15	0.02140	0.07977	0.74929	0.00329	0.14525	1.5941e-08
23	1.059	3.5310e+15	0.02574	0.00349	0.34783	0.24233	0.17421	0.02776	0.12142	2.0690e+15	0.02141	0.07951	0.74986	0.00328	0.14495	1.5941e-08
24	1.015	3.4050e+15	0.02444	0.00352	0.35516	0.24215	0.17296	0.02658	0.11822	1.9830e+15	0.02123	0.08242	0.75215	0.00334	0.13988	1.6182e-08
25	0.949	3.1960e+15	0.02260	0.00360	0.36578	0.24264	0.16991	0.02473	0.11397	1.8540e+15	0.02108	0.08798	0.75534	0.00345	0.13120	1.6405e-08
26	1.060	3.5330e+15	0.02566	0.00348	0.34802	0.24228	0.17479	0.02778	0.12119	2.0710e+15	0.02131	0.08042	0.74888	0.00330	0.14510	1.6022e-08
27	1.082	3.6210e+15	0.02609	0.00344	0.34561	0.24096	0.17609	0.02850	0.12248	2.1150e+15	0.02137	0.07782	0.74745	0.00323	0.14911	1.5929e-08
28	1.061	3.5580e+15	0.02553	0.00346	0.34882	0.24113	0.17539	0.02792	0.12102	2.0740e+15	0.02130	0.07908	0.74887	0.00326	0.14649	1.6034e-08
29	0.989	3.3240e+15	0.02360	0.00354	0.35990	0.24225	0.17221	0.02585	0.11629	1.9320e+15	0.02108	0.08519	0.75279	0.00339	0.13658	1.6354e-08
30	0.939	3.1660e+15	0.02229	0.00361	0.36771	0.24232	0.16951	0.02444	0.11321	1.8360e+15	0.02102	0.09022	0.75447	0.00351	0.12983	1.6459e-08
31	1.029	3.4470e+15	0.02482	0.00350	0.35312	0.24201	0.17340	0.02695	0.11919	2.0100e+15	0.02127	0.08165	0.75122	0.00333	0.14156	1.6119e-08
32	0.953	3.2070e+15	0.02271	0.00360	0.36533	0.24253	0.17001	0.02481	0.11421	1.8610e+15	0.02107	0.08830	0.75464	0.00347	0.13157	1.6399e-08
33	0.926	3.1370e+15	0.02182	0.00362	0.37030	0.24184	0.16923	0.02414	0.11228	1.8100e+15	0.02100	0.08994	0.75573	0.00349	0.12889	1.6495e-08
34	0.973	3.2770e+15	0.02323	0.00356	0.36210	0.24232	0.17129	0.02542	0.11538	1.9020e+15	0.02109	0.08579	0.75415	0.00340	0.13460	1.6360e-08
35	0.930	3.1450e+15	0.02196	0.00361	0.36961	0.24186	0.16931	0.02423	0.11256	1.8170e+15	0.02100	0.09031	0.75505	0.00351	0.12918	1.6480e-08
36	0.913	3.0990e+15	0.02138	0.00363	0.37286	0.24136	0.16885	0.02379	0.11126	1.7840e+15	0.02095	0.09155	0.75559	0.00353	0.12743	1.6537e-08
37	0.911	3.0920e+15	0.02135	0.00363	0.37302	0.24132	0.16861	0.02373	0.11119	1.7810e+15	0.02095	0.09216	0.75536	0.00355	0.12704	1.6531e-08
38	0.905	3.0780e+15	0.02108	0.00363	0.37464	0.24087	0.16862	0.02358	0.11067	1.7680e+15	0.02092	0.09263	0.75533	0.00356	0.12663	1.6567e-08
39	0.899	3.0600e+15	0.02091	0.00364	0.37558	0.24073	0.16825	0.02341	0.11029	1.7570e+15	0.02091	0.09336	0.75538	0.00357	0.12584	1.6567e-08
Assembly total[c]		8.8590e+17	0.02400	0.00354	0.35762	0.24203	0.17232	0.02620	0.11739	5.1590e+17	0.02119	0.08448	0.75191	0.00338	0.13806	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.62. HELIOS results for PWR MOX benchmark multicycle depletion at EOC 1/BOC 3 (30.0 MWd/kg)

Total production/total absorption = 1.00291
Multiplication factor (k_{eff}) = 0.99889

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.030	3.7540e+15	0.02475	0.00291	0.34189	0.20510	0.18035	0.03491	0.14360	2.0110e+15	0.02001	0.08411	0.69162	0.00380	0.19860	1.4221e-08
2	1.039	3.7500e+15	0.02492	0.00295	0.34143	0.20855	0.17976	0.03440	0.14229	2.0280e+15	0.02002	0.08341	0.69706	0.00376	0.19394	1.4429e-08
3	1.039	3.7410e+15	0.02485	0.00296	0.34204	0.20973	0.17945	0.03412	0.14155	2.0290e+15	0.01999	0.08346	0.69907	0.00375	0.19195	1.4550e-08
4	1.035	3.7280e+15	0.02474	0.00296	0.34280	0.20997	0.17927	0.03396	0.14114	2.0210e+15	0.01997	0.08345	0.69993	0.00375	0.19112	1.4592e-08
5	1.008	3.6340e+15	0.02392	0.00299	0.34784	0.21131	0.17817	0.03291	0.13843	1.9690e+15	0.01981	0.08544	0.70361	0.00380	0.18559	1.4902e-08
6	0.960	3.4400e+15	0.02261	0.00309	0.35587	0.21529	0.17503	0.03087	0.13403	1.8740e+15	0.01967	0.08919	0.71178	0.00388	0.17381	1.5348e-08
7	1.017	3.6650e+15	0.02440	0.00297	0.34442	0.20947	0.17885	0.03376	0.14099	1.9850e+15	0.01992	0.08596	0.69815	0.00383	0.19034	1.4595e-08
8	1.025	3.6880e+15	0.02447	0.00298	0.34421	0.21071	0.17908	0.03371	0.14053	2.0020e+15	0.01989	0.08453	0.70040	0.00377	0.18963	1.4712e-08
9	1.041	3.7500e+15	0.02494	0.00296	0.34143	0.20949	0.17967	0.03428	0.14193	2.0330e+15	0.02002	0.08317	0.69843	0.00375	0.19285	1.4501e-08
10	1.025	3.6800e+15	0.02442	0.00299	0.34472	0.21163	0.17882	0.03348	0.13991	2.0020e+15	0.01987	0.08468	0.70194	0.00377	0.18798	1.4806e-08
11	1.021	3.6690e+15	0.02428	0.00299	0.34556	0.21177	0.17870	0.03333	0.13949	1.9940e+15	0.01985	0.08453	0.70276	0.00376	0.18734	1.4851e-08
12	1.028	3.7030e+15	0.02451	0.00297	0.34425	0.21029	0.17906	0.03368	0.14043	2.0070e+15	0.01992	0.08429	0.70062	0.00377	0.18962	1.4688e-08
13	0.994	3.5720e+15	0.02346	0.00302	0.35064	0.21297	0.17750	0.03226	0.13683	1.9410e+15	0.01970	0.08721	0.70593	0.00383	0.18160	1.5137e-08
14	0.958	3.4290e+15	0.02254	0.00309	0.35632	0.21551	0.17493	0.03076	0.13373	1.8710e+15	0.01964	0.09034	0.71147	0.00391	0.17297	1.5396e-08
15	1.023	3.6670e+15	0.02450	0.00299	0.34420	0.21169	0.17845	0.03344	0.14013	1.9980e+15	0.01991	0.08551	0.70156	0.00380	0.18746	1.4742e-08
16	1.044	3.7600e+15	0.02499	0.00295	0.34119	0.20941	0.17978	0.03435	0.14207	2.0380e+15	0.02002	0.08300	0.69823	0.00374	0.19323	1.4498e-08
17	1.029	3.6930e+15	0.02451	0.00298	0.34416	0.21144	0.17896	0.03361	0.14023	2.0090e+15	0.01988	0.08434	0.70153	0.00376	0.18872	1.4772e-08
18	1.025	3.6820e+15	0.02438	0.00299	0.34497	0.21155	0.17885	0.03346	0.13985	2.0010e+15	0.01987	0.08420	0.70233	0.00375	0.18810	1.4812e-08
19	1.030	3.7100e+15	0.02457	0.00297	0.34390	0.21016	0.17913	0.03375	0.14064	2.0110e+15	0.01993	0.08426	0.70025	0.00378	0.19000	1.4667e-08
20	0.995	3.5780e+15	0.02348	0.00302	0.35047	0.21283	0.17757	0.03231	0.13696	1.9440e+15	0.01970	0.08703	0.70574	0.00382	0.18197	1.5128e-08
21	0.958	3.4300e+15	0.02253	0.00309	0.35640	0.21546	0.17492	0.03075	0.13374	1.8710e+15	0.01963	0.09031	0.71146	0.00391	0.17301	1.5399e-08
22	1.052	3.7920e+15	0.02518	0.00294	0.34009	0.20885	0.18010	0.03464	0.14278	2.0540e+15	0.02005	0.08238	0.69710	0.00372	0.19494	1.4420e-08
23	1.049	3.7840e+15	0.02510	0.00294	0.34058	0.20894	0.17997	0.03453	0.14258	2.0480e+15	0.02005	0.08217	0.69779	0.00372	0.19447	1.4435e-08
24	1.011	3.6460e+15	0.02396	0.00299	0.34753	0.21110	0.17837	0.03302	0.13870	1.9740e+15	0.01983	0.08491	0.70343	0.00378	0.18630	1.4878e-08
25	0.958	3.4330e+15	0.02253	0.00309	0.35650	0.21538	0.17489	0.03076	0.13379	1.8700e+15	0.01965	0.08960	0.71197	0.00389	0.17321	1.5378e-08
26	1.052	3.7900e+15	0.02507	0.00294	0.34057	0.20911	0.18040	0.03459	0.14240	2.0540e+15	0.01996	0.08294	0.69695	0.00373	0.19462	1.4523e-08
27	1.066	3.8730e+15	0.02529	0.00290	0.33914	0.20648	0.18170	0.03537	0.14380	2.0820e+15	0.02000	0.08081	0.69346	0.00366	0.20023	1.4351e-08
28	1.048	3.8040e+15	0.02481	0.00292	0.34216	0.20771	0.18087	0.03464	0.14203	2.0470e+15	0.01991	0.08200	0.69649	0.00370	0.19609	1.4547e-08
29	0.991	3.5640e+15	0.02332	0.00302	0.35154	0.21287	0.17735	0.03213	0.13652	1.9350e+15	0.01968	0.08729	0.70632	0.00383	0.18115	1.5173e-08
30	0.949	3.4000e+15	0.02224	0.00310	0.35839	0.21560	0.17439	0.03038	0.13287	1.8540e+15	0.01958	0.09183	0.71189	0.00396	0.17106	1.5480e-08
31	1.022	3.6890e+15	0.02426	0.00297	0.34582	0.21019	0.17891	0.03346	0.13982	1.9950e+15	0.01987	0.08430	0.70143	0.00377	0.18885	1.4760e-08
32	0.960	3.4430e+15	0.02259	0.00308	0.35626	0.21502	0.17503	0.03084	0.13403	1.8750e+15	0.01964	0.09005	0.71100	0.00391	0.17371	1.5366e-08
33	0.937	3.3670e+15	0.02179	0.00311	0.36093	0.21572	0.17402	0.02997	0.13172	1.8300e+15	0.01954	0.09153	0.71390	0.00394	0.16943	1.5580e-08
34	0.977	3.5140e+15	0.02299	0.00304	0.35359	0.21363	0.17640	0.03158	0.13541	1.9080e+15	0.01967	0.08782	0.70877	0.00385	0.17818	1.5239e-08
35	0.940	3.3740e+15	0.02190	0.00310	0.36043	0.21549	0.17412	0.03007	0.13202	1.8350e+15	0.01955	0.09198	0.71298	0.00396	0.16988	1.5550e-08
36	0.924	3.3240e+15	0.02135	0.00312	0.36361	0.21582	0.17348	0.02950	0.13046	1.8040e+15	0.01949	0.09316	0.71465	0.00398	0.16708	1.5682e-08
37	0.922	3.3160e+15	0.02132	0.00313	0.36373	0.21587	0.17326	0.02941	0.13038	1.8010e+15	0.01948	0.09380	0.71456	0.00400	0.16651	1.5685e-08
38	0.916	3.2990e+15	0.02104	0.00313	0.36546	0.21572	0.17316	0.02920	0.12970	1.7880e+15	0.01944	0.09428	0.71492	0.00401	0.16571	1.5757e-08
39	0.910	3.2790e+15	0.02087	0.00314	0.36641	0.21579	0.17279	0.02897	0.12923	1.7770e+15	0.01943	0.09507	0.71531	0.00403	0.16453	1.5781e-08
Assembly total[c]		9.5020e+17	0.02366	0.00301	0.34937	0.21200	0.17756	0.03257	0.13779	5.1550e+17	0.01979	0.08661	0.70447	0.00382	0.18356	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.63. HELIOS results for PWR MOX benchmark multicycle depletion at MOC 3 (27.5 MWd/kg)

Total production/total absorption = 0.96176
Multiplication factor (k_{eff}) = 0.95790

			Fraction of total capture rate								Fraction of total fission rate					
Pin	Relative pin power	Total capture rate (1/s)[a]	^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	^{135}Xe concentration (a/b-cm)[b]
1	1.025	4.0000e+15	0.02425	0.00242	0.33576	0.17939	0.18035	0.03979	0.16271	2.0010e+15	0.01825	0.08641	0.64676	0.00399	0.24162	1.2929e-08
2	1.032	3.9970e+15	0.02439	0.00245	0.33522	0.18194	0.18038	0.03945	0.16161	2.0150e+15	0.01833	0.08580	0.65118	0.00398	0.23783	1.3089e-08
3	1.033	3.9880e+15	0.02433	0.00247	0.33579	0.18300	0.18026	0.03920	0.16089	2.0150e+15	0.01831	0.08587	0.65317	0.00399	0.23581	1.3212e-08
4	1.029	3.9730e+15	0.02421	0.00247	0.33657	0.18337	0.18012	0.03902	0.16040	2.0080e+15	0.01830	0.08589	0.65427	0.00399	0.23472	1.3276e-08
5	1.006	3.8710e+15	0.02351	0.00251	0.34129	0.18589	0.17914	0.03787	0.15728	1.9630e+15	0.01816	0.08773	0.65992	0.00405	0.22736	1.3700e-08
6	0.968	3.6770e+15	0.02253	0.00262	0.34784	0.19199	0.17643	0.03576	0.15245	1.8900e+15	0.01808	0.09074	0.67163	0.00415	0.21276	1.4321e-08
7	1.017	3.9140e+15	0.02405	0.00249	0.33747	0.18398	0.17955	0.03878	0.16010	1.9840e+15	0.01826	0.08796	0.65404	0.00405	0.23283	1.3327e-08
8	1.024	3.9370e+15	0.02410	0.00249	0.33732	0.18472	0.17995	0.03881	0.15979	1.9980e+15	0.01825	0.08659	0.65560	0.00400	0.23272	1.3414e-08
9	1.034	3.9970e+15	0.02441	0.00246	0.33524	0.18263	0.18043	0.03937	0.16132	2.0190e+15	0.01834	0.08560	0.65231	0.00398	0.23691	1.3149e-08
10	1.024	3.9300e+15	0.02405	0.00250	0.33781	0.18556	0.17984	0.03860	0.15918	1.9980e+15	0.01824	0.08677	0.65715	0.00401	0.23103	1.3514e-08
11	1.020	3.9160e+15	0.02391	0.00251	0.33868	0.18584	0.17974	0.03842	0.15868	1.9910e+15	0.01822	0.08664	0.65822	0.00400	0.23013	1.3580e-08
12	1.022	3.9440e+15	0.02400	0.00248	0.33806	0.18397	0.17990	0.03869	0.15957	1.9950e+15	0.01825	0.08676	0.65547	0.00402	0.23268	1.3405e-08
13	0.996	3.8100e+15	0.02319	0.00255	0.34349	0.18827	0.17855	0.03723	0.15561	1.9440e+15	0.01808	0.08919	0.66339	0.00409	0.22251	1.3983e-08
14	0.967	3.6650e+15	0.02247	0.00262	0.34823	0.19230	0.17636	0.03564	0.15214	1.8870e+15	0.01806	0.09188	0.67149	0.00419	0.21175	1.4378e-08
15	1.023	3.9170e+15	0.02414	0.00251	0.33717	0.18565	0.17954	0.03857	0.15940	1.9960e+15	0.01828	0.08755	0.65687	0.00405	0.23045	1.3447e-08
16	1.037	4.0080e+15	0.02444	0.00246	0.33505	0.18246	0.18053	0.03945	0.16149	2.0230e+15	0.01834	0.08543	0.65197	0.00397	0.23743	1.3137e-08
17	1.027	3.9430e+15	0.02412	0.00250	0.33734	0.18521	0.17994	0.03874	0.15955	2.0040e+15	0.01825	0.08646	0.65650	0.00400	0.23197	1.3465e-08
18	1.023	3.9310e+15	0.02399	0.00250	0.33817	0.18547	0.17985	0.03856	0.15908	1.9960e+15	0.01823	0.08634	0.65754	0.00399	0.23110	1.3526e-08
19	1.024	3.9520e+15	0.02405	0.00248	0.33778	0.18375	0.17996	0.03877	0.15980	1.9980e+15	0.01825	0.08676	0.65496	0.00402	0.23317	1.3375e-08
20	0.997	3.8170e+15	0.02321	0.00254	0.34338	0.18807	0.17862	0.03728	0.15575	1.9470e+15	0.01808	0.08905	0.66311	0.00408	0.22294	1.3974e-08
21	0.967	3.6670e+15	0.02246	0.00262	0.34833	0.19225	0.17634	0.03563	0.15213	1.8870e+15	0.01805	0.09187	0.67149	0.00419	0.21177	1.4384e-08
22	1.042	4.0400e+15	0.02455	0.00244	0.33420	0.18151	0.18087	0.03972	0.16225	2.0340e+15	0.01835	0.08496	0.65026	0.00395	0.23959	1.3041e-08
23	1.039	4.0300e+15	0.02447	0.00245	0.33476	0.18166	0.18077	0.03959	0.16199	2.0280e+15	0.01834	0.08480	0.65107	0.00395	0.23895	1.3071e-08
24	1.007	3.8820e+15	0.02352	0.00251	0.34116	0.18550	0.17933	0.03796	0.15756	1.9660e+15	0.01816	0.08730	0.65945	0.00404	0.22826	1.3670e-08
25	0.966	3.6680e+15	0.02244	0.00262	0.34851	0.19214	0.17631	0.03562	0.15216	1.8850e+15	0.01806	0.09122	0.67193	0.00417	0.21198	1.4366e-08
26	1.043	4.0380e+15	0.02448	0.00245	0.33464	0.18190	0.18106	0.03968	0.16190	2.0360e+15	0.01828	0.08547	0.65031	0.00396	0.23910	1.3146e-08
27	1.052	4.1160e+15	0.02454	0.00240	0.33401	0.17883	0.18196	0.04035	0.16331	2.0540e+15	0.01825	0.08370	0.64588	0.00388	0.24534	1.2950e-08
28	1.037	4.0430e+15	0.02415	0.00243	0.33677	0.18076	0.18130	0.03959	0.16128	2.0240e+15	0.01818	0.08479	0.65011	0.00392	0.24009	1.3218e-08
29	0.993	3.8010e+15	0.02304	0.00255	0.34452	0.18830	0.17840	0.03705	0.15521	1.9370e+15	0.01805	0.08936	0.66401	0.00409	0.22175	1.4044e-08
30	0.958	3.6320e+15	0.02218	0.00263	0.35034	0.19274	0.17583	0.03519	0.15110	1.8700e+15	0.01800	0.09343	0.67255	0.00425	0.20915	1.4507e-08
31	1.015	3.9260e+15	0.02373	0.00248	0.33985	0.18410	0.17975	0.03839	0.15878	1.9820e+15	0.01818	0.08689	0.65669	0.00403	0.23140	1.3517e-08
32	0.967	3.6770e+15	0.02246	0.00261	0.34852	0.19162	0.17643	0.03568	0.15239	1.8880e+15	0.01804	0.09181	0.67079	0.00420	0.21252	1.4348e-08
33	0.947	3.5960e+15	0.02176	0.00265	0.35281	0.19344	0.17538	0.03471	0.14977	1.8490e+15	0.01795	0.09307	0.67535	0.00422	0.20681	1.4667e-08
34	0.980	3.7480e+15	0.02274	0.00257	0.34639	0.18952	0.17760	0.03644	0.15390	1.9130e+15	0.01805	0.08983	0.66732	0.00412	0.21799	1.4167e-08
35	0.949	3.6030e+15	0.02183	0.00264	0.35246	0.19304	0.17551	0.03481	0.15007	1.8520e+15	0.01795	0.09360	0.67424	0.00425	0.20735	1.4628e-08
36	0.935	3.5480e+15	0.02134	0.00267	0.35550	0.19408	0.17480	0.03415	0.14830	1.8240e+15	0.01789	0.09470	0.67698	0.00427	0.20358	1.4833e-08
37	0.933	3.5390e+15	0.02130	0.00267	0.35567	0.19415	0.17463	0.03404	0.14816	1.8210e+15	0.01788	0.09538	0.67701	0.00430	0.20285	1.4842e-08
38	0.927	3.5190e+15	0.02102	0.00268	0.35740	0.19430	0.17449	0.03378	0.14736	1.8080e+15	0.01784	0.09586	0.67779	0.00431	0.20163	1.4947e-08
39	0.921	3.4970e+15	0.02085	0.00268	0.35840	0.19456	0.17413	0.03351	0.14679	1.7970e+15	0.01782	0.09669	0.67852	0.00434	0.20007	1.4998e-08
Assembly total[c]		1.0130e+18	0.02333	0.00253	0.34245	0.18698	0.17857	0.03751	0.15662	5.1530e+17	0.01815	0.08871	0.66142	0.00408	0.22489	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.64. HELIOS results for PWR MOX benchmark multicycle depletion at EOC 3 (45.0 MWd/kg)

Total production/total absorption = 0.92441
Multiplication factor (k_{eff}) = 0.92069

Pin	Relative pin power	Total capture rate (1/s)[a]	Fraction of total capture rate							Total fission rate (1/s)	Fraction of total fission rate					^{135}Xe concentration (a/b-cm)[b]
			^{135}Xe	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	All fp		^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	
1	1.021	4.2420e+15	0.02375	0.00197	0.33059	0.15934	0.17696	0.04271	0.18024	1.9920e+15	0.01622	0.08862	0.61132	0.00402	0.27544	1.1770e-08
2	1.027	4.2390e+15	0.02386	0.00201	0.33008	0.16107	0.17739	0.04256	0.17934	2.0030e+15	0.01634	0.08813	0.61435	0.00403	0.27288	1.1890e-08
3	1.027	4.2300e+15	0.02380	0.00202	0.33063	0.16198	0.17743	0.04237	0.17864	2.0040e+15	0.01635	0.08823	0.61608	0.00405	0.27106	1.2014e-08
4	1.023	4.2130e+15	0.02369	0.00203	0.33140	0.16243	0.17735	0.04219	0.17808	1.9970e+15	0.01634	0.08825	0.61731	0.00406	0.26983	1.2095e-08
5	1.004	4.1050e+15	0.02311	0.00207	0.33572	0.16563	0.17675	0.04113	0.17465	1.9600e+15	0.01627	0.08994	0.62397	0.00414	0.26159	1.2604e-08
6	0.975	3.9120e+15	0.02240	0.00219	0.34095	0.17259	0.17500	0.03928	0.16958	1.9030e+15	0.01633	0.09234	0.63704	0.00428	0.24615	1.3327e-08
7	1.015	4.1580e+15	0.02366	0.00204	0.33170	0.16353	0.17690	0.04201	0.17774	1.9810e+15	0.01635	0.08999	0.61786	0.00412	0.26748	1.2161e-08
8	1.022	4.1820e+15	0.02368	0.00205	0.33163	0.16391	0.17739	0.04210	0.17753	1.9930e+15	0.01635	0.08867	0.61882	0.00406	0.26791	1.2225e-08
9	1.028	4.2400e+15	0.02386	0.00201	0.33013	0.16154	0.17752	0.04253	0.17910	2.0060e+15	0.01637	0.08796	0.61514	0.00403	0.27225	1.1941e-08
10	1.022	4.1740e+15	0.02363	0.00206	0.33211	0.16463	0.17741	0.04193	0.17694	1.9930e+15	0.01635	0.08889	0.62018	0.00408	0.26635	1.2327e-08
11	1.018	4.1590e+15	0.02350	0.00206	0.33297	0.16505	0.17733	0.04175	0.17637	1.9870e+15	0.01633	0.08876	0.62144	0.00408	0.26526	1.2411e-08
12	1.017	4.1810e+15	0.02350	0.00204	0.33287	0.16323	0.17722	0.04188	0.17714	1.9850e+15	0.01630	0.08913	0.61881	0.00409	0.26748	1.2252e-08
13	0.998	4.0460e+15	0.02290	0.00211	0.33740	0.16820	0.17655	0.04061	0.17296	1.9470e+15	0.01626	0.09117	0.62776	0.00419	0.25660	1.2911e-08
14	0.974	3.8990e+15	0.02236	0.00220	0.34129	0.17295	0.17494	0.03917	0.16926	1.9000e+15	0.01632	0.09346	0.63700	0.00432	0.24504	1.3390e-08
15	1.021	4.1630e+15	0.02373	0.00206	0.33140	0.16468	0.17715	0.04191	0.17718	1.9910e+15	0.01640	0.08964	0.61985	0.00412	0.26584	1.2255e-08
16	1.030	4.2510e+15	0.02389	0.00201	0.32998	0.16134	0.17757	0.04259	0.17930	2.0100e+15	0.01636	0.08781	0.61475	0.00403	0.27281	1.1926e-08
17	1.024	4.1880e+15	0.02368	0.00205	0.33171	0.16420	0.17748	0.04204	0.17733	1.9980e+15	0.01635	0.08862	0.61943	0.00407	0.26737	1.2273e-08
18	1.020	4.1740e+15	0.02356	0.00206	0.33257	0.16458	0.17739	0.04186	0.17679	1.9910e+15	0.01633	0.08850	0.62064	0.00407	0.26631	1.2351e-08
19	1.019	4.1890e+15	0.02353	0.00203	0.33265	0.16296	0.17724	0.04194	0.17738	1.9870e+15	0.01630	0.08917	0.61824	0.00409	0.26800	1.2222e-08
20	0.999	4.0530e+15	0.02290	0.00211	0.33735	0.16799	0.17657	0.04065	0.17311	1.9490e+15	0.01625	0.09106	0.62745	0.00418	0.25702	1.2899e-08
21	0.974	3.9000e+15	0.02235	0.00219	0.34142	0.17291	0.17492	0.03916	0.16925	1.9000e+15	0.01631	0.09347	0.63701	0.00432	0.24503	1.3396e-08
22	1.034	4.2820e+15	0.02394	0.00199	0.32943	0.16025	0.17773	0.04280	0.18008	2.0170e+15	0.01633	0.08748	0.61288	0.00401	0.27502	1.1821e-08
23	1.031	4.2700e+15	0.02385	0.00200	0.33004	0.16047	0.17766	0.04266	0.17975	2.0110e+15	0.01633	0.08735	0.61377	0.00401	0.27427	1.1866e-08
24	1.005	4.1150e+15	0.02309	0.00207	0.33578	0.16518	0.17687	0.04120	0.17491	1.9600e+15	0.01626	0.08960	0.62339	0.00412	0.26251	1.2580e-08
25	0.973	3.9010e+15	0.02231	0.00219	0.34167	0.17280	0.17489	0.03913	0.16925	1.8980e+15	0.01631	0.09286	0.63745	0.00430	0.24521	1.3387e-08
26	1.035	4.2800e+15	0.02389	0.00200	0.32982	0.16067	0.17796	0.04276	0.17975	2.0200e+15	0.01629	0.08798	0.61301	0.00401	0.27443	1.1929e-08
27	1.041	4.3540e+15	0.02384	0.00195	0.32978	0.15784	0.17826	0.04321	0.18109	2.0310e+15	0.01616	0.08642	0.60901	0.00391	0.28010	1.1743e-08
28	1.028	4.2770e+15	0.02353	0.00198	0.33226	0.16006	0.17799	0.04255	0.17885	2.0070e+15	0.01615	0.08743	0.61357	0.00397	0.27456	1.2062e-08
29	0.994	4.0350e+15	0.02274	0.00212	0.33853	0.16836	0.17640	0.04040	0.17246	1.9400e+15	0.01622	0.09141	0.62859	0.00420	0.25555	1.2999e-08
30	0.966	3.8630e+15	0.02208	0.00221	0.34339	0.17371	0.17449	0.03869	0.16808	1.8850e+15	0.01627	0.09505	0.63859	0.00439	0.24187	1.3565e-08
31	1.011	4.1570e+15	0.02322	0.00204	0.33482	0.16362	0.17707	0.04154	0.17618	1.9720e+15	0.01624	0.08936	0.62043	0.00411	0.26570	1.2411e-08
32	0.973	3.9070e+15	0.02228	0.00218	0.34192	0.17223	0.17496	0.03914	0.16942	1.8980e+15	0.01628	0.09360	0.63629	0.00433	0.24562	1.3378e-08
33	0.956	3.8240e+15	0.02170	0.00223	0.34574	0.17478	0.17415	0.03819	0.16657	1.8660e+15	0.01623	0.09464	0.64197	0.00437	0.23901	1.3776e-08
34	0.983	3.9780e+15	0.02248	0.00214	0.34028	0.16986	0.17574	0.03982	0.17101	1.9180e+15	0.01624	0.09183	0.63233	0.00424	0.25141	1.3161e-08
35	0.957	3.8290e+15	0.02173	0.00222	0.34554	0.17431	0.17425	0.03826	0.16685	1.8670e+15	0.01622	0.09525	0.64078	0.00440	0.23955	1.3733e-08
36	0.945	3.7720e+15	0.02130	0.00225	0.34834	0.17586	0.17367	0.03760	0.16490	1.8440e+15	0.01618	0.09622	0.64430	0.00443	0.23512	1.3995e-08
37	0.943	3.7610e+15	0.02126	0.00225	0.34853	0.17597	0.17349	0.03748	0.16474	1.8400e+15	0.01618	0.09694	0.64442	0.00446	0.23426	1.4017e-08
38	0.937	3.7390e+15	0.02099	0.00226	0.35030	0.17637	0.17333	0.03719	0.16382	1.8280e+15	0.01613	0.09741	0.64560	0.00447	0.23266	1.4155e-08
39	0.931	3.7140e+15	0.02083	0.00227	0.35124	0.17680	0.17304	0.03690	0.16316	1.8170e+15	0.01612	0.09826	0.64659	0.00451	0.23081	1.4233e-08
Assembly total[c]		1.0760e+18	0.02298	0.00210	0.33660	0.16687	0.17633	0.04080	0.17399	5.1510e+17	0.01628	0.09078	0.62577	0.00417	0.25893	

[a] Includes capture in fuel, clad, and coolant.
[b] Xenon-135 concentration in fuel pin, not homogenized over the unit cell.
[c] Fuel pins only (does not include BP pins, guide tubes, or instrument tube).

Table 4.65. HELIOS PWR MOX benchmark analysis assembly total actinide inventories and weight fractions

Burnup (MWd/kg)	U	^{235}U	^{236}U	^{237}U	^{238}U	Np	^{237}Np	^{238}Np	Pu	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
0.0	4.477e+05	2.00e-03	0.00e+00	0.00e+00	9.98e-01	0.000e+00	0.00e+00	0.00e+00	1.866e+04	0.00e+00	9.40e-01	5.00e-02	1.00e-02	0.00e+00
1.5	4.472e+05	1.95e-03	1.18e-05	1.45e-06	9.98e-01	2.026e+00	9.98e-01	1.83e-03	1.842e+04	1.07e-06	9.21e-01	6.34e-02	1.52e-02	1.78e-04
3.0	4.467e+05	1.91e-03	2.33e-05	1.51e-06	9.98e-01	4.673e+00	9.98e-01	1.97e-03	1.819e+04	6.18e-06	9.02e-01	7.63e-02	2.08e-02	4.37e-04
4.5	4.462e+05	1.86e-03	3.47e-05	1.55e-06	9.98e-01	7.322e+00	9.98e-01	2.02e-03	1.796e+04	1.63e-05	8.84e-01	8.88e-02	2.68e-02	7.84e-04
6.0	4.458e+05	1.81e-03	4.59e-05	1.58e-06	9.98e-01	9.957e+00	9.98e-01	2.06e-03	1.774e+04	3.23e-05	8.65e-01	1.01e-01	3.31e-02	1.23e-03
7.5	4.453e+05	1.77e-03	5.69e-05	1.62e-06	9.98e-01	1.257e+01	9.98e-01	2.09e-03	1.751e+04	5.50e-05	8.46e-01	1.12e-01	3.95e-02	1.77e-03
9.0	4.448e+05	1.72e-03	6.76e-05	1.65e-06	9.98e-01	1.517e+01	9.98e-01	2.11e-03	1.729e+04	8.53e-05	8.28e-01	1.24e-01	4.61e-02	2.42e-03
10.5	4.443e+05	1.67e-03	7.81e-05	1.68e-06	9.98e-01	1.774e+01	9.98e-01	2.14e-03	1.707e+04	1.24e-04	8.09e-01	1.35e-01	5.28e-02	3.18e-03
12.0	4.438e+05	1.63e-03	8.84e-05	1.71e-06	9.98e-01	2.029e+01	9.98e-01	2.16e-03	1.686e+04	1.73e-04	7.91e-01	1.45e-01	5.96e-02	4.06e-03
13.5	4.433e+05	1.58e-03	9.85e-05	1.74e-06	9.98e-01	2.282e+01	9.98e-01	2.19e-03	1.664e+04	2.32e-04	7.73e-01	1.55e-01	6.63e-02	5.05e-03
15.0	4.428e+05	1.54e-03	1.08e-04	1.78e-06	9.98e-01	2.531e+01	9.98e-01	2.21e-03	1.643e+04	3.04e-04	7.55e-01	1.65e-01	7.30e-02	6.17e-03
16.5	4.423e+05	1.50e-03	1.18e-04	1.77e-06	9.98e-01	2.774e+01	9.98e-01	2.17e-03	1.621e+04	3.87e-04	7.37e-01	1.75e-01	7.95e-02	7.44e-03
18.0	4.418e+05	1.45e-03	1.27e-04	1.80e-06	9.98e-01	3.013e+01	9.98e-01	2.20e-03	1.599e+04	4.85e-04	7.20e-01	1.85e-01	8.59e-02	8.84e-03
19.5	4.413e+05	1.41e-03	1.36e-04	1.83e-06	9.98e-01	3.250e+01	9.98e-01	2.23e-03	1.577e+04	5.98e-04	7.03e-01	1.94e-01	9.23e-02	1.04e-02
21.0	4.408e+05	1.37e-03	1.45e-04	1.86e-06	9.98e-01	3.483e+01	9.98e-01	2.25e-03	1.555e+04	7.28e-04	6.86e-01	2.03e-01	9.86e-02	1.20e-02
22.5	4.402e+05	1.33e-03	1.53e-04	1.90e-06	9.99e-01	3.715e+01	9.98e-01	2.28e-03	1.534e+04	8.75e-04	6.69e-01	2.11e-01	1.05e-01	1.39e-02
24.0	4.397e+05	1.29e-03	1.62e-04	1.93e-06	9.99e-01	3.943e+01	9.98e-01	2.31e-03	1.513e+04	1.04e-03	6.53e-01	2.19e-01	1.11e-01	1.58e-02
25.5	4.392e+05	1.25e-03	1.70e-04	1.96e-06	9.99e-01	4.168e+01	9.98e-01	2.34e-03	1.493e+04	1.23e-03	6.37e-01	2.27e-01	1.17e-01	1.79e-02
27.0	4.387e+05	1.20e-03	1.78e-04	1.99e-06	9.99e-01	4.389e+01	9.98e-01	2.37e-03	1.473e+04	1.43e-03	6.22e-01	2.34e-01	1.22e-01	2.02e-02
28.5	4.382e+05	1.17e-03	1.86e-04	2.03e-06	9.99e-01	4.608e+01	9.98e-01	2.40e-03	1.453e+04	1.66e-03	6.06e-01	2.41e-01	1.28e-01	2.26e-02
30.0	4.376e+05	1.13e-03	1.93e-04	2.06e-06	9.99e-01	4.822e+01	9.98e-01	2.43e-03	1.434e+04	1.91e-03	5.92e-01	2.48e-01	1.33e-01	2.52e-02
31.5	4.371e+05	1.09e-03	2.01e-04	2.09e-06	9.99e-01	5.034e+01	9.98e-01	2.46e-03	1.415e+04	2.19e-03	5.78e-01	2.54e-01	1.38e-01	2.79e-02
33.0	4.365e+05	1.05e-03	2.08e-04	2.12e-06	9.99e-01	5.241e+01	9.98e-01	2.49e-03	1.396e+04	2.49e-03	5.64e-01	2.59e-01	1.43e-01	3.07e-02
34.5	4.360e+05	1.01e-03	2.14e-04	2.15e-06	9.99e-01	5.445e+01	9.97e-01	2.52e-03	1.378e+04	2.81e-03	5.51e-01	2.65e-01	1.48e-01	3.38e-02
36.0	4.354e+05	9.75e-04	2.21e-04	2.18e-06	9.99e-01	5.644e+01	9.97e-01	2.55e-03	1.360e+04	3.16e-03	5.38e-01	2.69e-01	1.52e-01	3.69e-02
37.5	4.349e+05	9.39e-04	2.27e-04	2.21e-06	9.99e-01	5.840e+01	9.97e-01	2.58e-03	1.342e+04	3.53e-03	5.26e-01	2.74e-01	1.56e-01	4.03e-02
39.0	4.343e+05	9.03e-04	2.34e-04	2.25e-06	9.99e-01	6.031e+01	9.97e-01	2.61e-03	1.325e+04	3.93e-03	5.14e-01	2.78e-01	1.60e-01	4.37e-02
40.5	4.338e+05	8.69e-04	2.39e-04	2.28e-06	9.99e-01	6.218e+01	9.97e-01	2.64e-03	1.308e+04	4.35e-03	5.03e-01	2.81e-01	1.64e-01	4.73e-02
42.0	4.332e+05	8.35e-04	2.45e-04	2.31e-06	9.99e-01	6.401e+01	9.97e-01	2.67e-03	1.292e+04	4.79e-03	4.93e-01	2.84e-01	1.67e-01	5.11e-02
43.5	4.326e+05	8.01e-04	2.51e-04	2.33e-06	9.99e-01	6.579e+01	9.97e-01	2.70e-03	1.276e+04	5.26e-03	4.83e-01	2.87e-01	1.70e-01	5.49e-02
45.0	4.321e+05	7.69e-04	2.56e-04	2.36e-06	9.99e-01	6.753e+01	9.97e-01	2.73e-03	1.260e+04	5.75e-03	4.73e-01	2.89e-01	1.73e-01	5.89e-02

Table 4.65. (continued)

Burnup (MWd/kg)	Am	^{241}Am	^{242m}Am	^{243}Am	Cm	^{242}Cm	^{243}Cm	^{244}Cm	^{245}cm
0.0	0.000e+00	0.00e+00	0.00e+00	0.00e+00	0.000e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1.5	1.251e+00	9.52e-01	3.37e-03	4.44e-02	2.307e-02	9.59e-01	1.21e-03	4.01e-02	1.42e-04
3.0	3.073e+00	9.14e-01	5.78e-03	8.04e-02	1.042e-01	9.19e-01	2.29e-03	7.79e-02	5.91e-04
4.5	5.510e+00	8.80e-01	7.54e-03	1.13e-01	2.620e-01	8.82e-01	3.22e-03	1.14e-01	1.28e-03
6.0	8.593e+00	8.49e-01	8.87e-03	1.42e-01	5.162e-01	8.45e-01	4.03e-03	1.48e-01	2.19e-03
7.5	1.234e+01	8.21e-01	9.89e-03	1.69e-01	8.871e-01	8.11e-01	4.74e-03	1.81e-01	3.30e-03
9.0	1.677e+01	7.95e-01	1.07e-02	1.95e-01	1.396e+00	7.77e-01	5.36e-03	2.13e-01	4.58e-03
10.5	2.187e+01	7.70e-01	1.13e-02	2.19e-01	2.064e+00	7.45e-01	5.90e-03	2.43e-01	6.02e-03
12.0	2.765e+01	7.47e-01	1.17e-02	2.41e-01	2.914e+00	7.14e-01	6.38e-03	2.72e-01	7.61e-03
13.5	3.409e+01	7.25e-01	1.20e-02	2.63e-01	3.968e+00	6.84e-01	6.79e-03	3.00e-01	9.31e-03
15.0	4.118e+01	7.05e-01	1.22e-02	2.83e-01	5.247e+00	6.56e-01	7.15e-03	3.26e-01	1.11e-02
16.5	4.879e+01	6.87e-01	1.23e-02	3.01e-01	6.723e+00	6.30e-01	7.42e-03	3.50e-01	1.29e-02
18.0	5.698e+01	6.69e-01	1.23e-02	3.19e-01	8.461e+00	6.05e-01	7.67e-03	3.72e-01	1.47e-02
19.5	6.571e+01	6.52e-01	1.23e-02	3.36e-01	1.048e+01	5.82e-01	7.87e-03	3.94e-01	1.66e-02
21.0	7.496e+01	6.34e-01	1.23e-02	3.53e-01	1.281e+01	5.59e-01	8.05e-03	4.14e-01	1.86e-02
22.5	8.470e+01	6.17e-01	1.22e-02	3.70e-01	1.546e+01	5.37e-01	8.20e-03	4.34e-01	2.06e-02
24.0	9.490e+01	6.01e-01	1.21e-02	3.87e-01	1.846e+01	5.16e-01	8.33e-03	4.53e-01	2.27e-02
25.5	1.055e+02	5.85e-01	1.20e-02	4.03e-01	2.182e+01	4.95e-01	8.43e-03	4.72e-01	2.48e-02
27.0	1.165e+02	5.69e-01	1.18e-02	4.19e-01	2.556e+01	4.75e-01	8.50e-03	4.89e-01	2.70e-02
28.5	1.278e+02	5.54e-01	1.16e-02	4.35e-01	2.970e+01	4.56e-01	8.55e-03	5.06e-01	2.91e-02
30.0	1.395e+02	5.39e-01	1.14e-02	4.50e-01	3.426e+01	4.38e-01	8.58e-03	5.22e-01	3.13e-02
31.5	1.514e+02	5.24e-01	1.12e-02	4.65e-01	3.926e+01	4.20e-01	8.59e-03	5.38e-01	3.35e-02
33.0	1.636e+02	5.09e-01	1.10e-02	4.80e-01	4.471e+01	4.03e-01	8.59e-03	5.52e-01	3.57e-02
34.5	1.759e+02	4.95e-01	1.07e-02	4.94e-01	5.062e+01	3.87e-01	8.56e-03	5.67e-01	3.79e-02
36.0	1.885e+02	4.81e-01	1.05e-02	5.09e-01	5.700e+01	3.71e-01	8.52e-03	5.80e-01	4.00e-02
37.5	2.012e+02	4.67e-01	1.02e-02	5.23e-01	6.387e+01	3.56e-01	8.46e-03	5.93e-01	4.22e-02
39.0	2.139e+02	4.53e-01	9.98e-03	5.37e-01	7.125e+01	3.41e-01	8.39e-03	6.06e-01	4.43e-02
40.5	2.268e+02	4.40e-01	9.71e-03	5.51e-01	7.912e+01	3.27e-01	8.31e-03	6.18e-01	4.64e-02
42.0	2.397e+02	4.27e-01	9.44e-03	5.64e-01	8.751e+01	3.14e-01	8.22e-03	6.30e-01	4.84e-02
43.5	2.526e+02	4.13e-01	9.17e-03	5.77e-01	9.642e+01	3.00e-01	8.11e-03	6.41e-01	5.05e-02
45.0	2.655e+02	4.01e-01	8.90e-03	5.91e-01	1.059e+02	2.88e-01	8.00e-03	6.52e-01	5.24e-02

Table 4.66. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 1 (7.5 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.686e+03	1.75e-03	5.99e-05	1.64e-06	9.98e-01	4.819e-02	9.98e-01	2.17e-03	6.529e+01	5.90e-05	8.35e-01	1.21e-01	4.17e-02	2.06e-03
2	1.687e+03	1.76e-03	5.81e-05	1.63e-06	9.98e-01	4.780e-02	9.98e-01	2.13e-03	6.592e+01	5.66e-05	8.42e-01	1.16e-01	4.05e-02	1.89e-03
3	1.687e+03	1.76e-03	5.75e-05	1.62e-06	9.98e-01	4.764e-02	9.98e-01	2.11e-03	6.611e+01	5.58e-05	8.44e-01	1.14e-01	4.01e-02	1.84e-03
4	1.687e+03	1.76e-03	5.74e-05	1.61e-06	9.98e-01	4.743e-02	9.98e-01	2.11e-03	6.615e+01	5.55e-05	8.44e-01	1.14e-01	4.00e-02	1.83e-03
5	1.687e+03	1.76e-03	5.70e-05	1.61e-06	9.98e-01	4.739e-02	9.98e-01	2.09e-03	6.629e+01	5.49e-05	8.46e-01	1.13e-01	3.97e-02	1.78e-03
6	1.687e+03	1.77e-03	5.60e-05	1.60e-06	9.98e-01	4.713e-02	9.98e-01	2.06e-03	6.659e+01	5.35e-05	8.49e-01	1.10e-01	3.87e-02	1.68e-03
7	1.687e+03	1.76e-03	5.83e-05	1.64e-06	9.98e-01	4.836e-02	9.98e-01	2.13e-03	6.580e+01	5.73e-05	8.41e-01	1.17e-01	4.05e-02	1.90e-03
8	1.687e+03	1.76e-03	5.75e-05	1.62e-06	9.98e-01	4.782e-02	9.98e-01	2.11e-03	6.609e+01	5.61e-05	8.44e-01	1.14e-01	4.02e-02	1.84e-03
9	1.687e+03	1.76e-03	5.76e-05	1.62e-06	9.98e-01	4.763e-02	9.98e-01	2.12e-03	6.607e+01	5.59e-05	8.43e-01	1.15e-01	4.02e-02	1.85e-03
10	1.687e+03	1.76e-03	5.71e-05	1.62e-06	9.98e-01	4.770e-02	9.98e-01	2.10e-03	6.625e+01	5.54e-05	8.45e-01	1.13e-01	3.99e-02	1.80e-03
11	1.687e+03	1.76e-03	5.70e-05	1.61e-06	9.98e-01	4.745e-02	9.98e-01	2.10e-03	6.628e+01	5.51e-05	8.45e-01	1.13e-01	3.98e-02	1.79e-03
12	1.687e+03	1.76e-03	5.73e-05	1.62e-06	9.98e-01	4.763e-02	9.98e-01	2.10e-03	6.619e+01	5.55e-05	8.44e-01	1.14e-01	3.99e-02	1.81e-03
13	1.687e+03	1.77e-03	5.66e-05	1.62e-06	9.98e-01	4.768e-02	9.98e-01	2.08e-03	6.642e+01	5.47e-05	8.47e-01	1.12e-01	3.95e-02	1.75e-03
14	1.687e+03	1.77e-03	5.58e-05	1.61e-06	9.98e-01	4.761e-02	9.98e-01	2.05e-03	6.662e+01	5.38e-05	8.50e-01	1.10e-01	3.86e-02	1.67e-03
15	1.687e+03	1.76e-03	5.72e-05	1.63e-06	9.98e-01	4.808e-02	9.98e-01	2.10e-03	6.619e+01	5.58e-05	8.45e-01	1.13e-01	3.98e-02	1.80e-03
16	1.687e+03	1.76e-03	5.76e-05	1.62e-06	9.98e-01	4.762e-02	9.98e-01	2.12e-03	6.608e+01	5.59e-05	8.43e-01	1.15e-01	4.02e-02	1.85e-03
17	1.687e+03	1.76e-03	5.72e-05	1.62e-06	9.98e-01	4.767e-02	9.98e-01	2.10e-03	6.623e+01	5.55e-05	8.45e-01	1.13e-01	3.99e-02	1.80e-03
18	1.687e+03	1.76e-03	5.71e-05	1.61e-06	9.98e-01	4.741e-02	9.98e-01	2.10e-03	6.626e+01	5.52e-05	8.45e-01	1.13e-01	3.99e-02	1.80e-03
19	1.687e+03	1.76e-03	5.73e-05	1.62e-06	9.98e-01	4.770e-02	9.98e-01	2.10e-03	6.618e+01	5.56e-05	8.44e-01	1.14e-01	4.00e-02	1.82e-03
20	1.687e+03	1.77e-03	5.66e-05	1.62e-06	9.98e-01	4.768e-02	9.98e-01	2.08e-03	6.641e+01	5.48e-05	8.47e-01	1.12e-01	3.95e-02	1.75e-03
21	1.687e+03	1.77e-03	5.59e-05	1.61e-06	9.98e-01	4.761e-02	9.98e-01	2.06e-03	6.662e+01	5.38e-05	8.50e-01	1.10e-01	3.86e-02	1.67e-03
22	1.686e+03	1.76e-03	5.77e-05	1.62e-06	9.98e-01	4.761e-02	9.98e-01	2.12e-03	6.606e+01	5.60e-05	8.43e-01	1.15e-01	4.03e-02	1.86e-03
23	1.687e+03	1.76e-03	5.77e-05	1.61e-06	9.98e-01	4.738e-02	9.98e-01	2.12e-03	6.607e+01	5.57e-05	8.43e-01	1.15e-01	4.03e-02	1.85e-03
24	1.687e+03	1.76e-03	5.71e-05	1.61e-06	9.98e-01	4.728e-02	9.98e-01	2.09e-03	6.629e+01	5.48e-05	8.45e-01	1.13e-01	3.97e-02	1.79e-03
25	1.687e+03	1.77e-03	5.59e-05	1.60e-06	9.98e-01	4.727e-02	9.98e-01	2.06e-03	6.662e+01	5.36e-05	8.50e-01	1.10e-01	3.86e-02	1.67e-03
26	1.686e+03	1.76e-03	5.77e-05	1.63e-06	9.98e-01	4.790e-02	9.98e-01	2.12e-03	6.610e+01	5.62e-05	8.43e-01	1.14e-01	4.04e-02	1.85e-03
27	1.686e+03	1.76e-03	5.82e-05	1.62e-06	9.98e-01	4.747e-02	9.98e-01	2.13e-03	6.597e+01	5.64e-05	8.41e-01	1.16e-01	4.10e-02	1.91e-03
28	1.686e+03	1.76e-03	5.79e-05	1.61e-06	9.98e-01	4.740e-02	9.98e-01	2.12e-03	6.607e+01	5.59e-05	8.42e-01	1.15e-01	4.07e-02	1.88e-03
29	1.687e+03	1.77e-03	5.66e-05	1.62e-06	9.98e-01	4.769e-02	9.98e-01	2.08e-03	6.644e+01	5.47e-05	8.47e-01	1.12e-01	3.95e-02	1.75e-03
30	1.687e+03	1.77e-03	5.58e-05	1.62e-06	9.98e-01	4.803e-02	9.98e-01	2.05e-03	6.666e+01	5.41e-05	8.50e-01	1.10e-01	3.85e-02	1.66e-03
31	1.687e+03	1.76e-03	5.73e-05	1.61e-06	9.98e-01	4.750e-02	9.98e-01	2.10e-03	6.622e+01	5.53e-05	8.44e-01	1.14e-01	3.99e-02	1.81e-03
32	1.687e+03	1.77e-03	5.60e-05	1.62e-06	9.98e-01	4.772e-02	9.98e-01	2.06e-03	6.660e+01	5.41e-05	8.49e-01	1.10e-01	3.87e-02	1.68e-03
33	1.687e+03	1.77e-03	5.57e-05	1.60e-06	9.98e-01	4.741e-02	9.98e-01	2.05e-03	6.672e+01	5.33e-05	8.51e-01	1.09e-01	3.84e-02	1.65e-03
34	1.687e+03	1.77e-03	5.64e-05	1.60e-06	9.98e-01	4.734e-02	9.98e-01	2.07e-03	6.651e+01	5.41e-05	8.48e-01	1.11e-01	3.91e-02	1.72e-03
35	1.687e+03	1.77e-03	5.57e-05	1.61e-06	9.98e-01	4.775e-02	9.98e-01	2.05e-03	6.669e+01	5.37e-05	8.50e-01	1.09e-01	3.85e-02	1.65e-03
36	1.687e+03	1.77e-03	5.55e-05	1.61e-06	9.98e-01	4.763e-02	9.98e-01	2.04e-03	6.678e+01	5.33e-05	8.51e-01	1.09e-01	3.83e-02	1.63e-03
37	1.687e+03	1.77e-03	5.54e-05	1.62e-06	9.98e-01	4.788e-02	9.98e-01	2.03e-03	6.679e+01	5.34e-05	8.52e-01	1.09e-01	3.82e-02	1.63e-03
38	1.687e+03	1.77e-03	5.54e-05	1.62e-06	9.98e-01	4.785e-02	9.98e-01	2.03e-03	6.680e+01	5.34e-05	8.52e-01	1.09e-01	3.82e-02	1.62e-03
39	1.687e+03	1.78e-03	5.53e-05	1.62e-06	9.98e-01	4.797e-02	9.98e-01	2.03e-03	6.683e+01	5.34e-05	8.52e-01	1.08e-01	3.80e-02	1.61e-03
Total	4.453e+05	1.77e-03	5.69e-05	1.62e-06	9.98e-01	1.257e+01	9.98e-01	2.09e-03	1.751e+04	5.50e-05	8.46e-01	1.12e-01	3.95e-02	1.77e-03

Table 4.66. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	2.442e-02	8.03e-01	9.81e-03	1.87e-01	1.851e-03	7.99e-01	4.72e-03	1.93e-01	3.53e-03
2	2.380e-02	8.13e-01	9.87e-03	1.77e-01	1.752e-03	8.06e-01	4.73e-03	1.86e-01	3.39e-03
3	2.362e-02	8.17e-01	9.89e-03	1.73e-01	1.723e-03	8.08e-01	4.73e-03	1.84e-01	3.35e-03
4	2.359e-02	8.17e-01	9.89e-03	1.73e-01	1.716e-03	8.09e-01	4.74e-03	1.83e-01	3.34e-03
5	2.344e-02	8.20e-01	9.89e-03	1.70e-01	1.689e-03	8.10e-01	4.74e-03	1.82e-01	3.30e-03
6	2.297e-02	8.26e-01	9.89e-03	1.64e-01	1.623e-03	8.13e-01	4.74e-03	1.79e-01	3.24e-03
7	2.385e-02	8.12e-01	9.85e-03	1.78e-01	1.760e-03	8.04e-01	4.72e-03	1.88e-01	3.42e-03
8	4.733e-02	8.17e-01	9.88e-03	1.74e-01	3.450e-03	8.08e-01	4.73e-03	1.84e-01	3.36e-03
9	4.732e-02	8.16e-01	9.89e-03	1.74e-01	3.456e-03	8.08e-01	4.73e-03	1.84e-01	3.35e-03
10	4.706e-02	8.19e-01	9.90e-03	1.71e-01	3.403e-03	8.10e-01	4.73e-03	1.82e-01	3.32e-03
11	4.701e-02	8.20e-01	9.90e-03	1.70e-01	3.393e-03	8.10e-01	4.73e-03	1.82e-01	3.31e-03
12	4.709e-02	8.18e-01	9.89e-03	1.72e-01	3.415e-03	8.09e-01	4.74e-03	1.83e-01	3.32e-03
13	4.667e-02	8.22e-01	9.89e-03	1.68e-01	3.335e-03	8.12e-01	4.73e-03	1.80e-01	3.27e-03
14	4.589e-02	8.26e-01	9.89e-03	1.64e-01	3.234e-03	8.14e-01	4.74e-03	1.78e-01	3.22e-03
15	2.348e-02	8.18e-01	9.88e-03	1.72e-01	1.701e-03	8.09e-01	4.73e-03	1.83e-01	3.33e-03
16	4.736e-02	8.16e-01	9.89e-03	1.74e-01	3.460e-03	8.08e-01	4.73e-03	1.84e-01	3.35e-03
17	4.711e-02	8.19e-01	9.90e-03	1.71e-01	3.411e-03	8.09e-01	4.73e-03	1.83e-01	3.33e-03
18	4.706e-02	8.19e-01	9.90e-03	1.71e-01	3.403e-03	8.10e-01	4.74e-03	1.82e-01	3.32e-03
19	4.712e-02	8.18e-01	9.89e-03	1.72e-01	3.419e-03	8.09e-01	4.74e-03	1.83e-01	3.32e-03
20	4.671e-02	8.22e-01	9.90e-03	1.68e-01	3.341e-03	8.12e-01	4.74e-03	1.80e-01	3.28e-03
21	4.590e-02	8.26e-01	9.89e-03	1.64e-01	3.236e-03	8.14e-01	4.74e-03	1.78e-01	3.23e-03
22	4.744e-02	8.16e-01	9.89e-03	1.74e-01	3.471e-03	8.08e-01	4.74e-03	1.84e-01	3.36e-03
23	4.739e-02	8.16e-01	9.89e-03	1.74e-01	3.464e-03	8.08e-01	4.74e-03	1.84e-01	3.36e-03
24	4.693e-02	8.20e-01	9.89e-03	1.70e-01	3.384e-03	8.10e-01	4.74e-03	1.82e-01	3.30e-03
25	4.590e-02	8.26e-01	9.89e-03	1.64e-01	3.237e-03	8.14e-01	4.74e-03	1.78e-01	3.23e-03
26	2.376e-02	8.16e-01	9.89e-03	1.74e-01	1.735e-03	8.08e-01	4.74e-03	1.84e-01	3.36e-03
27	4.808e-02	8.14e-01	9.90e-03	1.77e-01	3.545e-03	8.07e-01	4.74e-03	1.85e-01	3.39e-03
28	4.780e-02	8.15e-01	9.90e-03	1.75e-01	3.500e-03	8.08e-01	4.74e-03	1.84e-01	3.36e-03
29	4.667e-02	8.23e-01	9.89e-03	1.68e-01	3.335e-03	8.12e-01	4.74e-03	1.80e-01	3.27e-03
30	4.580e-02	8.27e-01	9.88e-03	1.63e-01	3.219e-03	8.14e-01	4.74e-03	1.78e-01	3.21e-03
31	4.711e-02	8.19e-01	9.89e-03	1.72e-01	3.413e-03	8.09e-01	4.75e-03	1.82e-01	3.32e-03
32	4.597e-02	8.26e-01	9.89e-03	1.64e-01	3.246e-03	8.13e-01	4.75e-03	1.79e-01	3.24e-03
33	4.571e-02	8.28e-01	9.89e-03	1.62e-01	3.203e-03	8.15e-01	4.75e-03	1.77e-01	3.21e-03
34	2.317e-02	8.24e-01	9.89e-03	1.66e-01	1.647e-03	8.12e-01	4.75e-03	1.80e-01	3.26e-03
35	4.576e-02	8.27e-01	9.88e-03	1.63e-01	3.210e-03	8.15e-01	4.75e-03	1.78e-01	3.21e-03
36	4.557e-02	8.29e-01	9.88e-03	1.61e-01	3.179e-03	8.15e-01	4.75e-03	1.77e-01	3.19e-03
37	2.274e-02	8.29e-01	9.88e-03	1.61e-01	1.585e-03	8.16e-01	4.75e-03	1.77e-01	3.19e-03
38	4.551e-02	8.29e-01	9.88e-03	1.61e-01	3.169e-03	8.16e-01	4.75e-03	1.76e-01	3.18e-03
39	2.269e-02	8.30e-01	9.87e-03	1.60e-01	1.576e-03	8.16e-01	4.75e-03	1.76e-01	3.18e-03
Total	1.234e+01	8.21e-01	9.89e-03	1.69e-01	8.871e-01	8.11e-01	4.74e-03	1.81e-01	3.30e-03

Table 4.67. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 1/BOC 2 (15.0 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.677e+03	1.50e-03	1.13e-04	1.80e-06	9.98e-01	9.677e-02	9.98e-01	2.30e-03	6.045e+01	3.32e-04	7.34e-01	1.80e-01	7.81e-02	7.34e-03
2	1.677e+03	1.52e-03	1.11e-04	1.79e-06	9.98e-01	9.618e-02	9.98e-01	2.26e-03	6.141e+01	3.17e-04	7.45e-01	1.72e-01	7.53e-02	6.71e-03
3	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.594e-02	9.98e-01	2.25e-03	6.174e+01	3.12e-04	7.49e-01	1.70e-01	7.45e-02	6.51e-03
4	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.553e-02	9.98e-01	2.24e-03	6.182e+01	3.10e-04	7.50e-01	1.69e-01	7.44e-02	6.47e-03
5	1.677e+03	1.54e-03	1.09e-04	1.77e-06	9.98e-01	9.544e-02	9.98e-01	2.22e-03	6.216e+01	3.04e-04	7.54e-01	1.66e-01	7.35e-02	6.25e-03
6	1.677e+03	1.55e-03	1.06e-04	1.75e-06	9.98e-01	9.492e-02	9.98e-01	2.17e-03	6.283e+01	2.93e-04	7.63e-01	1.60e-01	7.09e-02	5.75e-03
7	1.677e+03	1.52e-03	1.11e-04	1.80e-06	9.98e-01	9.720e-02	9.98e-01	2.25e-03	6.132e+01	3.19e-04	7.45e-01	1.72e-01	7.53e-02	6.71e-03
8	1.677e+03	1.53e-03	1.10e-04	1.79e-06	9.98e-01	9.623e-02	9.98e-01	2.24e-03	6.176e+01	3.12e-04	7.50e-01	1.69e-01	7.46e-02	6.48e-03
9	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.589e-02	9.98e-01	2.25e-03	6.165e+01	3.13e-04	7.48e-01	1.70e-01	7.47e-02	6.56e-03
10	1.677e+03	1.54e-03	1.09e-04	1.78e-06	9.98e-01	9.606e-02	9.98e-01	2.23e-03	6.203e+01	3.08e-04	7.53e-01	1.67e-01	7.39e-02	6.33e-03
11	1.677e+03	1.54e-03	1.09e-04	1.77e-06	9.98e-01	9.557e-02	9.98e-01	2.23e-03	6.210e+01	3.06e-04	7.53e-01	1.66e-01	7.38e-02	6.29e-03
12	1.677e+03	1.53e-03	1.09e-04	1.78e-06	9.98e-01	9.591e-02	9.98e-01	2.23e-03	6.191e+01	3.09e-04	7.51e-01	1.68e-01	7.41e-02	6.41e-03
13	1.677e+03	1.54e-03	1.08e-04	1.78e-06	9.98e-01	9.600e-02	9.98e-01	2.20e-03	6.242e+01	3.02e-04	7.57e-01	1.64e-01	7.28e-02	6.08e-03
14	1.677e+03	1.55e-03	1.06e-04	1.77e-06	9.98e-01	9.587e-02	9.98e-01	2.16e-03	6.287e+01	2.94e-04	7.63e-01	1.60e-01	7.07e-02	5.71e-03
15	1.677e+03	1.54e-03	1.09e-04	1.80e-06	9.98e-01	9.679e-02	9.98e-01	2.23e-03	6.194e+01	3.10e-04	7.52e-01	1.68e-01	7.37e-02	6.34e-03
16	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.589e-02	9.98e-01	2.25e-03	6.166e+01	3.13e-04	7.48e-01	1.70e-01	7.48e-02	6.57e-03
17	1.677e+03	1.54e-03	1.09e-04	1.78e-06	9.98e-01	9.601e-02	9.98e-01	2.23e-03	6.200e+01	3.09e-04	7.52e-01	1.67e-01	7.40e-02	6.36e-03
18	1.677e+03	1.54e-03	1.09e-04	1.77e-06	9.98e-01	9.551e-02	9.98e-01	2.23e-03	6.206e+01	3.07e-04	7.53e-01	1.67e-01	7.39e-02	6.32e-03
19	1.677e+03	1.53e-03	1.09e-04	1.78e-06	9.98e-01	9.605e-02	9.98e-01	2.24e-03	6.189e+01	3.10e-04	7.51e-01	1.68e-01	7.42e-02	6.42e-03
20	1.677e+03	1.54e-03	1.08e-04	1.78e-06	9.98e-01	9.600e-02	9.98e-01	2.20e-03	6.241e+01	3.02e-04	7.57e-01	1.64e-01	7.29e-02	6.09e-03
21	1.677e+03	1.55e-03	1.06e-04	1.77e-06	9.98e-01	9.586e-02	9.98e-01	2.16e-03	6.287e+01	2.94e-04	7.63e-01	1.60e-01	7.08e-02	5.72e-03
22	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.587e-02	9.98e-01	2.26e-03	6.161e+01	3.14e-04	7.47e-01	1.71e-01	7.51e-02	6.62e-03
23	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.542e-02	9.98e-01	2.26e-03	6.165e+01	3.12e-04	7.48e-01	1.71e-01	7.49e-02	6.59e-03
24	1.677e+03	1.54e-03	1.09e-04	1.77e-06	9.98e-01	9.520e-02	9.98e-01	2.22e-03	6.213e+01	3.04e-04	7.53e-01	1.67e-01	7.36e-02	6.27e-03
25	1.677e+03	1.55e-03	1.06e-04	1.76e-06	9.98e-01	9.518e-02	9.98e-01	2.17e-03	6.287e+01	2.93e-04	7.63e-01	1.60e-01	7.07e-02	5.72e-03
26	1.677e+03	1.53e-03	1.10e-04	1.80e-06	9.98e-01	9.646e-02	9.98e-01	2.25e-03	6.169e+01	3.14e-04	7.48e-01	1.70e-01	7.52e-02	6.60e-03
27	1.677e+03	1.52e-03	1.11e-04	1.78e-06	9.98e-01	9.558e-02	9.98e-01	2.28e-03	6.141e+01	3.18e-04	7.44e-01	1.73e-01	7.66e-02	6.87e-03
28	1.677e+03	1.53e-03	1.10e-04	1.78e-06	9.98e-01	9.544e-02	9.98e-01	2.26e-03	6.165e+01	3.14e-04	7.46e-01	1.71e-01	7.58e-02	6.70e-03
29	1.677e+03	1.54e-03	1.08e-04	1.78e-06	9.98e-01	9.598e-02	9.98e-01	2.20e-03	6.247e+01	3.01e-04	7.57e-01	1.63e-01	7.28e-02	6.06e-03
30	1.677e+03	1.56e-03	1.06e-04	1.78e-06	9.98e-01	9.663e-02	9.98e-01	2.15e-03	6.298e+01	2.94e-04	7.64e-01	1.59e-01	7.04e-02	5.65e-03
31	1.677e+03	1.53e-03	1.09e-04	1.77e-06	9.98e-01	9.562e-02	9.98e-01	2.23e-03	6.198e+01	3.08e-04	7.51e-01	1.68e-01	7.41e-02	6.39e-03
32	1.677e+03	1.55e-03	1.07e-04	1.77e-06	9.98e-01	9.602e-02	9.98e-01	2.17e-03	6.283e+01	2.95e-04	7.63e-01	1.60e-01	7.09e-02	5.75e-03
33	1.677e+03	1.56e-03	1.06e-04	1.76e-06	9.98e-01	9.540e-02	9.98e-01	2.15e-03	6.312e+01	2.90e-04	7.66e-01	1.58e-01	7.01e-02	5.58e-03
34	1.677e+03	1.55e-03	1.07e-04	1.76e-06	9.98e-01	9.530e-02	9.98e-01	2.18e-03	6.263e+01	2.97e-04	7.60e-01	1.62e-01	7.19e-02	5.93e-03
35	1.677e+03	1.56e-03	1.06e-04	1.77e-06	9.98e-01	9.605e-02	9.98e-01	2.15e-03	6.306e+01	2.92e-04	7.65e-01	1.59e-01	7.03e-02	5.61e-03
36	1.677e+03	1.56e-03	1.05e-04	1.76e-06	9.98e-01	9.579e-02	9.98e-01	2.13e-03	6.325e+01	2.88e-04	7.67e-01	1.57e-01	6.97e-02	5.50e-03
37	1.677e+03	1.56e-03	1.05e-04	1.77e-06	9.98e-01	9.627e-02	9.98e-01	2.13e-03	6.327e+01	2.89e-04	7.68e-01	1.57e-01	6.95e-02	5.48e-03
38	1.677e+03	1.56e-03	1.05e-04	1.77e-06	9.98e-01	9.620e-02	9.98e-01	2.13e-03	6.332e+01	2.88e-04	7.68e-01	1.57e-01	6.95e-02	5.46e-03
39	1.677e+03	1.56e-03	1.05e-04	1.77e-06	9.98e-01	9.642e-02	9.98e-01	2.12e-03	6.338e+01	2.87e-04	7.69e-01	1.56e-01	6.92e-02	5.41e-03
Total	4.428e+05	1.54e-03	1.08e-04	1.78e-06	9.98e-01	2.531e+01	9.98e-01	2.21e-03	1.643e+04	3.04e-04	7.55e-01	1.65e-01	7.30e-02	6.17e-03

Table 4.67. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	8.271e-02	6.79e-01	1.17e-02	3.09e-01	1.115e-02	6.39e-01	7.03e-03	3.43e-01	1.17e-02
2	8.005e-02	6.93e-01	1.20e-02	2.95e-01	1.051e-02	6.48e-01	7.09e-03	3.33e-01	1.14e-02
3	7.930e-02	6.97e-01	1.21e-02	2.91e-01	1.031e-02	6.52e-01	7.11e-03	3.30e-01	1.12e-02
4	7.915e-02	6.98e-01	1.21e-02	2.90e-01	1.026e-02	6.52e-01	7.12e-03	3.29e-01	1.12e-02
5	7.836e-02	7.03e-01	1.22e-02	2.85e-01	1.002e-02	6.55e-01	7.14e-03	3.27e-01	1.11e-02
6	7.606e-02	7.14e-01	1.24e-02	2.74e-01	9.470e-03	6.60e-01	7.18e-03	3.22e-01	1.10e-02
7	8.014e-02	6.92e-01	1.20e-02	2.96e-01	1.050e-02	6.47e-01	7.08e-03	3.35e-01	1.14e-02
8	1.587e-01	6.98e-01	1.21e-02	2.90e-01	2.058e-02	6.51e-01	7.11e-03	3.30e-01	1.13e-02
9	1.589e-01	6.96e-01	1.21e-02	2.92e-01	2.070e-02	6.51e-01	7.11e-03	3.30e-01	1.13e-02
10	1.575e-01	7.02e-01	1.22e-02	2.86e-01	2.026e-02	6.54e-01	7.13e-03	3.28e-01	1.12e-02
11	1.572e-01	7.02e-01	1.22e-02	2.85e-01	2.017e-02	6.55e-01	7.14e-03	3.27e-01	1.12e-02
12	1.578e-01	7.00e-01	1.21e-02	2.88e-01	2.036e-02	6.54e-01	7.13e-03	3.28e-01	1.12e-02
13	1.555e-01	7.08e-01	1.23e-02	2.80e-01	1.968e-02	6.58e-01	7.16e-03	3.24e-01	1.11e-02
14	1.518e-01	7.15e-01	1.24e-02	2.73e-01	1.884e-02	6.61e-01	7.18e-03	3.21e-01	1.09e-02
15	7.856e-02	7.00e-01	1.22e-02	2.87e-01	1.012e-02	6.53e-01	7.12e-03	3.29e-01	1.12e-02
16	1.591e-01	6.96e-01	1.21e-02	2.92e-01	2.073e-02	6.51e-01	7.11e-03	3.30e-01	1.13e-02
17	1.577e-01	7.01e-01	1.22e-02	2.87e-01	2.032e-02	6.54e-01	7.13e-03	3.28e-01	1.12e-02
18	1.575e-01	7.02e-01	1.22e-02	2.86e-01	2.025e-02	6.54e-01	7.14e-03	3.27e-01	1.12e-02
19	1.579e-01	6.99e-01	1.21e-02	2.88e-01	2.040e-02	6.53e-01	7.13e-03	3.28e-01	1.12e-02
20	1.557e-01	7.07e-01	1.23e-02	2.81e-01	1.972e-02	6.57e-01	7.16e-03	3.24e-01	1.11e-02
21	1.519e-01	7.15e-01	1.24e-02	2.73e-01	1.886e-02	6.61e-01	7.18e-03	3.21e-01	1.09e-02
22	1.595e-01	6.95e-01	1.21e-02	2.93e-01	2.084e-02	6.51e-01	7.11e-03	3.31e-01	1.13e-02
23	1.593e-01	6.96e-01	1.21e-02	2.92e-01	2.078e-02	6.51e-01	7.12e-03	3.30e-01	1.13e-02
24	1.569e-01	7.03e-01	1.22e-02	2.85e-01	2.009e-02	6.55e-01	7.15e-03	3.27e-01	1.11e-02
25	1.519e-01	7.15e-01	1.24e-02	2.73e-01	1.886e-02	6.61e-01	7.19e-03	3.21e-01	1.10e-02
26	7.993e-02	6.96e-01	1.21e-02	2.92e-01	1.042e-02	6.51e-01	7.12e-03	3.30e-01	1.13e-02
27	1.625e-01	6.91e-01	1.20e-02	2.97e-01	2.144e-02	6.49e-01	7.11e-03	3.32e-01	1.14e-02
28	1.611e-01	6.95e-01	1.21e-02	2.93e-01	2.105e-02	6.51e-01	7.13e-03	3.30e-01	1.13e-02
29	1.555e-01	7.08e-01	1.23e-02	2.80e-01	1.965e-02	6.58e-01	7.17e-03	3.24e-01	1.11e-02
30	1.513e-01	7.16e-01	1.25e-02	2.71e-01	1.869e-02	6.62e-01	7.19e-03	3.20e-01	1.09e-02
31	1.578e-01	7.01e-01	1.22e-02	2.87e-01	2.032e-02	6.54e-01	7.14e-03	3.28e-01	1.12e-02
32	1.522e-01	7.14e-01	1.24e-02	2.74e-01	1.893e-02	6.60e-01	7.19e-03	3.21e-01	1.10e-02
33	1.508e-01	7.18e-01	1.25e-02	2.70e-01	1.856e-02	6.63e-01	7.20e-03	3.19e-01	1.09e-02
34	7.699e-02	7.10e-01	1.23e-02	2.78e-01	9.667e-03	6.59e-01	7.18e-03	3.23e-01	1.10e-02
35	1.511e-01	7.17e-01	1.25e-02	2.70e-01	1.861e-02	6.62e-01	7.20e-03	3.20e-01	1.09e-02
36	1.501e-01	7.20e-01	1.25e-02	2.68e-01	1.835e-02	6.64e-01	7.21e-03	3.18e-01	1.09e-02
37	7.487e-02	7.20e-01	1.25e-02	2.67e-01	9.142e-03	6.64e-01	7.21e-03	3.18e-01	1.08e-02
38	1.498e-01	7.21e-01	1.25e-02	2.66e-01	1.825e-02	6.64e-01	7.22e-03	3.18e-01	1.08e-02
39	7.463e-02	7.22e-01	1.26e-02	2.65e-01	9.064e-03	6.65e-01	7.22e-03	3.17e-01	1.08e-02
Total	4.118e+01	7.05e-01	1.22e-02	2.83e-01	5.247e+00	6.56e-01	7.15e-03	3.26e-01	1.11e-02

Table 4.68. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 2 (22.5 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.667e+03	1.28e-03	1.59e-04	1.92e-06	9.99e-01	1.417e-01	9.98e-01	2.36e-03	5.597e+01	9.61e-04	6.43e-01	2.28e-01	1.12e-01	1.64e-02
2	1.667e+03	1.30e-03	1.57e-04	1.92e-06	9.99e-01	1.411e-01	9.98e-01	2.36e-03	5.678e+01	9.25e-04	6.53e-01	2.22e-01	1.09e-01	1.54e-02
3	1.667e+03	1.31e-03	1.56e-04	1.92e-06	9.99e-01	1.409e-01	9.98e-01	2.35e-03	5.709e+01	9.13e-04	6.56e-01	2.20e-01	1.08e-01	1.51e-02
4	1.667e+03	1.31e-03	1.56e-04	1.91e-06	9.99e-01	1.403e-01	9.98e-01	2.34e-03	5.723e+01	9.06e-04	6.58e-01	2.19e-01	1.07e-01	1.49e-02
5	1.667e+03	1.32e-03	1.54e-04	1.89e-06	9.99e-01	1.401e-01	9.98e-01	2.29e-03	5.787e+01	8.81e-04	6.66e-01	2.14e-01	1.06e-01	1.42e-02
6	1.668e+03	1.35e-03	1.50e-04	1.87e-06	9.98e-01	1.395e-01	9.98e-01	2.21e-03	5.919e+01	8.29e-04	6.83e-01	2.03e-01	1.01e-01	1.25e-02
7	1.667e+03	1.31e-03	1.56e-04	1.93e-06	9.99e-01	1.425e-01	9.98e-01	2.32e-03	5.703e+01	9.19e-04	6.57e-01	2.19e-01	1.08e-01	1.50e-02
8	1.667e+03	1.31e-03	1.55e-04	1.91e-06	9.99e-01	1.412e-01	9.98e-01	2.32e-03	5.736e+01	9.06e-04	6.60e-01	2.17e-01	1.07e-01	1.47e-02
9	1.667e+03	1.30e-03	1.57e-04	1.92e-06	9.99e-01	1.407e-01	9.98e-01	2.36e-03	5.696e+01	9.17e-04	6.55e-01	2.21e-01	1.08e-01	1.52e-02
10	1.667e+03	1.32e-03	1.55e-04	1.91e-06	9.99e-01	1.411e-01	9.98e-01	2.32e-03	5.762e+01	8.96e-04	6.63e-01	2.15e-01	1.07e-01	1.44e-02
11	1.667e+03	1.32e-03	1.55e-04	1.90e-06	9.99e-01	1.404e-01	9.98e-01	2.31e-03	5.774e+01	8.89e-04	6.64e-01	2.14e-01	1.06e-01	1.43e-02
12	1.667e+03	1.31e-03	1.56e-04	1.91e-06	9.99e-01	1.408e-01	9.98e-01	2.33e-03	5.737e+01	9.02e-04	6.60e-01	2.18e-01	1.07e-01	1.47e-02
13	1.668e+03	1.33e-03	1.53e-04	1.90e-06	9.99e-01	1.410e-01	9.98e-01	2.26e-03	5.838e+01	8.67e-04	6.72e-01	2.09e-01	1.04e-01	1.36e-02
14	1.668e+03	1.35e-03	1.50e-04	1.88e-06	9.98e-01	1.408e-01	9.98e-01	2.20e-03	5.926e+01	8.30e-04	6.84e-01	2.02e-01	1.01e-01	1.24e-02
15	1.667e+03	1.32e-03	1.55e-04	1.93e-06	9.99e-01	1.421e-01	9.98e-01	2.31e-03	5.754e+01	8.98e-04	6.63e-01	2.16e-01	1.06e-01	1.44e-02
16	1.667e+03	1.30e-03	1.57e-04	1.92e-06	9.99e-01	1.408e-01	9.98e-01	2.36e-03	5.694e+01	9.19e-04	6.55e-01	2.21e-01	1.08e-01	1.53e-02
17	1.667e+03	1.32e-03	1.55e-04	1.91e-06	9.99e-01	1.410e-01	9.98e-01	2.33e-03	5.755e+01	8.99e-04	6.62e-01	2.16e-01	1.07e-01	1.45e-02
18	1.667e+03	1.32e-03	1.55e-04	1.90e-06	9.99e-01	1.403e-01	9.98e-01	2.32e-03	5.765e+01	8.93e-04	6.63e-01	2.15e-01	1.06e-01	1.44e-02
19	1.667e+03	1.31e-03	1.56e-04	1.91e-06	9.99e-01	1.410e-01	9.98e-01	2.33e-03	5.733e+01	9.04e-04	6.59e-01	2.18e-01	1.07e-01	1.48e-02
20	1.668e+03	1.33e-03	1.53e-04	1.90e-06	9.99e-01	1.409e-01	9.98e-01	2.27e-03	5.835e+01	8.68e-04	6.72e-01	2.09e-01	1.05e-01	1.36e-02
21	1.668e+03	1.35e-03	1.50e-04	1.88e-06	9.98e-01	1.408e-01	9.98e-01	2.21e-03	5.926e+01	8.30e-04	6.84e-01	2.02e-01	1.01e-01	1.24e-02
22	1.667e+03	1.30e-03	1.57e-04	1.92e-06	9.99e-01	1.408e-01	9.98e-01	2.37e-03	5.680e+01	9.25e-04	6.53e-01	2.22e-01	1.09e-01	1.55e-02
23	1.667e+03	1.30e-03	1.57e-04	1.91e-06	9.99e-01	1.401e-01	9.98e-01	2.37e-03	5.685e+01	9.20e-04	6.53e-01	2.22e-01	1.08e-01	1.54e-02
24	1.667e+03	1.32e-03	1.54e-04	1.89e-06	9.99e-01	1.397e-01	9.98e-01	2.30e-03	5.781e+01	8.83e-04	6.65e-01	2.14e-01	1.06e-01	1.43e-02
25	1.668e+03	1.35e-03	1.50e-04	1.87e-06	9.98e-01	1.397e-01	9.98e-01	2.21e-03	5.926e+01	8.28e-04	6.84e-01	2.02e-01	1.01e-01	1.24e-02
26	1.667e+03	1.30e-03	1.57e-04	1.93e-06	9.99e-01	1.416e-01	9.98e-01	2.37e-03	5.693e+01	9.25e-04	6.54e-01	2.21e-01	1.09e-01	1.54e-02
27	1.667e+03	1.29e-03	1.59e-04	1.92e-06	9.99e-01	1.402e-01	9.98e-01	2.40e-03	5.642e+01	9.46e-04	6.46e-01	2.26e-01	1.11e-01	1.63e-02
28	1.667e+03	1.30e-03	1.58e-04	1.91e-06	9.99e-01	1.400e-01	9.98e-01	2.37e-03	5.687e+01	9.26e-04	6.52e-01	2.22e-01	1.10e-01	1.57e-02
29	1.668e+03	1.33e-03	1.53e-04	1.89e-06	9.99e-01	1.408e-01	9.98e-01	2.26e-03	5.847e+01	8.64e-04	6.73e-01	2.08e-01	1.04e-01	1.35e-02
30	1.668e+03	1.36e-03	1.49e-04	1.89e-06	9.98e-01	1.418e-01	9.98e-01	2.19e-03	5.947e+01	8.26e-04	6.86e-01	2.00e-01	1.00e-01	1.22e-02
31	1.667e+03	1.31e-03	1.55e-04	1.90e-06	9.99e-01	1.402e-01	9.98e-01	2.32e-03	5.752e+01	8.96e-04	6.61e-01	2.17e-01	1.07e-01	1.46e-02
32	1.668e+03	1.35e-03	1.50e-04	1.88e-06	9.98e-01	1.409e-01	9.98e-01	2.21e-03	5.919e+01	8.34e-04	6.83e-01	2.03e-01	1.01e-01	1.25e-02
33	1.668e+03	1.36e-03	1.49e-04	1.86e-06	9.98e-01	1.399e-01	9.98e-01	2.17e-03	5.976e+01	8.12e-04	6.89e-01	1.98e-01	9.96e-02	1.19e-02
34	1.668e+03	1.34e-03	1.52e-04	1.87e-06	9.99e-01	1.398e-01	9.98e-01	2.24e-03	5.877e+01	8.47e-04	6.77e-01	2.06e-01	1.03e-01	1.31e-02
35	1.668e+03	1.36e-03	1.49e-04	1.87e-06	9.98e-01	1.409e-01	9.98e-01	2.18e-03	5.966e+01	8.17e-04	6.88e-01	1.99e-01	9.98e-02	1.20e-02
36	1.668e+03	1.37e-03	1.48e-04	1.86e-06	9.98e-01	1.404e-01	9.98e-01	2.15e-03	6.003e+01	8.03e-04	6.93e-01	1.96e-01	9.89e-02	1.17e-02
37	1.668e+03	1.37e-03	1.48e-04	1.87e-06	9.98e-01	1.411e-01	9.98e-01	2.15e-03	6.007e+01	8.03e-04	6.93e-01	1.96e-01	9.86e-02	1.16e-02
38	1.668e+03	1.37e-03	1.47e-04	1.86e-06	9.98e-01	1.410e-01	9.98e-01	2.14e-03	6.020e+01	8.00e-04	6.95e-01	1.95e-01	9.85e-02	1.15e-02
39	1.668e+03	1.37e-03	1.47e-04	1.86e-06	9.98e-01	1.412e-01	9.98e-01	2.13e-03	6.031e+01	7.96e-04	6.96e-01	1.94e-01	9.80e-02	1.14e-02
Total	4.402e+05	1.33e-03	1.53e-04	1.90e-06	9.99e-01	3.715e+01	9.98e-01	2.28e-03	1.534e+04	8.75e-04	6.69e-01	2.11e-01	1.05e-01	1.39e-02

Table 4.68. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	1.704e-01	5.90e-01	1.15e-02	3.99e-01	3.284e-02	5.18e-01	8.01e-03	4.53e-01	2.15e-02
2	1.652e-01	6.00e-01	1.17e-02	3.88e-01	3.132e-02	5.29e-01	8.10e-03	4.42e-01	2.08e-02
3	1.637e-01	6.04e-01	1.18e-02	3.84e-01	3.084e-02	5.33e-01	8.14e-03	4.38e-01	2.06e-02
4	1.633e-01	6.06e-01	1.18e-02	3.82e-01	3.065e-02	5.34e-01	8.15e-03	4.38e-01	2.06e-02
5	1.614e-01	6.14e-01	1.21e-02	3.73e-01	2.964e-02	5.37e-01	8.19e-03	4.35e-01	2.06e-02
6	1.558e-01	6.33e-01	1.26e-02	3.55e-01	2.743e-02	5.42e-01	8.27e-03	4.29e-01	2.06e-02
7	1.649e-01	6.05e-01	1.18e-02	3.84e-01	3.085e-02	5.27e-01	8.09e-03	4.44e-01	2.11e-02
8	3.269e-01	6.08e-01	1.19e-02	3.80e-01	6.097e-02	5.32e-01	8.14e-03	4.39e-01	2.08e-02
9	3.281e-01	6.03e-01	1.17e-02	3.85e-01	6.201e-02	5.32e-01	8.13e-03	4.39e-01	2.07e-02
10	3.246e-01	6.12e-01	1.20e-02	3.76e-01	6.020e-02	5.35e-01	8.17e-03	4.36e-01	2.07e-02
11	3.239e-01	6.13e-01	1.21e-02	3.75e-01	5.989e-02	5.36e-01	8.18e-03	4.35e-01	2.07e-02
12	3.255e-01	6.08e-01	1.19e-02	3.80e-01	6.076e-02	5.35e-01	8.17e-03	4.36e-01	2.06e-02
13	3.198e-01	6.22e-01	1.23e-02	3.66e-01	5.780e-02	5.39e-01	8.23e-03	4.32e-01	2.06e-02
14	3.109e-01	6.34e-01	1.27e-02	3.53e-01	5.450e-02	5.43e-01	8.28e-03	4.28e-01	2.05e-02
15	1.618e-01	6.11e-01	1.20e-02	3.77e-01	3.000e-02	5.34e-01	8.15e-03	4.37e-01	2.07e-02
16	3.285e-01	6.02e-01	1.17e-02	3.86e-01	6.218e-02	5.32e-01	8.13e-03	4.39e-01	2.07e-02
17	3.251e-01	6.10e-01	1.20e-02	3.78e-01	6.048e-02	5.35e-01	8.17e-03	4.36e-01	2.07e-02
18	3.246e-01	6.12e-01	1.20e-02	3.76e-01	6.022e-02	5.35e-01	8.18e-03	4.36e-01	2.07e-02
19	3.258e-01	6.08e-01	1.19e-02	3.81e-01	6.088e-02	5.35e-01	8.17e-03	4.37e-01	2.06e-02
20	3.202e-01	6.21e-01	1.23e-02	3.66e-01	5.796e-02	5.39e-01	8.22e-03	4.32e-01	2.06e-02
21	3.110e-01	6.34e-01	1.27e-02	3.53e-01	5.454e-02	5.43e-01	8.28e-03	4.28e-01	2.05e-02
22	3.296e-01	6.00e-01	1.17e-02	3.88e-01	6.271e-02	5.32e-01	8.13e-03	4.39e-01	2.06e-02
23	3.290e-01	6.01e-01	1.17e-02	3.88e-01	6.253e-02	5.32e-01	8.14e-03	4.39e-01	2.06e-02
24	3.233e-01	6.14e-01	1.21e-02	3.74e-01	5.954e-02	5.37e-01	8.20e-03	4.35e-01	2.06e-02
25	3.110e-01	6.34e-01	1.27e-02	3.54e-01	5.458e-02	5.43e-01	8.28e-03	4.29e-01	2.06e-02
26	1.651e-01	6.02e-01	1.17e-02	3.87e-01	3.133e-02	5.32e-01	8.13e-03	4.39e-01	2.07e-02
27	3.365e-01	5.94e-01	1.15e-02	3.95e-01	6.502e-02	5.30e-01	8.12e-03	4.41e-01	2.07e-02
28	3.331e-01	6.00e-01	1.17e-02	3.88e-01	6.339e-02	5.32e-01	8.15e-03	4.39e-01	2.07e-02
29	3.196e-01	6.23e-01	1.23e-02	3.65e-01	5.765e-02	5.39e-01	8.24e-03	4.32e-01	2.06e-02
30	3.096e-01	6.37e-01	1.28e-02	3.50e-01	5.381e-02	5.44e-01	8.30e-03	4.27e-01	2.05e-02
31	3.253e-01	6.10e-01	1.19e-02	3.78e-01	6.048e-02	5.35e-01	8.19e-03	4.36e-01	2.06e-02
32	3.117e-01	6.33e-01	1.26e-02	3.54e-01	5.477e-02	5.43e-01	8.29e-03	4.29e-01	2.05e-02
33	3.084e-01	6.40e-01	1.29e-02	3.47e-01	5.324e-02	5.45e-01	8.32e-03	4.26e-01	2.06e-02
34	1.581e-01	6.26e-01	1.24e-02	3.61e-01	2.822e-02	5.40e-01	8.26e-03	4.31e-01	2.06e-02
35	3.089e-01	6.39e-01	1.28e-02	3.48e-01	5.339e-02	5.44e-01	8.32e-03	4.27e-01	2.05e-02
36	3.066e-01	6.44e-01	1.30e-02	3.43e-01	5.235e-02	5.46e-01	8.34e-03	4.25e-01	2.05e-02
37	1.529e-01	6.44e-01	1.30e-02	3.43e-01	2.606e-02	5.46e-01	8.34e-03	4.25e-01	2.05e-02
38	3.058e-01	6.46e-01	1.31e-02	3.41e-01	5.189e-02	5.47e-01	8.36e-03	4.24e-01	2.05e-02
39	1.523e-01	6.47e-01	1.31e-02	3.39e-01	2.572e-02	5.47e-01	8.37e-03	4.24e-01	2.05e-02
Total	8.470e+01	6.17e-01	1.22e-02	3.70e-01	1.546e+01	5.37e-01	8.20e-03	4.34e-01	2.06e-02

Table 4.69. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 2/BOC 3 (30.00 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.657e+03	1.07e-03	2.00e-04	2.08e-06	9.99e-01	1.834e-01	9.97e-01	2.52e-03	5.191e+01	2.11e-03	5.62e-01	2.65e-01	1.41e-01	2.97e-02
2	1.657e+03	1.09e-03	1.98e-04	2.08e-06	9.99e-01	1.828e-01	9.97e-01	2.51e-03	5.258e+01	2.05e-03	5.70e-01	2.61e-01	1.38e-01	2.84e-02
3	1.657e+03	1.09e-03	1.97e-04	2.08e-06	9.99e-01	1.827e-01	9.97e-01	2.51e-03	5.288e+01	2.02e-03	5.74e-01	2.59e-01	1.37e-01	2.78e-02
4	1.657e+03	1.10e-03	1.97e-04	2.07e-06	9.99e-01	1.819e-01	9.98e-01	2.50e-03	5.307e+01	2.00e-03	5.76e-01	2.58e-01	1.37e-01	2.75e-02
5	1.657e+03	1.12e-03	1.94e-04	2.06e-06	9.99e-01	1.820e-01	9.98e-01	2.44e-03	5.398e+01	1.94e-03	5.87e-01	2.50e-01	1.35e-01	2.58e-02
6	1.658e+03	1.16e-03	1.89e-04	2.03e-06	9.99e-01	1.814e-01	9.98e-01	2.35e-03	5.576e+01	1.80e-03	6.10e-01	2.37e-01	1.29e-01	2.23e-02
7	1.657e+03	1.10e-03	1.96e-04	2.09e-06	9.99e-01	1.847e-01	9.98e-01	2.47e-03	5.306e+01	2.01e-03	5.77e-01	2.57e-01	1.37e-01	2.72e-02
8	1.657e+03	1.11e-03	1.96e-04	2.08e-06	9.99e-01	1.832e-01	9.98e-01	2.48e-03	5.331e+01	1.99e-03	5.79e-01	2.55e-01	1.37e-01	2.69e-02
9	1.657e+03	1.09e-03	1.98e-04	2.08e-06	9.99e-01	1.824e-01	9.97e-01	2.51e-03	5.272e+01	2.03e-03	5.72e-01	2.60e-01	1.38e-01	2.81e-02
10	1.657e+03	1.11e-03	1.95e-04	2.08e-06	9.99e-01	1.831e-01	9.98e-01	2.47e-03	5.356e+01	1.98e-03	5.82e-01	2.53e-01	1.36e-01	2.65e-02
11	1.657e+03	1.11e-03	1.95e-04	2.07e-06	9.99e-01	1.822e-01	9.98e-01	2.46e-03	5.373e+01	1.96e-03	5.84e-01	2.52e-01	1.35e-01	2.62e-02
12	1.657e+03	1.10e-03	1.96e-04	2.07e-06	9.99e-01	1.826e-01	9.98e-01	2.48e-03	5.327e+01	1.99e-03	5.78e-01	2.56e-01	1.36e-01	2.71e-02
13	1.658e+03	1.13e-03	1.92e-04	2.06e-06	9.99e-01	1.831e-01	9.98e-01	2.41e-03	5.464e+01	1.89e-03	5.96e-01	2.45e-01	1.33e-01	2.46e-02
14	1.658e+03	1.16e-03	1.89e-04	2.04e-06	9.99e-01	1.831e-01	9.98e-01	2.34e-03	5.585e+01	1.80e-03	6.12e-01	2.36e-01	1.28e-01	2.21e-02
15	1.658e+03	1.11e-03	1.95e-04	2.09e-06	9.99e-01	1.844e-01	9.98e-01	2.47e-03	5.348e+01	1.98e-03	5.82e-01	2.54e-01	1.35e-01	2.64e-02
16	1.657e+03	1.09e-03	1.98e-04	2.08e-06	9.99e-01	1.825e-01	9.97e-01	2.52e-03	5.268e+01	2.04e-03	5.71e-01	2.61e-01	1.38e-01	2.82e-02
17	1.657e+03	1.11e-03	1.96e-04	2.08e-06	9.99e-01	1.830e-01	9.98e-01	2.48e-03	5.345e+01	1.98e-03	5.81e-01	2.54e-01	1.36e-01	2.67e-02
18	1.657e+03	1.11e-03	1.95e-04	2.07e-06	9.99e-01	1.820e-01	9.98e-01	2.47e-03	5.360e+01	1.97e-03	5.83e-01	2.53e-01	1.36e-01	2.65e-02
19	1.657e+03	1.10e-03	1.96e-04	2.08e-06	9.99e-01	1.829e-01	9.98e-01	2.49e-03	5.321e+01	2.00e-03	5.78e-01	2.57e-01	1.37e-01	2.72e-02
20	1.658e+03	1.13e-03	1.92e-04	2.06e-06	9.99e-01	1.831e-01	9.98e-01	2.41e-03	5.461e+01	1.90e-03	5.95e-01	2.45e-01	1.33e-01	2.47e-02
21	1.658e+03	1.16e-03	1.89e-04	2.04e-06	9.99e-01	1.831e-01	9.98e-01	2.34e-03	5.586e+01	1.80e-03	6.12e-01	2.36e-01	1.28e-01	2.21e-02
22	1.657e+03	1.09e-03	1.98e-04	2.08e-06	9.99e-01	1.824e-01	9.97e-01	2.53e-03	5.247e+01	2.05e-03	5.68e-01	2.63e-01	1.39e-01	2.87e-02
23	1.657e+03	1.09e-03	1.98e-04	2.07e-06	9.99e-01	1.816e-01	9.97e-01	2.53e-03	5.255e+01	2.04e-03	5.69e-01	2.62e-01	1.38e-01	2.86e-02
24	1.657e+03	1.12e-03	1.95e-04	2.05e-06	9.99e-01	1.813e-01	9.98e-01	2.45e-03	5.389e+01	1.94e-03	5.86e-01	2.51e-01	1.35e-01	2.60e-02
25	1.658e+03	1.16e-03	1.89e-04	2.03e-06	9.99e-01	1.817e-01	9.98e-01	2.34e-03	5.585e+01	1.79e-03	6.11e-01	2.36e-01	1.28e-01	2.22e-02
26	1.657e+03	1.09e-03	1.98e-04	2.09e-06	9.99e-01	1.836e-01	9.97e-01	2.53e-03	5.263e+01	2.05e-03	5.70e-01	2.60e-01	1.39e-01	2.85e-02
27	1.656e+03	1.07e-03	2.00e-04	2.08e-06	9.99e-01	1.816e-01	9.97e-01	2.57e-03	5.200e+01	2.11e-03	5.61e-01	2.65e-01	1.42e-01	3.03e-02
28	1.657e+03	1.09e-03	1.99e-04	2.07e-06	9.99e-01	1.814e-01	9.97e-01	2.53e-03	5.262e+01	2.06e-03	5.68e-01	2.61e-01	1.40e-01	2.89e-02
29	1.658e+03	1.14e-03	1.92e-04	2.06e-06	9.99e-01	1.829e-01	9.98e-01	2.40e-03	5.478e+01	1.89e-03	5.97e-01	2.44e-01	1.33e-01	2.44e-02
30	1.658e+03	1.17e-03	1.88e-04	2.05e-06	9.99e-01	1.844e-01	9.98e-01	2.32e-03	5.617e+01	1.78e-03	6.15e-01	2.34e-01	1.27e-01	2.16e-02
31	1.657e+03	1.11e-03	1.96e-04	2.06e-06	9.99e-01	1.819e-01	9.98e-01	2.47e-03	5.350e+01	1.97e-03	5.81e-01	2.55e-01	1.36e-01	2.68e-02
32	1.658e+03	1.16e-03	1.89e-04	2.04e-06	9.99e-01	1.831e-01	9.98e-01	2.34e-03	5.577e+01	1.80e-03	6.10e-01	2.37e-01	1.29e-01	2.23e-02
33	1.659e+03	1.18e-03	1.87e-04	2.02e-06	9.99e-01	1.820e-01	9.98e-01	2.30e-03	5.659e+01	1.75e-03	6.20e-01	2.31e-01	1.27e-01	2.11e-02
34	1.658e+03	1.15e-03	1.91e-04	2.04e-06	9.99e-01	1.817e-01	9.98e-01	2.37e-03	5.520e+01	1.84e-03	6.03e-01	2.41e-01	1.31e-01	2.35e-02
35	1.658e+03	1.17e-03	1.87e-04	2.03e-06	9.99e-01	1.832e-01	9.98e-01	2.30e-03	5.646e+01	1.76e-03	6.19e-01	2.32e-01	1.27e-01	2.12e-02
36	1.659e+03	1.18e-03	1.86e-04	2.02e-06	9.99e-01	1.827e-01	9.98e-01	2.27e-03	5.700e+01	1.72e-03	6.25e-01	2.28e-01	1.25e-01	2.04e-02
37	1.659e+03	1.18e-03	1.86e-04	2.03e-06	9.99e-01	1.836e-01	9.98e-01	2.27e-03	5.704e+01	1.72e-03	6.26e-01	2.27e-01	1.25e-01	2.03e-02
38	1.659e+03	1.19e-03	1.85e-04	2.02e-06	9.99e-01	1.834e-01	9.98e-01	2.26e-03	5.726e+01	1.71e-03	6.28e-01	2.26e-01	1.25e-01	2.01e-02
39	1.659e+03	1.19e-03	1.85e-04	2.02e-06	9.99e-01	1.837e-01	9.98e-01	2.25e-03	5.742e+01	1.69e-03	6.30e-01	2.24e-01	1.24e-01	1.98e-02
Total	4.376e+05	1.13e-03	1.93e-04	2.06e-06	9.99e-01	4.822e+01	9.98e-01	2.43e-03	1.434e+04	1.91e-03	5.92e-01	2.48e-01	1.33e-01	2.52e-02

Table 4.69. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	2.794e-01	5.09e-01	1.06e-02	4.81e-01	7.274e-02	4.20e-01	8.31e-03	5.40e-01	3.22e-02
2	2.723e-01	5.17e-01	1.07e-02	4.73e-01	6.978e-02	4.29e-01	8.43e-03	5.31e-01	3.14e-02
3	2.703e-01	5.20e-01	1.08e-02	4.69e-01	6.880e-02	4.32e-01	8.48e-03	5.29e-01	3.12e-02
4	2.696e-01	5.22e-01	1.09e-02	4.67e-01	6.835e-02	4.33e-01	8.50e-03	5.28e-01	3.12e-02
5	2.662e-01	5.34e-01	1.13e-02	4.54e-01	6.580e-02	4.37e-01	8.57e-03	5.23e-01	3.12e-02
6	2.559e-01	5.59e-01	1.21e-02	4.29e-01	6.035e-02	4.45e-01	8.69e-03	5.15e-01	3.13e-02
7	2.707e-01	5.25e-01	1.10e-02	4.64e-01	6.832e-02	4.29e-01	8.43e-03	5.30e-01	3.17e-02
8	5.383e-01	5.27e-01	1.10e-02	4.62e-01	1.355e-01	4.33e-01	8.50e-03	5.27e-01	3.15e-02
9	5.418e-01	5.19e-01	1.08e-02	4.71e-01	1.384e-01	4.31e-01	8.47e-03	5.29e-01	3.12e-02
10	5.351e-01	5.30e-01	1.11e-02	4.59e-01	1.340e-01	4.36e-01	8.53e-03	5.24e-01	3.13e-02
11	5.340e-01	5.32e-01	1.12e-02	4.57e-01	1.332e-01	4.36e-01	8.55e-03	5.24e-01	3.13e-02
12	5.374e-01	5.26e-01	1.10e-02	4.63e-01	1.354e-01	4.34e-01	8.52e-03	5.26e-01	3.12e-02
13	5.265e-01	5.44e-01	1.16e-02	4.44e-01	1.279e-01	4.41e-01	8.62e-03	5.19e-01	3.13e-02
14	5.105e-01	5.61e-01	1.21e-02	4.27e-01	1.198e-01	4.47e-01	8.70e-03	5.13e-01	3.13e-02
15	2.666e-01	5.29e-01	1.11e-02	4.59e-01	6.671e-02	4.35e-01	8.51e-03	5.25e-01	3.13e-02
16	5.425e-01	5.18e-01	1.07e-02	4.71e-01	1.389e-01	4.31e-01	8.47e-03	5.29e-01	3.12e-02
17	5.361e-01	5.28e-01	1.11e-02	4.60e-01	1.347e-01	4.35e-01	8.53e-03	5.25e-01	3.13e-02
18	5.353e-01	5.30e-01	1.11e-02	4.59e-01	1.341e-01	4.36e-01	8.54e-03	5.25e-01	3.14e-02
19	5.378e-01	5.25e-01	1.10e-02	4.64e-01	1.356e-01	4.34e-01	8.52e-03	5.26e-01	3.12e-02
20	5.272e-01	5.44e-01	1.16e-02	4.45e-01	1.283e-01	4.41e-01	8.62e-03	5.19e-01	3.13e-02
21	5.107e-01	5.61e-01	1.21e-02	4.27e-01	1.199e-01	4.47e-01	8.70e-03	5.13e-01	3.13e-02
22	5.446e-01	5.15e-01	1.06e-02	4.75e-01	1.402e-01	4.30e-01	8.46e-03	5.30e-01	3.12e-02
23	5.437e-01	5.15e-01	1.07e-02	4.74e-01	1.398e-01	4.30e-01	8.47e-03	5.30e-01	3.13e-02
24	5.333e-01	5.33e-01	1.12e-02	4.56e-01	1.322e-01	4.37e-01	8.57e-03	5.24e-01	3.13e-02
25	5.107e-01	5.60e-01	1.21e-02	4.28e-01	1.200e-01	4.46e-01	8.71e-03	5.14e-01	3.13e-02
26	2.729e-01	5.16e-01	1.07e-02	4.73e-01	7.006e-02	4.31e-01	8.47e-03	5.30e-01	3.13e-02
27	5.569e-01	5.06e-01	1.05e-02	4.83e-01	1.458e-01	4.27e-01	8.44e-03	5.33e-01	3.14e-02
28	5.508e-01	5.15e-01	1.07e-02	4.74e-01	1.417e-01	4.30e-01	8.49e-03	5.30e-01	3.14e-02
29	5.262e-01	5.45e-01	1.17e-02	4.43e-01	1.275e-01	4.41e-01	8.64e-03	5.19e-01	3.13e-02
30	5.080e-01	5.65e-01	1.23e-02	4.23e-01	1.181e-01	4.48e-01	8.74e-03	5.12e-01	3.12e-02
31	5.370e-01	5.28e-01	1.11e-02	4.61e-01	1.345e-01	4.35e-01	8.55e-03	5.25e-01	3.13e-02
32	5.118e-01	5.59e-01	1.21e-02	4.29e-01	1.204e-01	4.46e-01	8.71e-03	5.14e-01	3.13e-02
33	5.059e-01	5.69e-01	1.25e-02	4.18e-01	1.166e-01	4.49e-01	8.77e-03	5.11e-01	3.14e-02
34	2.602e-01	5.51e-01	1.18e-02	4.38e-01	6.229e-02	4.43e-01	8.66e-03	5.17e-01	3.13e-02
35	5.067e-01	5.68e-01	1.24e-02	4.20e-01	1.169e-01	4.49e-01	8.76e-03	5.11e-01	3.13e-02
36	5.027e-01	5.75e-01	1.26e-02	4.13e-01	1.143e-01	4.51e-01	8.80e-03	5.09e-01	3.13e-02
37	2.507e-01	5.75e-01	1.26e-02	4.12e-01	5.692e-02	4.51e-01	8.80e-03	5.08e-01	3.13e-02
38	5.011e-01	5.78e-01	1.28e-02	4.09e-01	1.131e-01	4.52e-01	8.82e-03	5.07e-01	3.13e-02
39	2.495e-01	5.80e-01	1.28e-02	4.07e-01	5.603e-02	4.53e-01	8.83e-03	5.07e-01	3.13e-02
Total	1.395e+02	5.39e-01	1.14e-02	4.50e-01	3.426e+01	4.38e-01	8.58e-03	5.22e-01	3.13e-02

Table 4.70. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at MOC 3 (45.0 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.646e+03	8.77e-04	2.34e-04	2.24e-06	9.99e-01	2.212e-01	9.97e-01	2.69e-03	4.827e+01	3.90e-03	4.95e-01	2.90e-01	1.64e-01	4.76e-02
2	1.647e+03	8.93e-04	2.32e-04	2.23e-06	9.99e-01	2.207e-01	9.97e-01	2.68e-03	4.882e+01	3.79e-03	5.01e-01	2.88e-01	1.61e-01	4.58e-02
3	1.647e+03	9.00e-04	2.32e-04	2.23e-06	9.99e-01	2.207e-01	9.97e-01	2.67e-03	4.911e+01	3.75e-03	5.04e-01	2.86e-01	1.61e-01	4.50e-02
4	1.647e+03	9.05e-04	2.31e-04	2.23e-06	9.99e-01	2.199e-01	9.97e-01	2.66e-03	4.933e+01	3.72e-03	5.07e-01	2.85e-01	1.60e-01	4.44e-02
5	1.647e+03	9.30e-04	2.28e-04	2.21e-06	9.99e-01	2.203e-01	9.97e-01	2.59e-03	5.046e+01	3.57e-03	5.21e-01	2.77e-01	1.58e-01	4.13e-02
6	1.648e+03	9.79e-04	2.23e-04	2.18e-06	9.99e-01	2.202e-01	9.98e-01	2.49e-03	5.254e+01	3.30e-03	5.47e-01	2.63e-01	1.51e-01	3.54e-02
7	1.647e+03	9.09e-04	2.30e-04	2.24e-06	9.99e-01	2.232e-01	9.97e-01	2.63e-03	4.944e+01	3.72e-03	5.10e-01	2.83e-01	1.60e-01	4.36e-02
8	1.647e+03	9.14e-04	2.30e-04	2.23e-06	9.99e-01	2.214e-01	9.97e-01	2.64e-03	4.962e+01	3.70e-03	5.11e-01	2.82e-01	1.60e-01	4.34e-02
9	1.647e+03	8.96e-04	2.32e-04	2.23e-06	9.99e-01	2.203e-01	9.97e-01	2.68e-03	4.892e+01	3.77e-03	5.02e-01	2.88e-01	1.61e-01	4.55e-02
10	1.647e+03	9.19e-04	2.30e-04	2.23e-06	9.99e-01	2.214e-01	9.97e-01	2.63e-03	4.987e+01	3.66e-03	5.14e-01	2.81e-01	1.59e-01	4.28e-02
11	1.647e+03	9.23e-04	2.29e-04	2.22e-06	9.99e-01	2.205e-01	9.97e-01	2.62e-03	5.008e+01	3.63e-03	5.16e-01	2.79e-01	1.59e-01	4.23e-02
12	1.647e+03	9.11e-04	2.31e-04	2.23e-06	9.99e-01	2.208e-01	9.97e-01	2.64e-03	4.961e+01	3.69e-03	5.10e-01	2.83e-01	1.60e-01	4.37e-02
13	1.647e+03	9.49e-04	2.26e-04	2.22e-06	9.99e-01	2.219e-01	9.97e-01	2.55e-03	5.122e+01	3.49e-03	5.30e-01	2.71e-01	1.56e-01	3.93e-02
14	1.648e+03	9.82e-04	2.22e-04	2.20e-06	9.99e-01	2.223e-01	9.98e-01	2.48e-03	5.266e+01	3.29e-03	5.48e-01	2.62e-01	1.51e-01	3.51e-02
15	1.647e+03	9.18e-04	2.30e-04	2.24e-06	9.99e-01	2.229e-01	9.97e-01	2.63e-03	4.977e+01	3.66e-03	5.13e-01	2.82e-01	1.59e-01	4.27e-02
16	1.647e+03	8.95e-04	2.33e-04	2.23e-06	9.99e-01	2.204e-01	9.97e-01	2.68e-03	4.887e+01	3.78e-03	5.01e-01	2.88e-01	1.61e-01	4.58e-02
17	1.647e+03	9.16e-04	2.30e-04	2.23e-06	9.99e-01	2.213e-01	9.97e-01	2.64e-03	4.974e+01	3.68e-03	5.12e-01	2.82e-01	1.60e-01	4.32e-02
18	1.647e+03	9.20e-04	2.30e-04	2.22e-06	9.99e-01	2.202e-01	9.97e-01	2.63e-03	4.993e+01	3.65e-03	5.14e-01	2.80e-01	1.59e-01	4.28e-02
19	1.647e+03	9.09e-04	2.31e-04	2.23e-06	9.99e-01	2.211e-01	9.97e-01	2.64e-03	4.954e+01	3.70e-03	5.09e-01	2.83e-01	1.60e-01	4.39e-02
20	1.647e+03	9.48e-04	2.27e-04	2.22e-06	9.99e-01	2.218e-01	9.97e-01	2.56e-03	5.118e+01	3.50e-03	5.29e-01	2.71e-01	1.57e-01	3.94e-02
21	1.648e+03	9.82e-04	2.22e-04	2.20e-06	9.99e-01	2.223e-01	9.98e-01	2.48e-03	5.267e+01	3.29e-03	5.48e-01	2.62e-01	1.51e-01	3.51e-02
22	1.646e+03	8.88e-04	2.33e-04	2.24e-06	9.99e-01	2.202e-01	9.97e-01	2.70e-03	4.863e+01	3.82e-03	4.98e-01	2.90e-01	1.62e-01	4.66e-02
23	1.646e+03	8.90e-04	2.33e-04	2.23e-06	9.99e-01	2.193e-01	9.97e-01	2.70e-03	4.873e+01	3.80e-03	4.99e-01	2.89e-01	1.62e-01	4.63e-02
24	1.647e+03	9.27e-04	2.29e-04	2.21e-06	9.99e-01	2.196e-01	9.97e-01	2.60e-03	5.037e+01	3.59e-03	5.19e-01	2.77e-01	1.58e-01	4.16e-02
25	1.648e+03	9.81e-04	2.23e-04	2.18e-06	9.99e-01	2.206e-01	9.98e-01	2.48e-03	5.267e+01	3.29e-03	5.48e-01	2.62e-01	1.51e-01	3.52e-02
26	1.646e+03	8.93e-04	2.33e-04	2.25e-06	9.99e-01	2.217e-01	9.97e-01	2.69e-03	4.880e+01	3.82e-03	5.00e-01	2.87e-01	1.62e-01	4.63e-02
27	1.646e+03	8.74e-04	2.35e-04	2.24e-06	9.99e-01	2.192e-01	9.97e-01	2.73e-03	4.815e+01	3.93e-03	4.91e-01	2.91e-01	1.65e-01	4.91e-02
28	1.646e+03	8.91e-04	2.33e-04	2.23e-06	9.99e-01	2.192e-01	9.97e-01	2.69e-03	4.889e+01	3.82e-03	5.00e-01	2.86e-01	1.64e-01	4.66e-02
29	1.647e+03	9.52e-04	2.26e-04	2.21e-06	9.99e-01	2.217e-01	9.97e-01	2.55e-03	5.140e+01	3.47e-03	5.32e-01	2.70e-01	1.56e-01	3.89e-02
30	1.648e+03	9.90e-04	2.21e-04	2.21e-06	9.99e-01	2.239e-01	9.98e-01	2.45e-03	5.308e+01	3.25e-03	5.53e-01	2.59e-01	1.50e-01	3.42e-02
31	1.647e+03	9.16e-04	2.30e-04	2.22e-06	9.99e-01	2.200e-01	9.97e-01	2.62e-03	4.993e+01	3.65e-03	5.13e-01	2.81e-01	1.60e-01	4.30e-02
32	1.648e+03	9.79e-04	2.23e-04	2.20e-06	9.99e-01	2.223e-01	9.98e-01	2.48e-03	5.259e+01	3.31e-03	5.47e-01	2.63e-01	1.51e-01	3.54e-02
33	1.649e+03	1.00e-03	2.20e-04	2.18e-06	9.99e-01	2.213e-01	9.98e-01	2.43e-03	5.360e+01	3.19e-03	5.59e-01	2.56e-01	1.49e-01	3.31e-02
34	1.648e+03	9.63e-04	2.25e-04	2.19e-06	9.99e-01	2.204e-01	9.97e-01	2.52e-03	5.192e+01	3.39e-03	5.38e-01	2.67e-01	1.54e-01	3.74e-02
35	1.648e+03	9.97e-04	2.21e-04	2.19e-06	9.99e-01	2.226e-01	9.98e-01	2.43e-03	5.347e+01	3.21e-03	5.57e-01	2.57e-01	1.49e-01	3.34e-02
36	1.649e+03	1.01e-03	2.19e-04	2.18e-06	9.99e-01	2.222e-01	9.98e-01	2.40e-03	5.414e+01	3.13e-03	5.65e-01	2.52e-01	1.48e-01	3.20e-02
37	1.649e+03	1.01e-03	2.19e-04	2.19e-06	9.99e-01	2.232e-01	9.98e-01	2.40e-03	5.420e+01	3.12e-03	5.66e-01	2.51e-01	1.47e-01	3.18e-02
38	1.649e+03	1.02e-03	2.18e-04	2.18e-06	9.99e-01	2.231e-01	9.98e-01	2.38e-03	5.449e+01	3.10e-03	5.69e-01	2.49e-01	1.47e-01	3.13e-02
39	1.649e+03	1.02e-03	2.18e-04	2.18e-06	9.99e-01	2.235e-01	9.98e-01	2.37e-03	5.471e+01	3.07e-03	5.72e-01	2.48e-01	1.46e-01	3.08e-02
Total	4.349e+05	9.39e-04	2.27e-04	2.21e-06	9.99e-01	5.840e+01	9.97e-01	2.58e-03	1.342e+04	3.53e-03	5.26e-01	2.74e-01	1.56e-01	4.03e-02

Table 4.70. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	4.004e-01	4.35e-01	9.26e-03	5.56e-01	1.351e-01	3.39e-01	8.13e-03	6.10e-01	4.28e-02
2	3.924e-01	4.41e-01	9.39e-03	5.50e-01	1.304e-01	3.46e-01	8.25e-03	6.04e-01	4.20e-02
3	3.900e-01	4.44e-01	9.48e-03	5.46e-01	1.288e-01	3.48e-01	8.30e-03	6.02e-01	4.19e-02
4	3.892e-01	4.47e-01	9.57e-03	5.43e-01	1.279e-01	3.49e-01	8.32e-03	6.01e-01	4.20e-02
5	3.841e-01	4.62e-01	1.01e-02	5.28e-01	1.228e-01	3.54e-01	8.43e-03	5.95e-01	4.21e-02
6	3.687e-01	4.91e-01	1.10e-02	4.98e-01	1.121e-01	3.65e-01	8.64e-03	5.84e-01	4.24e-02
7	3.888e-01	4.52e-01	9.72e-03	5.39e-01	1.271e-01	3.48e-01	8.30e-03	6.01e-01	4.24e-02
8	7.752e-01	4.53e-01	9.76e-03	5.37e-01	2.530e-01	3.51e-01	8.35e-03	5.98e-01	4.22e-02
9	7.818e-01	4.42e-01	9.42e-03	5.48e-01	2.591e-01	3.47e-01	8.29e-03	6.03e-01	4.19e-02
10	7.717e-01	4.56e-01	9.84e-03	5.34e-01	2.504e-01	3.53e-01	8.39e-03	5.97e-01	4.21e-02
11	7.703e-01	4.58e-01	9.93e-03	5.32e-01	2.489e-01	3.54e-01	8.41e-03	5.96e-01	4.21e-02
12	7.759e-01	4.51e-01	9.71e-03	5.39e-01	2.531e-01	3.51e-01	8.36e-03	5.99e-01	4.20e-02
13	7.592e-01	4.73e-01	1.04e-02	5.16e-01	2.383e-01	3.59e-01	8.52e-03	5.90e-01	4.22e-02
14	7.356e-01	4.93e-01	1.11e-02	4.96e-01	2.224e-01	3.67e-01	8.66e-03	5.82e-01	4.23e-02
15	3.844e-01	4.55e-01	9.79e-03	5.35e-01	1.246e-01	3.53e-01	8.37e-03	5.97e-01	4.19e-02
16	7.829e-01	4.41e-01	9.39e-03	5.49e-01	2.600e-01	3.47e-01	8.28e-03	6.03e-01	4.19e-02
17	7.732e-01	4.54e-01	9.78e-03	5.36e-01	2.518e-01	3.52e-01	8.38e-03	5.97e-01	4.20e-02
18	7.721e-01	4.56e-01	9.86e-03	5.34e-01	2.506e-01	3.53e-01	8.40e-03	5.97e-01	4.21e-02
19	7.764e-01	4.50e-01	9.68e-03	5.40e-01	2.536e-01	3.50e-01	8.36e-03	5.99e-01	4.20e-02
20	7.603e-01	4.73e-01	1.04e-02	5.17e-01	2.391e-01	3.59e-01	8.52e-03	5.90e-01	4.23e-02
21	7.359e-01	4.93e-01	1.11e-02	4.96e-01	2.226e-01	3.67e-01	8.66e-03	5.82e-01	4.23e-02
22	7.861e-01	4.38e-01	9.29e-03	5.53e-01	2.628e-01	3.46e-01	8.27e-03	6.04e-01	4.19e-02
23	7.850e-01	4.39e-01	9.33e-03	5.52e-01	2.619e-01	3.46e-01	8.28e-03	6.04e-01	4.19e-02
24	7.697e-01	4.61e-01	1.00e-02	5.29e-01	2.468e-01	3.54e-01	8.43e-03	5.96e-01	4.22e-02
25	7.360e-01	4.93e-01	1.11e-02	4.96e-01	2.229e-01	3.66e-01	8.66e-03	5.83e-01	4.23e-02
26	3.940e-01	4.40e-01	9.36e-03	5.51e-01	1.313e-01	3.46e-01	8.28e-03	6.03e-01	4.20e-02
27	8.043e-01	4.29e-01	9.09e-03	5.62e-01	2.734e-01	3.41e-01	8.21e-03	6.08e-01	4.21e-02
28	7.955e-01	4.39e-01	9.41e-03	5.52e-01	2.653e-01	3.45e-01	8.29e-03	6.04e-01	4.22e-02
29	7.589e-01	4.75e-01	1.05e-02	5.14e-01	2.374e-01	3.60e-01	8.54e-03	5.89e-01	4.23e-02
30	7.319e-01	4.99e-01	1.13e-02	4.90e-01	2.188e-01	3.69e-01	8.70e-03	5.80e-01	4.23e-02
31	7.753e-01	4.54e-01	9.84e-03	5.36e-01	2.513e-01	3.51e-01	8.40e-03	5.98e-01	4.22e-02
32	7.376e-01	4.92e-01	1.10e-02	4.97e-01	2.235e-01	3.66e-01	8.66e-03	5.83e-01	4.23e-02
33	7.289e-01	5.04e-01	1.15e-02	4.84e-01	2.159e-01	3.70e-01	8.75e-03	5.79e-01	4.25e-02
34	3.753e-01	4.81e-01	1.07e-02	5.08e-01	1.159e-01	3.62e-01	8.58e-03	5.87e-01	4.24e-02
35	7.299e-01	5.03e-01	1.14e-02	4.86e-01	2.165e-01	3.70e-01	8.74e-03	5.79e-01	4.24e-02
36	7.242e-01	5.11e-01	1.18e-02	4.77e-01	2.113e-01	3.73e-01	8.80e-03	5.76e-01	4.25e-02
37	3.613e-01	5.12e-01	1.18e-02	4.76e-01	1.052e-01	3.73e-01	8.80e-03	5.76e-01	4.25e-02
38	7.218e-01	5.15e-01	1.19e-02	4.73e-01	2.088e-01	3.74e-01	8.83e-03	5.74e-01	4.26e-02
39	3.594e-01	5.18e-01	1.20e-02	4.70e-01	1.034e-01	3.75e-01	8.85e-03	5.74e-01	4.26e-02
Total	2.012e+02	4.67e-01	1.02e-02	5.23e-01	6.387e+01	3.56e-01	8.46e-03	5.93e-01	4.22e-02

Table 4.71. HELIOS PWR MOX benchmark analysis actinide inventories and weight fractions at EOC 3 (45.00 MWd/kg)

Pin	U (g)	^{235}U (wt. %)	^{236}U (wt. %)	^{237}U (wt. %)	^{238}U (wt. %)	Np (g)	^{237}Np (wt. %)	^{237}Np (wt. %)	Pu (g)	^{238}Pu (wt. %)	^{239}Pu (wt. %)	^{240}Pu (wt. %)	^{241}Pu (wt. %)	^{237}Np (wt. %)
1	1.635e+03	7.04e-04	2.61e-04	2.38e-06	9.99e-01	2.547e-01	9.97e-01	2.86e-03	4.504e+01	6.33e-03	4.43e-01	3.03e-01	1.78e-01	6.95e-02
2	1.636e+03	7.17e-04	2.61e-04	2.38e-06	9.99e-01	2.543e-01	9.97e-01	2.85e-03	4.549e+01	6.19e-03	4.47e-01	3.03e-01	1.77e-01	6.74e-02
3	1.636e+03	7.24e-04	2.60e-04	2.38e-06	9.99e-01	2.544e-01	9.97e-01	2.84e-03	4.578e+01	6.13e-03	4.50e-01	3.02e-01	1.76e-01	6.63e-02
4	1.636e+03	7.30e-04	2.60e-04	2.37e-06	9.99e-01	2.537e-01	9.97e-01	2.82e-03	4.603e+01	6.07e-03	4.52e-01	3.00e-01	1.76e-01	6.54e-02
5	1.636e+03	7.59e-04	2.57e-04	2.36e-06	9.99e-01	2.547e-01	9.97e-01	2.75e-03	4.732e+01	5.83e-03	4.67e-01	2.92e-01	1.74e-01	6.05e-02
6	1.638e+03	8.13e-04	2.51e-04	2.33e-06	9.99e-01	2.554e-01	9.97e-01	2.63e-03	4.957e+01	5.38e-03	4.94e-01	2.81e-01	1.68e-01	5.18e-02
7	1.636e+03	7.36e-04	2.58e-04	2.39e-06	9.99e-01	2.573e-01	9.97e-01	2.80e-03	4.617e+01	6.07e-03	4.56e-01	2.99e-01	1.75e-01	6.41e-02
8	1.636e+03	7.39e-04	2.59e-04	2.38e-06	9.99e-01	2.554e-01	9.97e-01	2.81e-03	4.631e+01	6.04e-03	4.56e-01	2.98e-01	1.76e-01	6.41e-02
9	1.636e+03	7.20e-04	2.61e-04	2.38e-06	9.99e-01	2.539e-01	9.97e-01	2.85e-03	4.557e+01	6.17e-03	4.47e-01	3.03e-01	1.77e-01	6.72e-02
10	1.636e+03	7.45e-04	2.58e-04	2.38e-06	9.99e-01	2.555e-01	9.97e-01	2.80e-03	4.655e+01	5.99e-03	4.59e-01	2.97e-01	1.75e-01	6.32e-02
11	1.636e+03	7.50e-04	2.58e-04	2.37e-06	9.99e-01	2.546e-01	9.97e-01	2.79e-03	4.680e+01	5.94e-03	4.61e-01	2.95e-01	1.75e-01	6.24e-02
12	1.636e+03	7.37e-04	2.59e-04	2.38e-06	9.99e-01	2.548e-01	9.97e-01	2.80e-03	4.636e+01	6.02e-03	4.56e-01	2.98e-01	1.76e-01	6.42e-02
13	1.637e+03	7.80e-04	2.55e-04	2.37e-06	9.99e-01	2.568e-01	9.97e-01	2.71e-03	4.812e+01	5.70e-03	4.77e-01	2.87e-01	1.73e-01	5.75e-02
14	1.638e+03	8.17e-04	2.51e-04	2.35e-06	9.99e-01	2.578e-01	9.97e-01	2.62e-03	4.969e+01	5.37e-03	4.95e-01	2.80e-01	1.68e-01	5.13e-02
15	1.636e+03	7.44e-04	2.58e-04	2.39e-06	9.99e-01	2.571e-01	9.97e-01	2.80e-03	4.644e+01	5.99e-03	4.58e-01	2.98e-01	1.75e-01	6.31e-02
16	1.636e+03	7.18e-04	2.61e-04	2.38e-06	9.99e-01	2.539e-01	9.97e-01	2.86e-03	4.551e+01	6.18e-03	4.46e-01	3.03e-01	1.77e-01	6.75e-02
17	1.636e+03	7.41e-04	2.59e-04	2.38e-06	9.99e-01	2.553e-01	9.97e-01	2.81e-03	4.640e+01	6.02e-03	4.57e-01	2.98e-01	1.76e-01	6.38e-02
18	1.636e+03	7.46e-04	2.58e-04	2.37e-06	9.99e-01	2.542e-01	9.97e-01	2.80e-03	4.663e+01	5.97e-03	4.59e-01	2.96e-01	1.75e-01	6.31e-02
19	1.636e+03	7.35e-04	2.59e-04	2.38e-06	9.99e-01	2.551e-01	9.97e-01	2.81e-03	4.629e+01	6.04e-03	4.55e-01	2.98e-01	1.76e-01	6.44e-02
20	1.637e+03	7.78e-04	2.55e-04	2.37e-06	9.99e-01	2.567e-01	9.97e-01	2.71e-03	4.807e+01	5.71e-03	4.76e-01	2.87e-01	1.73e-01	5.77e-02
21	1.638e+03	8.17e-04	2.51e-04	2.35e-06	9.99e-01	2.578e-01	9.97e-01	2.62e-03	4.971e+01	5.37e-03	4.95e-01	2.80e-01	1.68e-01	5.13e-02
22	1.635e+03	7.11e-04	2.62e-04	2.39e-06	9.99e-01	2.536e-01	9.97e-01	2.87e-03	4.526e+01	6.24e-03	4.43e-01	3.04e-01	1.77e-01	6.87e-02
23	1.635e+03	7.13e-04	2.61e-04	2.38e-06	9.99e-01	2.526e-01	9.97e-01	2.87e-03	4.539e+01	6.20e-03	4.45e-01	3.04e-01	1.77e-01	6.82e-02
24	1.636e+03	7.56e-04	2.57e-04	2.36e-06	9.99e-01	2.538e-01	9.97e-01	2.75e-03	4.724e+01	5.85e-03	4.66e-01	2.92e-01	1.75e-01	6.09e-02
25	1.638e+03	8.16e-04	2.51e-04	2.33e-06	9.99e-01	2.560e-01	9.97e-01	2.62e-03	4.972e+01	5.35e-03	4.95e-01	2.80e-01	1.68e-01	5.13e-02
26	1.635e+03	7.16e-04	2.61e-04	2.40e-06	9.99e-01	2.554e-01	9.97e-01	2.86e-03	4.543e+01	6.24e-03	4.46e-01	3.02e-01	1.78e-01	6.83e-02
27	1.635e+03	6.97e-04	2.63e-04	2.39e-06	9.99e-01	2.523e-01	9.97e-01	2.91e-03	4.482e+01	6.40e-03	4.38e-01	3.03e-01	1.80e-01	7.21e-02
28	1.635e+03	7.17e-04	2.61e-04	2.38e-06	9.99e-01	2.528e-01	9.97e-01	2.85e-03	4.565e+01	6.22e-03	4.48e-01	2.99e-01	1.79e-01	6.83e-02
29	1.637e+03	7.83e-04	2.54e-04	2.36e-06	9.99e-01	2.566e-01	9.97e-01	2.70e-03	4.835e+01	5.67e-03	4.79e-01	2.86e-01	1.73e-01	5.69e-02
30	1.638e+03	8.27e-04	2.50e-04	2.36e-06	9.99e-01	2.598e-01	9.97e-01	2.59e-03	5.020e+01	5.29e-03	5.01e-01	2.77e-01	1.67e-01	4.98e-02
31	1.636e+03	7.44e-04	2.58e-04	2.37e-06	9.99e-01	2.542e-01	9.97e-01	2.78e-03	4.677e+01	5.95e-03	4.60e-01	2.95e-01	1.76e-01	6.29e-02
32	1.638e+03	8.14e-04	2.51e-04	2.35e-06	9.99e-01	2.578e-01	9.97e-01	2.62e-03	4.966e+01	5.38e-03	4.94e-01	2.80e-01	1.69e-01	5.16e-02
33	1.638e+03	8.39e-04	2.49e-04	2.33e-06	9.99e-01	2.571e-01	9.97e-01	2.57e-03	5.083e+01	5.18e-03	5.07e-01	2.73e-01	1.66e-01	4.81e-02
34	1.637e+03	7.96e-04	2.53e-04	2.34e-06	9.99e-01	2.554e-01	9.97e-01	2.66e-03	4.894e+01	5.52e-03	4.86e-01	2.83e-01	1.71e-01	5.45e-02
35	1.638e+03	8.36e-04	2.49e-04	2.34e-06	9.99e-01	2.585e-01	9.97e-01	2.57e-03	5.069e+01	5.21e-03	5.06e-01	2.74e-01	1.67e-01	4.85e-02
36	1.638e+03	8.52e-04	2.47e-04	2.33e-06	9.99e-01	2.583e-01	9.97e-01	2.53e-03	5.148e+01	5.08e-03	5.15e-01	2.69e-01	1.65e-01	4.62e-02
37	1.638e+03	8.54e-04	2.47e-04	2.34e-06	9.99e-01	2.596e-01	9.97e-01	2.53e-03	5.155e+01	5.07e-03	5.16e-01	2.68e-01	1.65e-01	4.59e-02
38	1.638e+03	8.61e-04	2.46e-04	2.33e-06	9.99e-01	2.596e-01	9.97e-01	2.51e-03	5.192e+01	5.02e-03	5.20e-01	2.66e-01	1.65e-01	4.51e-02
39	1.639e+03	8.66e-04	2.46e-04	2.33e-06	9.99e-01	2.602e-01	9.98e-01	2.50e-03	5.218e+01	4.98e-03	5.23e-01	2.64e-01	1.64e-01	4.42e-02
Total	4.321e+05	7.69e-04	2.56e-04	2.36e-06	9.99e-01	6.753e+01	9.97e-01	2.73e-03	1.260e+04	5.75e-03	4.73e-01	2.89e-01	1.73e-01	5.89e-02

Table 4.71. (continued)

Pin	Am (g)	^{241}Am (wt. %)	^{242m}Am (wt. %)	^{243}Am (wt. %)	Cm (g)	^{242}Cm (wt. %)	^{243}Cm (wt. %)	^{244}Cm (wt. %)	^{245}Cm (wt. %)
1	5.251e-01	3.66e-01	7.85e-03	6.26e-01	2.228e-01	2.71e-01	7.61e-03	6.68e-01	5.25e-02
2	5.169e-01	3.71e-01	7.96e-03	6.21e-01	2.162e-01	2.77e-01	7.72e-03	6.64e-01	5.18e-02
3	5.145e-01	3.75e-01	8.06e-03	6.17e-01	2.138e-01	2.79e-01	7.77e-03	6.62e-01	5.18e-02
4	5.136e-01	3.78e-01	8.16e-03	6.14e-01	2.124e-01	2.80e-01	7.80e-03	6.61e-01	5.19e-02
5	5.072e-01	3.95e-01	8.72e-03	5.96e-01	2.036e-01	2.86e-01	7.95e-03	6.54e-01	5.24e-02
6	4.870e-01	4.28e-01	9.71e-03	5.63e-01	1.855e-01	2.99e-01	8.24e-03	6.40e-01	5.29e-02
7	5.112e-01	3.84e-01	8.31e-03	6.08e-01	2.102e-01	2.81e-01	7.81e-03	6.59e-01	5.22e-02
8	1.021e+00	3.84e-01	8.33e-03	6.08e-01	4.194e-01	2.83e-01	7.86e-03	6.57e-01	5.21e-02
9	1.031e+00	3.72e-01	7.99e-03	6.20e-01	4.303e-01	2.78e-01	7.75e-03	6.63e-01	5.17e-02
10	1.018e+00	3.87e-01	8.42e-03	6.05e-01	4.157e-01	2.84e-01	7.90e-03	6.56e-01	5.20e-02
11	1.016e+00	3.90e-01	8.52e-03	6.02e-01	4.132e-01	2.85e-01	7.92e-03	6.55e-01	5.22e-02
12	1.024e+00	3.83e-01	8.32e-03	6.09e-01	4.201e-01	2.82e-01	7.85e-03	6.59e-01	5.21e-02
13	1.002e+00	4.08e-01	9.09e-03	5.83e-01	3.949e-01	2.92e-01	8.08e-03	6.48e-01	5.26e-02
14	9.716e-01	4.30e-01	9.78e-03	5.60e-01	3.680e-01	3.00e-01	8.27e-03	6.38e-01	5.28e-02
15	5.069e-01	3.86e-01	8.37e-03	6.05e-01	2.068e-01	2.84e-01	7.88e-03	6.56e-01	5.18e-02
16	1.033e+00	3.71e-01	7.96e-03	6.21e-01	4.318e-01	2.78e-01	7.75e-03	6.63e-01	5.17e-02
17	1.020e+00	3.85e-01	8.35e-03	6.07e-01	4.181e-01	2.83e-01	7.88e-03	6.57e-01	5.20e-02
18	1.019e+00	3.87e-01	8.44e-03	6.04e-01	4.161e-01	2.84e-01	7.90e-03	6.56e-01	5.22e-02
19	1.025e+00	3.81e-01	8.28e-03	6.10e-01	4.210e-01	2.81e-01	7.84e-03	6.59e-01	5.20e-02
20	1.004e+00	4.07e-01	9.07e-03	5.84e-01	3.962e-01	2.91e-01	8.07e-03	6.48e-01	5.26e-02
21	9.721e-01	4.30e-01	9.79e-03	5.60e-01	3.683e-01	3.00e-01	8.27e-03	6.39e-01	5.28e-02
22	1.037e+00	3.67e-01	7.85e-03	6.25e-01	4.366e-01	2.76e-01	7.71e-03	6.65e-01	5.17e-02
23	1.036e+00	3.69e-01	7.90e-03	6.24e-01	4.352e-01	2.76e-01	7.73e-03	6.64e-01	5.18e-02
24	1.016e+00	3.94e-01	8.69e-03	5.97e-01	4.093e-01	2.85e-01	7.95e-03	6.54e-01	5.25e-02
25	9.722e-01	4.30e-01	9.78e-03	5.61e-01	3.688e-01	3.00e-01	8.27e-03	6.39e-01	5.29e-02
26	5.197e-01	3.69e-01	7.93e-03	6.23e-01	2.181e-01	2.77e-01	7.74e-03	6.64e-01	5.19e-02
27	1.061e+00	3.58e-01	7.66e-03	6.34e-01	4.542e-01	2.71e-01	7.63e-03	6.69e-01	5.21e-02
28	1.050e+00	3.70e-01	8.01e-03	6.22e-01	4.404e-01	2.75e-01	7.73e-03	6.65e-01	5.23e-02
29	1.002e+00	4.10e-01	9.19e-03	5.81e-01	3.933e-01	2.92e-01	8.10e-03	6.47e-01	5.28e-02
30	9.670e-01	4.36e-01	1.00e-02	5.54e-01	3.618e-01	3.03e-01	8.34e-03	6.36e-01	5.29e-02
31	1.024e+00	3.87e-01	8.48e-03	6.05e-01	4.169e-01	2.82e-01	7.89e-03	6.57e-01	5.24e-02
32	9.745e-01	4.29e-01	9.76e-03	5.61e-01	3.698e-01	2.99e-01	8.27e-03	6.39e-01	5.29e-02
33	9.633e-01	4.43e-01	1.03e-02	5.46e-01	3.567e-01	3.04e-01	8.39e-03	6.34e-01	5.33e-02
34	4.959e-01	4.17e-01	9.42e-03	5.73e-01	1.919e-01	2.94e-01	8.16e-03	6.45e-01	5.29e-02
35	9.646e-01	4.42e-01	1.02e-02	5.48e-01	3.576e-01	3.04e-01	8.38e-03	6.34e-01	5.32e-02
36	9.573e-01	4.52e-01	1.06e-02	5.38e-01	3.488e-01	3.07e-01	8.47e-03	6.31e-01	5.34e-02
37	4.777e-01	4.53e-01	1.06e-02	5.37e-01	1.736e-01	3.07e-01	8.47e-03	6.31e-01	5.34e-02
38	9.544e-01	4.57e-01	1.08e-02	5.32e-01	3.443e-01	3.09e-01	8.51e-03	6.29e-01	5.36e-02
39	4.753e-01	4.60e-01	1.09e-02	5.29e-01	1.704e-01	3.10e-01	8.53e-03	6.28e-01	5.37e-02
Total	2.655e+02	4.01e-01	8.90e-03	5.91e-01	1.059e+02	2.88e-01	8.00e-03	6.52e-01	5.24e-02

4.2.4 Comparisons

4.2.4.1 Introduction

In this section comparisons of a few key calculated quantities will be presented for the BOL, depletion, and EOL cases. These key quantities include k_{eff}, power density distributions, and actinide inventories. The additional reported quantities, such as reaction rates, can be used to help explain the observed differences. Comparisons of all the results will not be presented.

Results for the different energy-group structure libraries for each code system will be presented to address the applicability of the libraries. Next, intercode comparisons will be presented for the reference calculations. For the intercode comparisons, the HELIOS 190-group results were chosen as the reference. The reason for this choice is to provide a consistent reference throughout all of the comparisons.

4.2.4.2 Cross section library comparisons

In addition to the results presented in Sect. 4.2.3, calculations were performed with KENO and VENTURE using the SCALE ENDF/B-V 44-group library and with HELIOS using its 34- and 89-group libraries. Comparisons have been made with the reference calculations. In the case of KENO and VENTURE, the reference library is the SCALE 238-group ENDF/B-V library; in the case of HELIOS, the reference is the 190-group ENDF/B-VI library.

The results of the comparisons of k_{eff} for the BOL cases are presented in Fig. 4.4. These results show that the libraries with the smaller number of groups (i.e., SCALE 44-group and HELIOS 89-group libraries) lead to substantial errors in k_{eff}. For the BOL cases, the errors range from about 0.4% to almost 0.8% in k_{eff}. The HELIOS 89-group library gives acceptable results with an almost constant 0.2% bias in k_{eff}. The comparison of k_{eff} values for the multicycle depletion calculation are presented in Fig. 4.5. This figure shows large errors for the SCALE 44-group library from the beginning of the irradiation through about 30 MWd/kg. Similarly, the HELIOS 34-group library shows large errors near the start of irradiation.

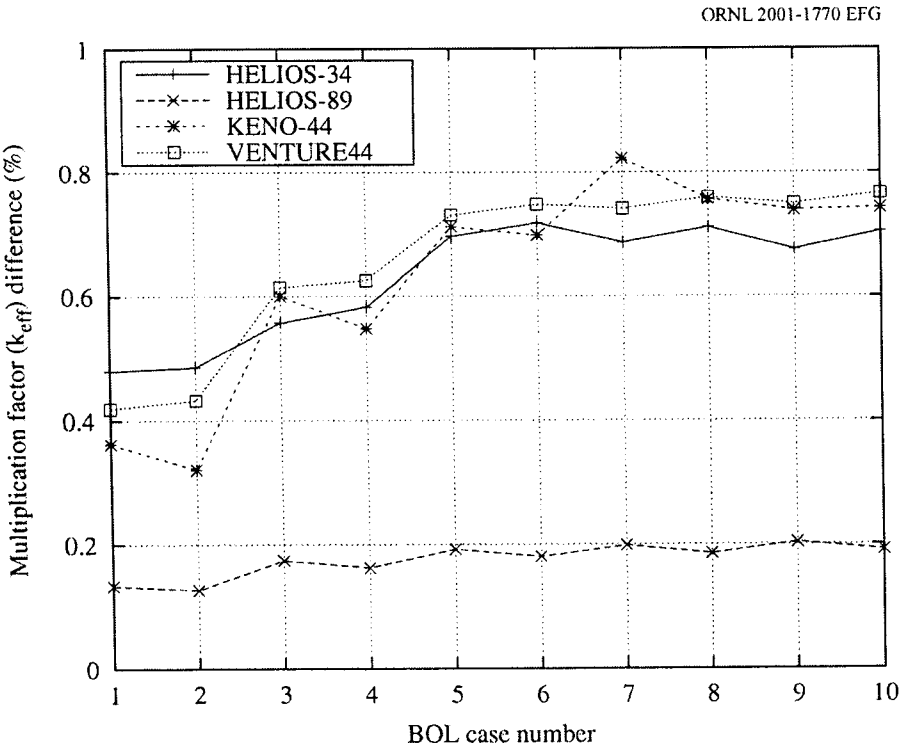


Fig. 4.4. Comparison of multiplication factors between different energy-group libraries for BOL cases (HELIOS reference 190-group, KENO and VENTURE reference 238-group).

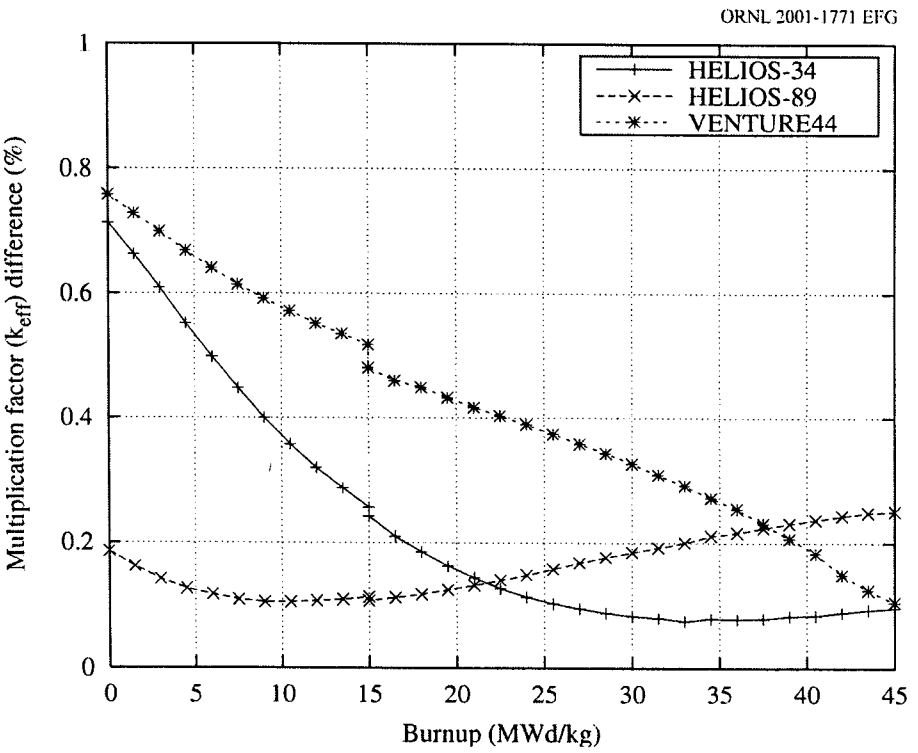


Fig. 4.5. Comparison of multiplication factors between different energy-group libraries (HELIOS reference 190-group, KENO and VENTURE reference 238-group).

The HELIOS 89-group library shows a relatively constant error of 0.2%, similar to the error in the BOL cases. Note that beyond about 20 MWd/kg, the HELIOS 34-group library appears to give better results than the HELIOS 89-group library. This is most probably because of a cancellation of errors.

The fact that the SCALE 44-group and HELIOS 34-group libraries do not perform well for weapons-grade MOX is not surprising. These libraries were collapsed using a neutron energy spectrum that is typical of a LWR with uranium fuel, which is softer than that of weapons-grade MOX fuel. In the case of the BOL calculations, the 44- and 34-group libraries give results with a very similar level of error.

4.2.4.3 BOL calculation comparisons

Calculations of the BOL cases were performed with KENO, VENTURE, and HELIOS. A comparison of the k_{eff} values are presented in Fig. 4.6. As this figure shows, there is excellent agreement among the results; the KENO and HELIOS results agree within 0.1%, and the VENTURE and HELIOS results agree within 0.2%. The VENTURE calculations, however, show a definite trend that corresponds to the presence of burnable absorber rods.

The maximum and average absolute-difference in the computed power density distributions are shown in Fig. 4.7. The maximum KENO differences are around 1%, while the VENTURE maximum errors are typically about 0.75%. The larger apparent differences in the KENO power densities are the results of the statistical uncertainties (about 0.5%). The average differences in power densities are almost identical for both VENTURE and KENO and are less than 0.5%.

4.2.4.4 Multicycle depletion comparisons

Calculations of the multicycle depletion case were performed with VENTURE and HELIOS. A comparison of the k_{eff} values as a function of burnup is given in Fig. 4.8. This figure shows that the largest difference in k_{eff} occurs near 32 MWd/kg with the VENTURE model underestimating k_{eff} by 0.8% in comparison to HELIOS results. The difference improves slightly at EOL to about 0.6%. Note that the perturbation in the k_{eff} difference at 15 MWd/kg is the result of the removal of the burnable absorber rods.

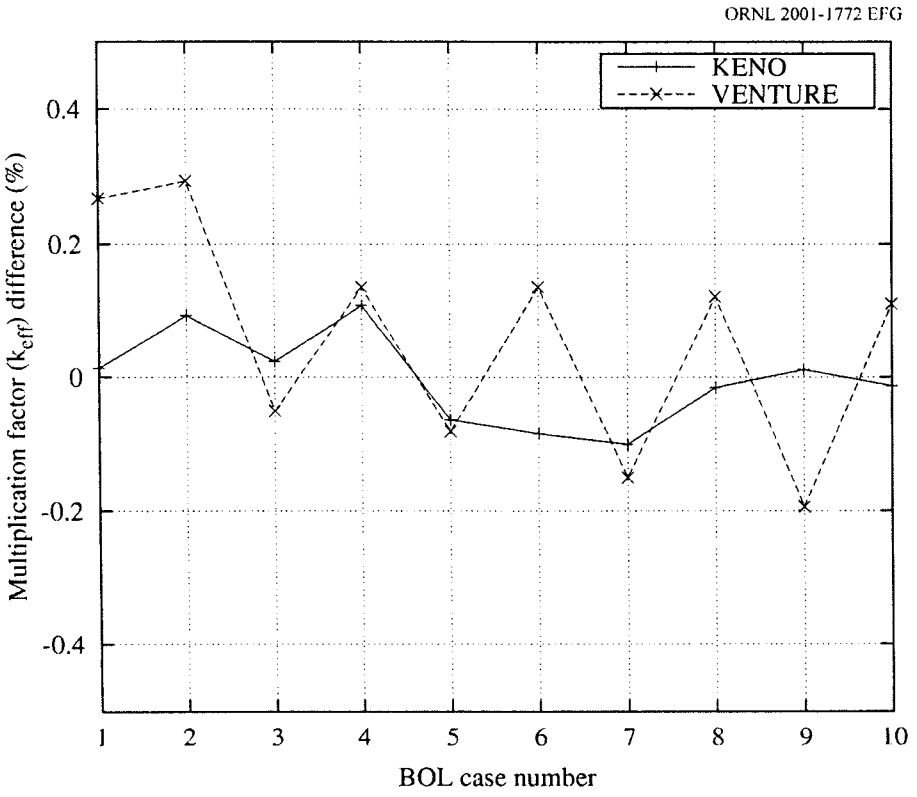


Fig. 4.6. Comparison of KENO and VENTURE to HELIOS multiplication factors.

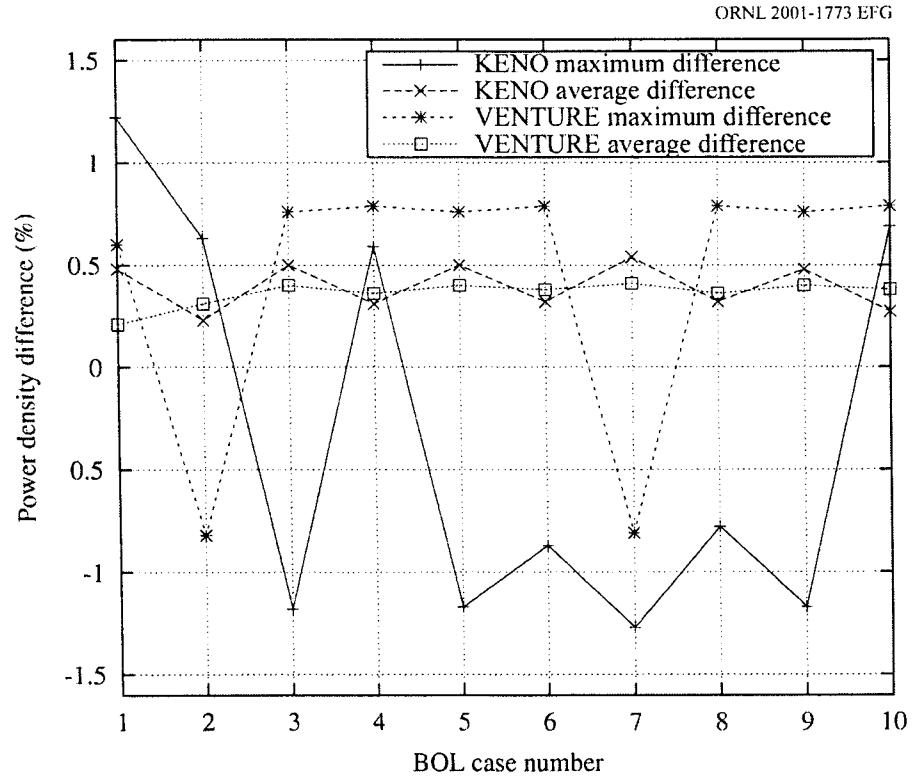


Fig. 4.7. Comparison of KENO and VENTURE to HELIOS relative pin power densities.

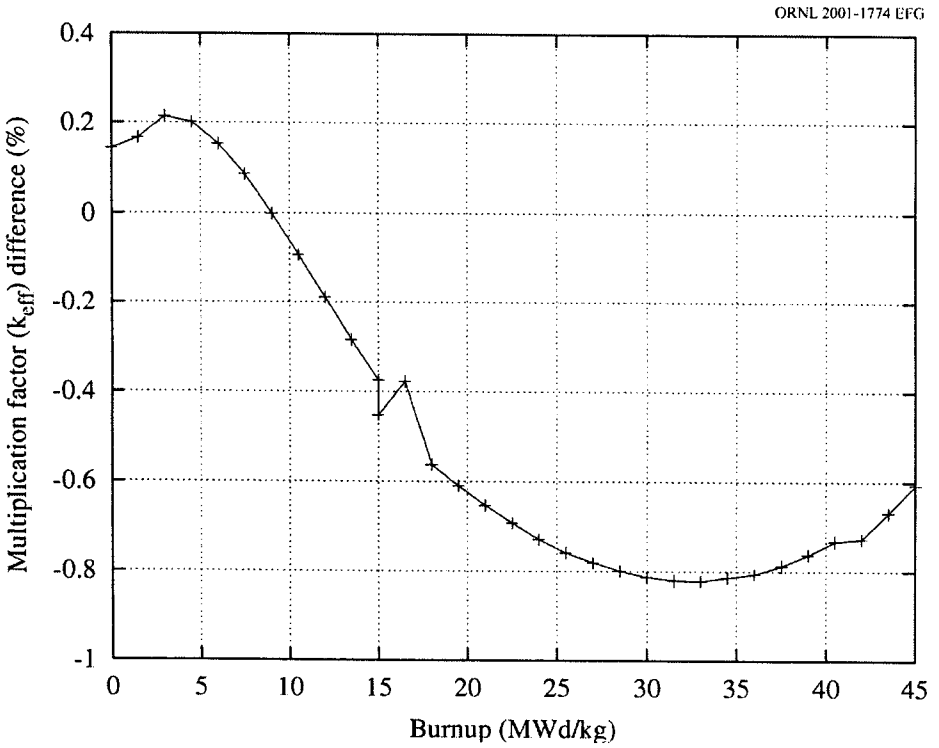


Fig. 4.8. Comparison of multiplication factors between HELIOS and VENTURE for the multicycle depletion calculation (HELIOS reference).

The maximum and average absolute difference in power density distribution is shown in Fig. 4.9. Before the removal of the burnable absorber rods, the maximum error is less than 1%, and the average error is less than 0.5%. After the removal of the burnable absorber rods, the differences increase slightly to about 1.5% maximum difference and 0.5% average difference.

A comparison of the inventories of neptunium, plutonium, americium, curium, and uranium are presented in Figs. 4.10–4.14. The comparisons are generally very good. As expected, the largest differences (approximately 25–30%) occur in the higher actinides (americium and curium) and are the results of an accumulation of differences in the lower actinides (uranium, neptunium, and plutonium).

4.2.4.5 EOL calculations

The k_{eff} values for the EOL cases were computed with VENTURE and HELIOS. A comparison of the k_{eff} values are presented in Fig. 4.15. The comparison shows an almost constant k_{eff} difference of 0.5%, which is consistent with that obtained at the end of the multicycle depletion. The cold cases (5–7) show slightly better agreement than the hot cases (1–4).

4.2.5 Summary and Conclusions

Calculations of the MOX PWR benchmark have been performed with the KENO, VENTURE, and HELIOS code systems. The results have been tabulated, and a comparison of key quantities has been performed.

A comparison of the different libraries shows that for unburned weapons-grade MOX, the SCALE 44-group ENDF/B-V library can lead to a large k_{eff} bias in comparison to the SCALE 238-group ENDF/B-V library. Similarly, the HELIOS 34-group ENDF/B-VI library shows a large bias in comparison to the HELIOS 190-group ENDF/B-VI library. The HELIOS 89-group ENDF/B-VI library, however, compares rather well with the HELIOS 190-group library.

An intercode comparison of the results computed with the reference libraries shows excellent agreement in k_{eff} and power density for the BOL cases computed with KENO, VENTURE, and HELIOS.

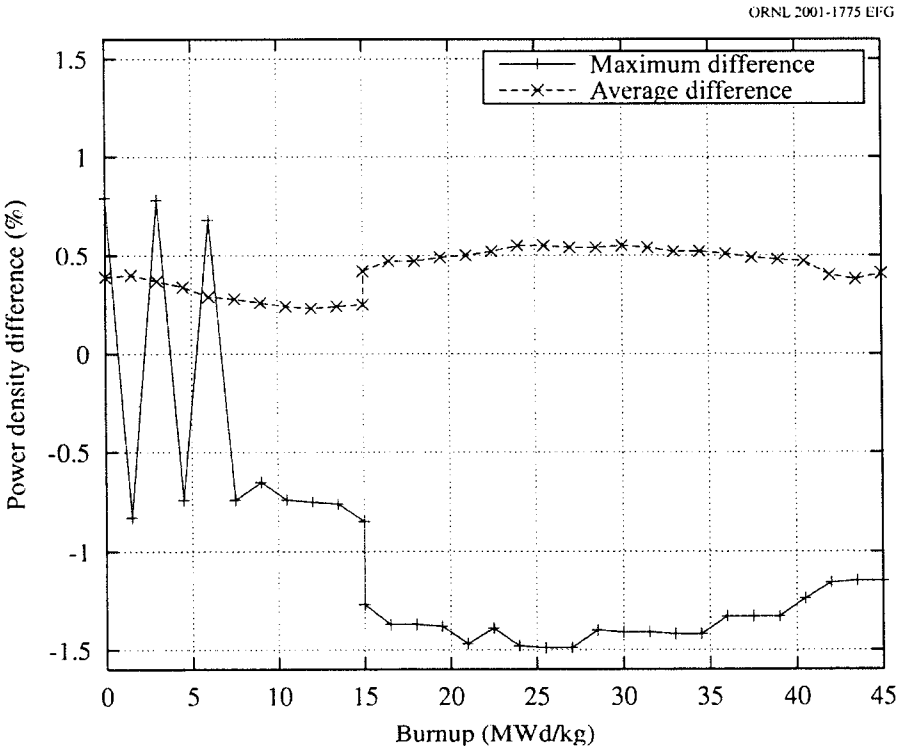


Fig. 4.9. Comparison of KENO and VENTURE to HELIOS relative pin power densities for the multicycle depletion calculation.

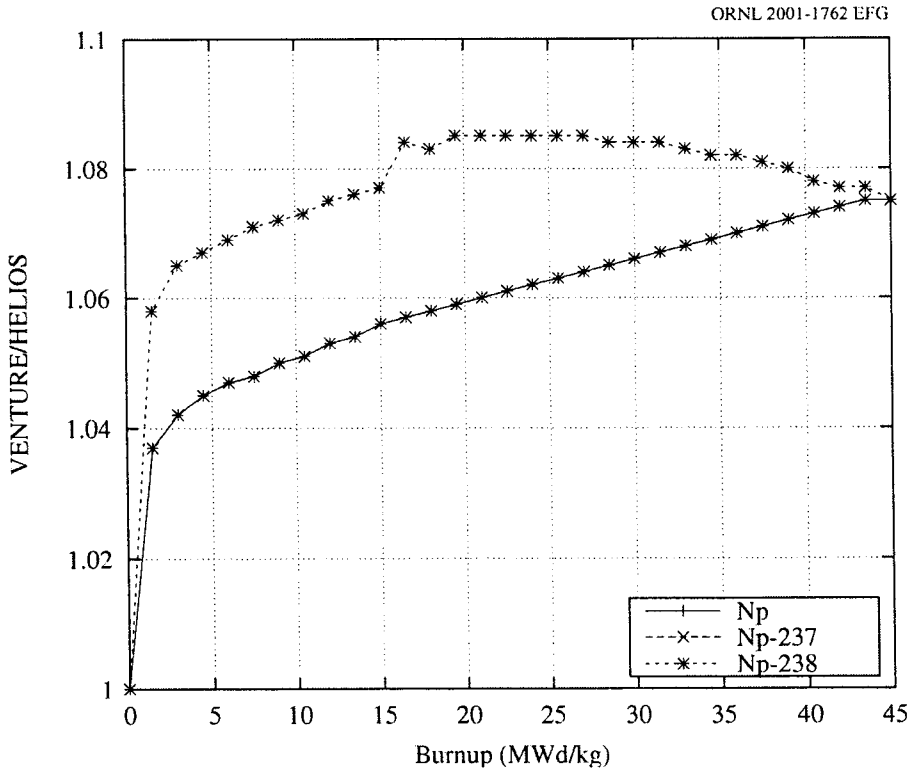


Fig. 4.10. Comparison of VENTURE to HELIOS neptunium inventories.

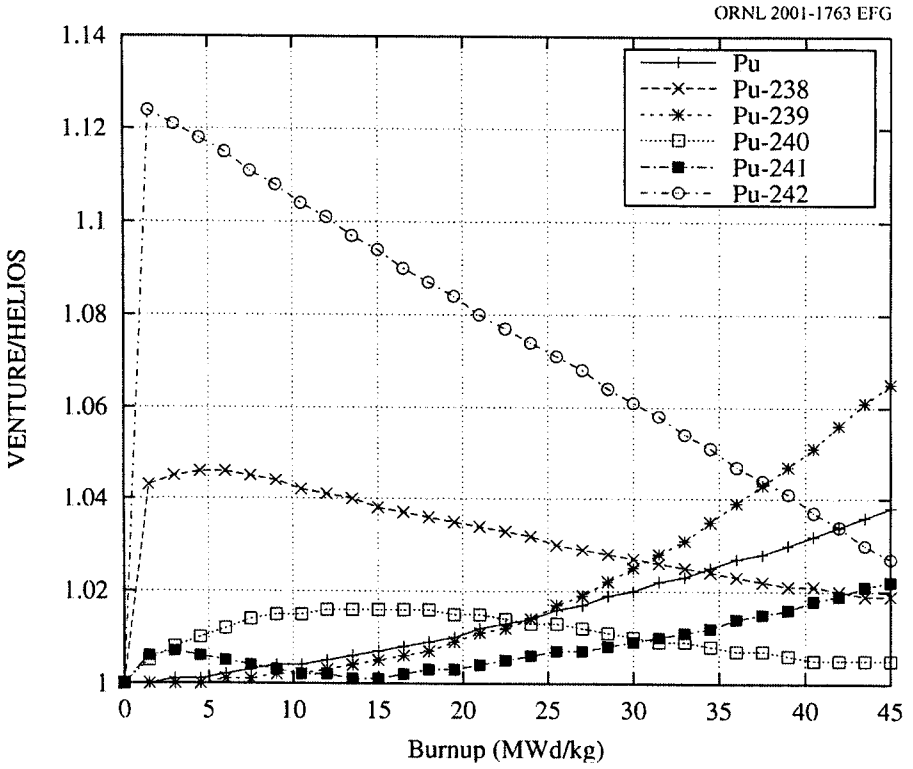


Fig. 4.11. Comparison of VENTURE to HELIOS plutonium inventories.

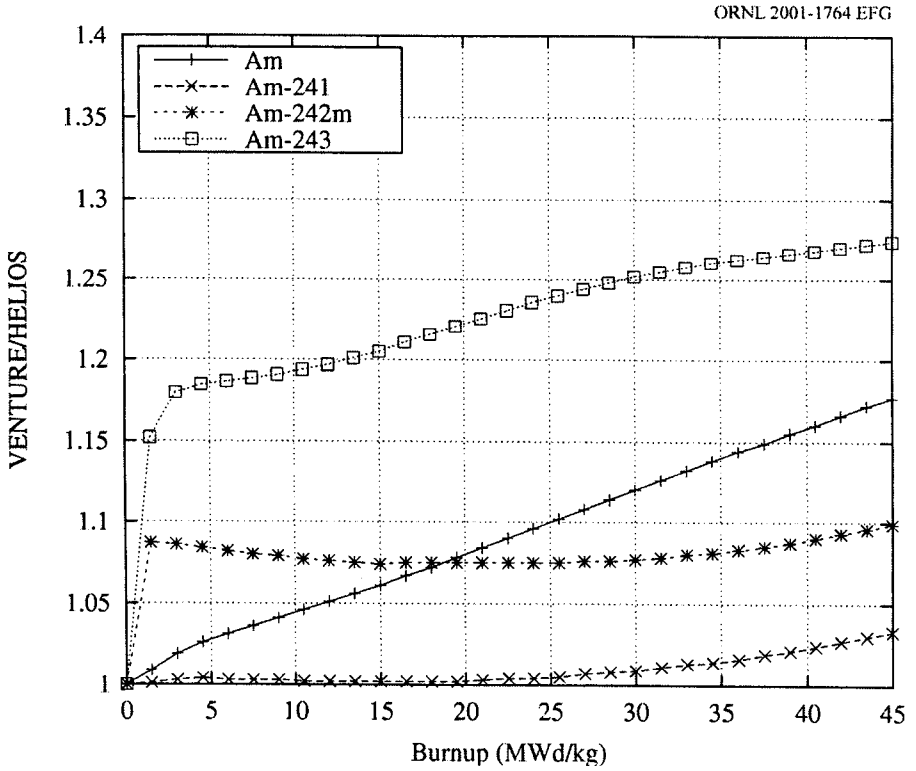


Fig. 4.12. Comparison of VENTURE to HELIOS americium inventories.

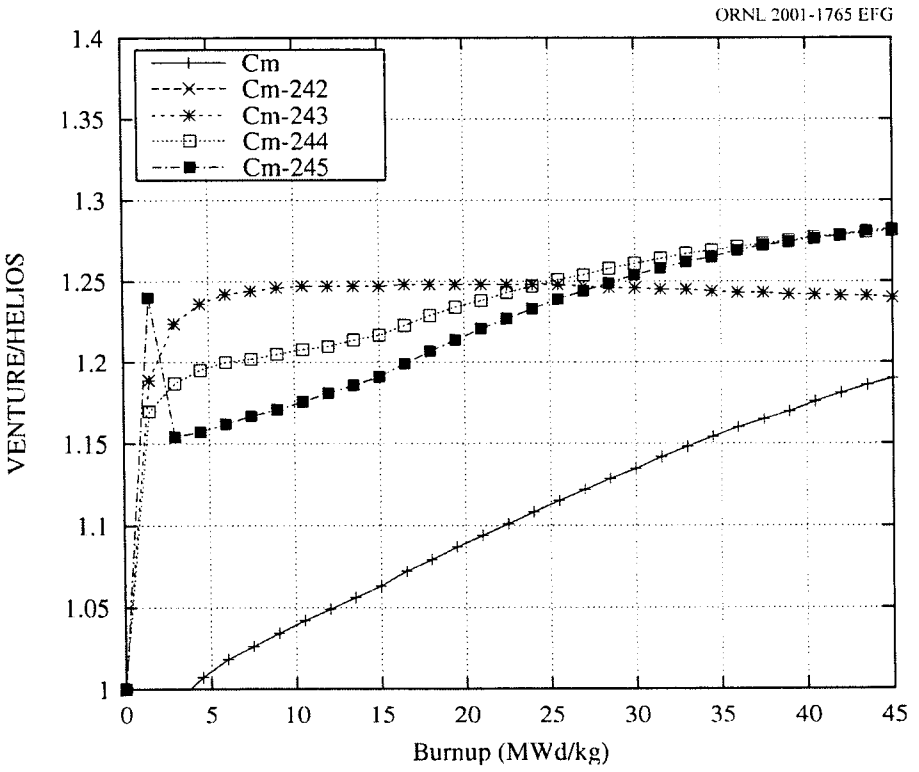


Fig. 4.13. Comparison of VENTURE to HELIOS curium inventories.

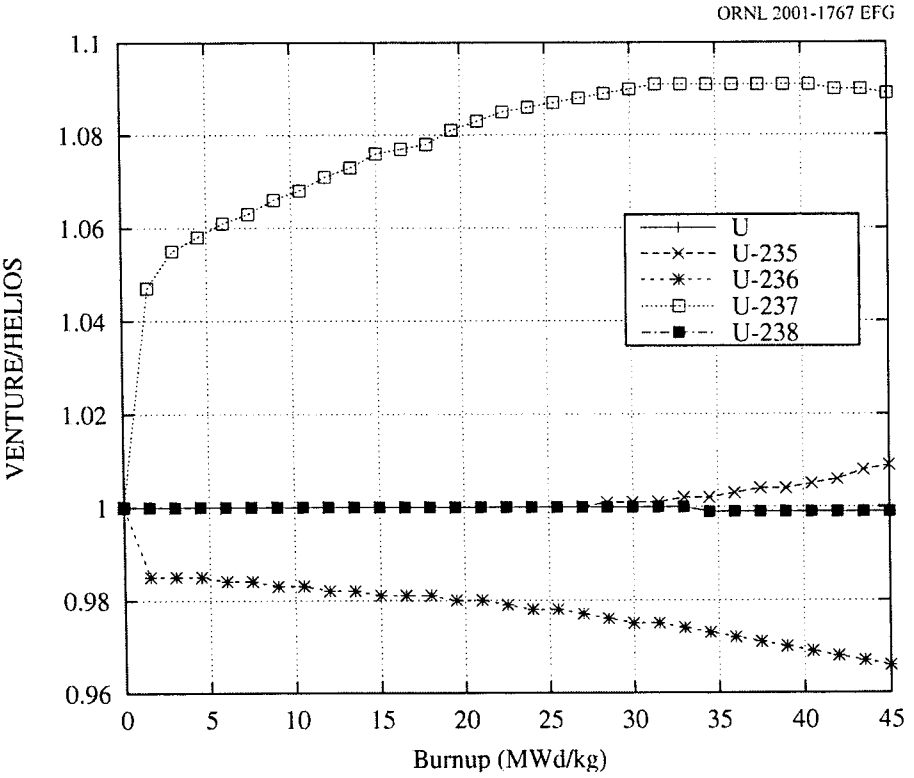


Fig. 4.14. Comparison of VENTURE to HELIOS uranium inventories.

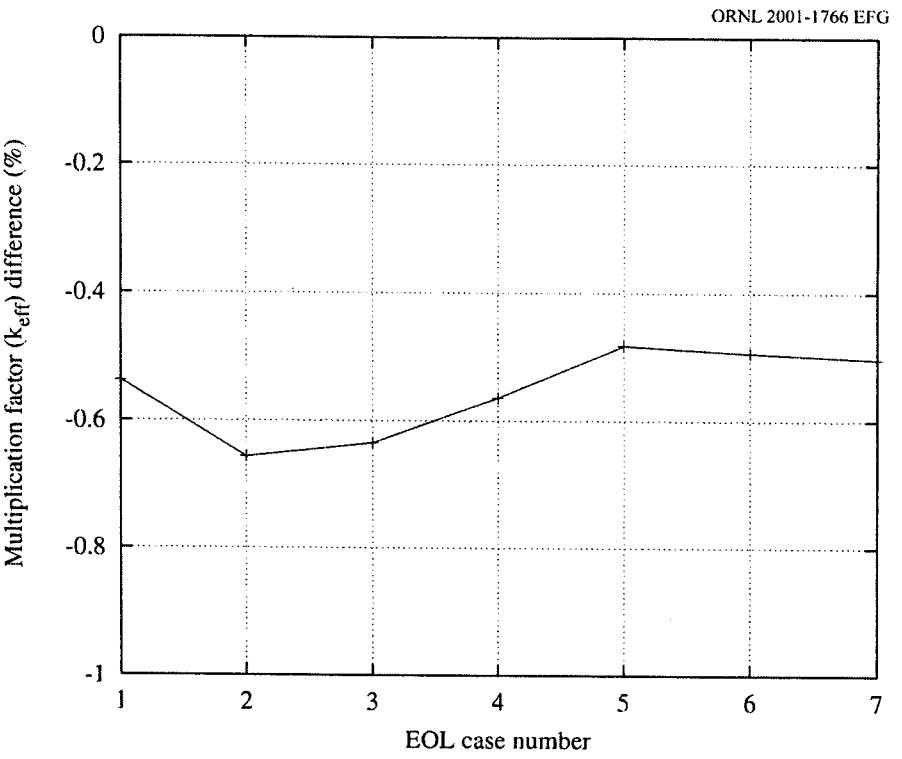


Fig. 4.15. Comparison of VENTURE to HELIOS multiplication factors for EOL cases.

The comparison of the multicycle depletion results indicates that the VENTURE calculation underpredicts k_{eff} by as much as 0.8% in comparison to HELIOS. The VENTURE- and HELIOS-calculated relative pin power densities compare well with maximum errors of about 1.5% and average errors of about 0.5%. Actinide inventories as a function of burnup were also compared for the HELIOS and VENTURE calculations. The results were generally good with the largest errors (25–30%) occurring in the higher actinides.

4.3 DESCRIPTION OF THE VVER 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. 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 4.72. Spent fuel specifications are given in Table 4.73.

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 three types (K331), and
- a multiassembly structure formed by assemblies of two types (MK2).

Table 4.72. 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 4.73. 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}		

The n-zones elementary cell C_n are

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. 4.16. 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

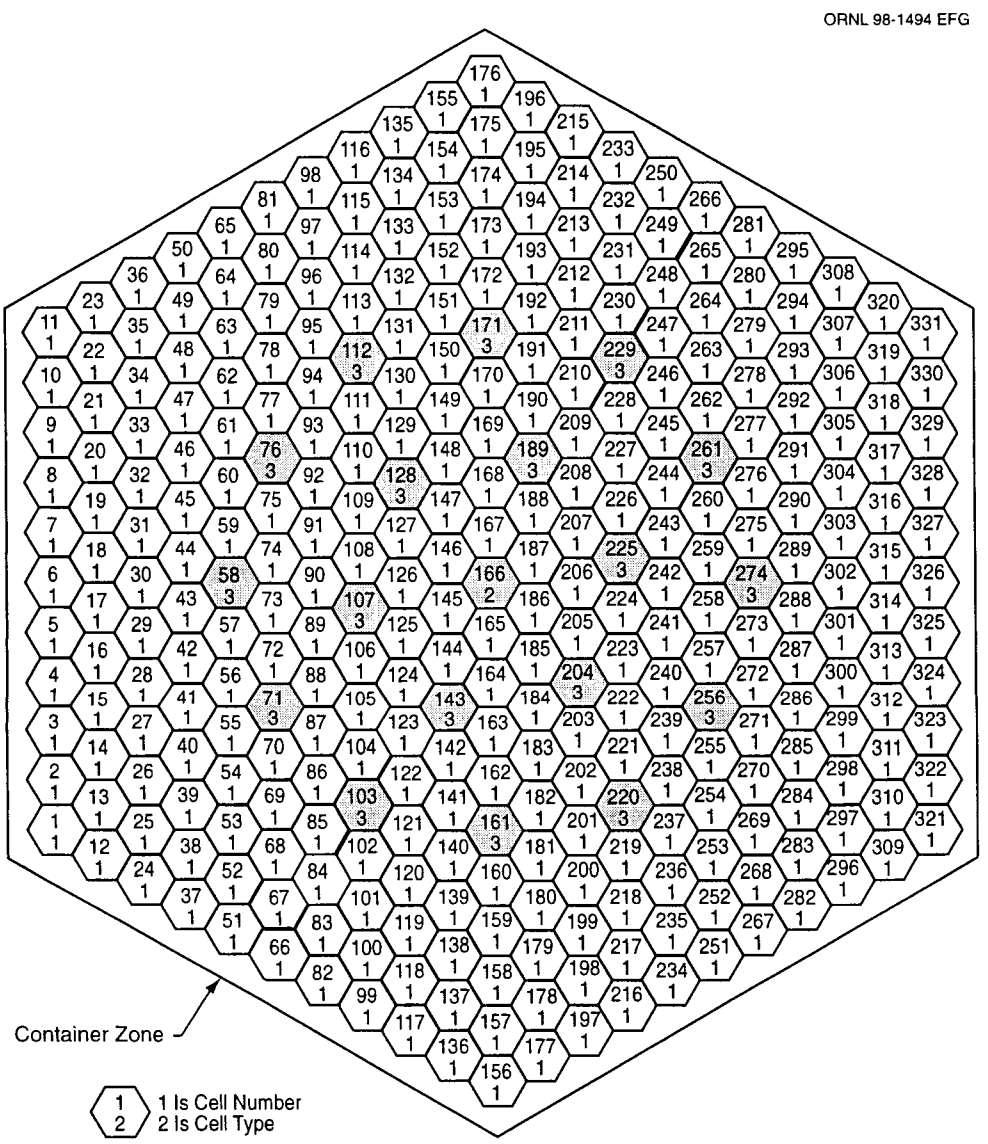


Fig. 4.16. Map of K331 assembly.

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 4.74.

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. 4.17).

4.3.3 Specification of Calculations to be Performed

Definition of the states to be calculated are given in Table 4.75. Definitions of the cases to be calculated (i.e., variants) are given in Table 4.76. Burnup calculations (with a power density equal to

Table 4.74. 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.

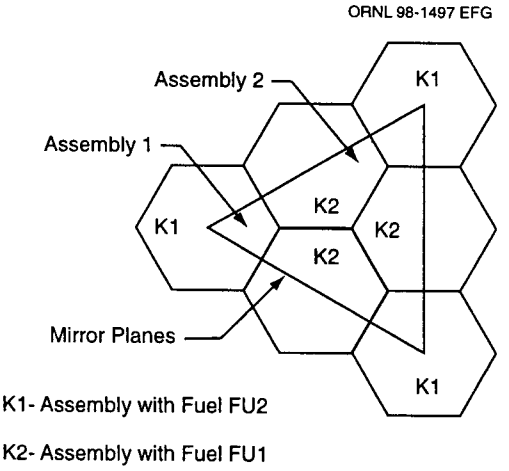


Fig. 4.17. MK2 multiassembly structure.

Table 4.75. State parameters for VVER computational benchmarks

State	Fuel zones temperature (K)	Nonfuel zones temperature (K)	Moderator material	Cell of type 3 (see Fig. 4.16)	^{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 atoms/(b•cm), $\rho(^{149}Sm)$ = 7.3667E–8 atoms/(b•cm); at nonzero burnup points—equilibrium concentrations.

Table 4.76. Set of calculation variants[a]

Variant	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 4.76.
2. Data in parentheses ( ) correspond to state S2.

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.

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 FPs in fuel (for geometry type K331 in cells numbered 1, 29, and 72); and
- 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); and
- 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 FPs, 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 4.77. The list of variants calculated is given in Table 4.78.

Table 4.77. 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 4.78. 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 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 SCALE-KENO Computational System (M. D. DeHart)

The calculations performed in this study are based on problem specifications provided in Sect. 4.3. The 11 variants are defined with 6 operational states desired for each variant. However, during the time period allowed for computation, two of these variants were insufficiently defined for computation. In addition, one of the specified states was found to be redundant for certain variants. Finally, some variants specified only a single criticality calculation, while others requested multistep depletion calculations with a criticality calculation performed at each step. Thus for clarity, Table 4.79 is provided to illustrate the cases for which results are reported in this section.

Table 4.79. Variants and states calculated at ORNL using SCALE

Variant No.	State 1	State 2	State 3	State 4	State 5	State 6
1	D[a]		D	D	D	D
2	D		D	D	D	D
3	C[b]		C	C	C	C
4	C		C	C	C	C
5						
6						
7	C		C	C	C	C
8	C		C	C	C	C
9	C		C	C	C	C
10	D		D	D	D	D
11	D	D	D	D	D	D
12	D	D	D	D	D	D
13						C

[a]D—Criticality and depletion calculations performed for 0 to 60 GWd/MT uranium in 2-GWd/MT steps
[b]C—Criticality calculation was performed for initial isotopics only, with no depletion calculations.

4.4.1.1 Computational procedure

Calculations reported here were performed using the SCALE 4.3 and the SCALE 44-group ENDF/B-V library. Specifically, ORNL's version that was identified as 4.3r and maintained under configuration control at ORNL was used. Problems were solved on an IBM RS-6000/580 class machine. Criticality calculations were performed using the CSAS26 sequence of SCALE, which invokes the Monte Carlo code KENO-VI for k_{eff} calculations. Depletion calculations were performed using SCALE's SAS2H sequence. The calculational process used an iterative procedure, alternately invoking CSAS26/KENO-VI for a transport solution and SAS2H for depletion calculations. The following subsections briefly describe the KENO-VI and SAS2H models used.

CSAS26 model

The CSAS26 sequence in SCALE automates the process of cross-section processing prior to a KENO-VI calculation. This sequence invokes BONAMI and NITAWL to perform resonance calculations necessary to generate a problem-dependent, multigroup, cross section library for KENO-VI. For Variants 1 through 10, the model used in these calculations was based on a single hexagonal pin-cell with reflective

boundary conditions on each side of the hexagon as shown in Fig. 4.18. For Variants 11 and 12, a hexagonal assembly model was developed, also with reflective boundary conditions on all radial boundaries. This model is illustrated in Fig. 4.19. Finally, Variant 13 was based on a single MOX assembly surrounded by six one-third hexagonal UO_2 assemblies, as shown in Fig. 4.20. All variants were based on an axial fuel length of 51.35 cm, a value that approximates a system with a 0.003-cm^{-2} axial buckling. In the computational models, the fuel was modeled as a 25.675-cm half-length rod or assembly with a reflective boundary condition at the top (core midplane) and a vacuum boundary condition at the bottom.

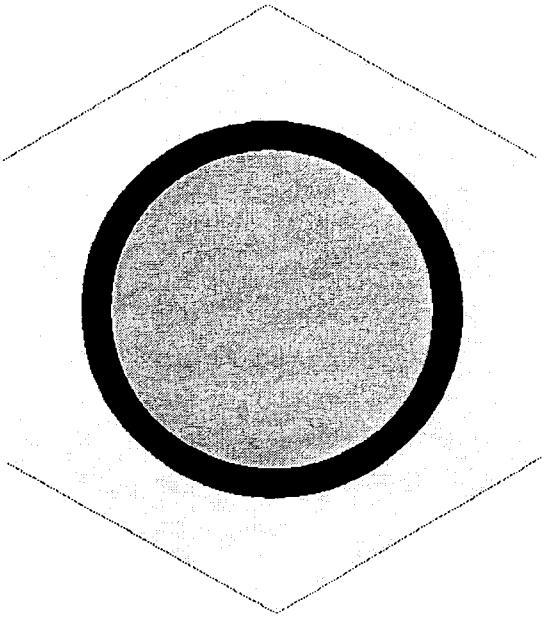


Figure 4.18. Pin-cell model applied in KENO-VI calculations for Variants 1–10.

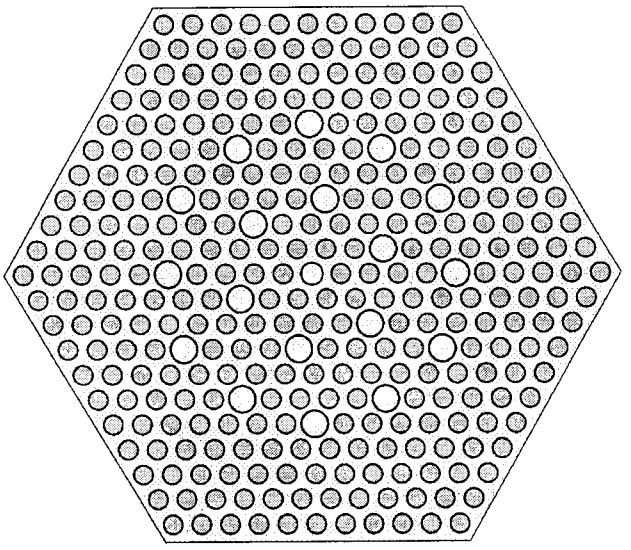


Figure 4.19. Single-assembly model applied in KENO-VI calculations for Variants 11–12.

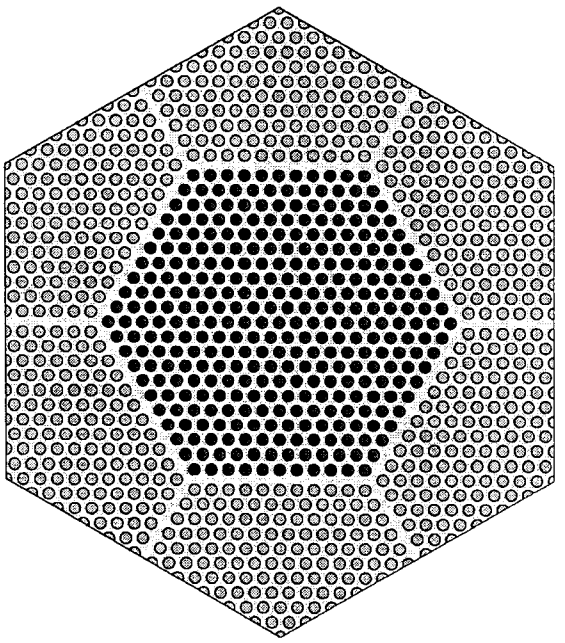


Figure 4.20. Multiassembly model applied in KENO-VI calculations for Variant 13.

For generation of spatially-dependent cross sections from the depletion calculations in Variants 11 and 12, it was assumed that the fuel could be represented by six different regions of uniform fuel composition. Specifically, rather than attempt to perform pin-by-pin depletion, depletion calculations were performed using six different fuel types, each representing all of the fuel pins in a particular region of the core. Figure 4.21 illustrates the six fuel groups used to represent the core. However, although only six fuel

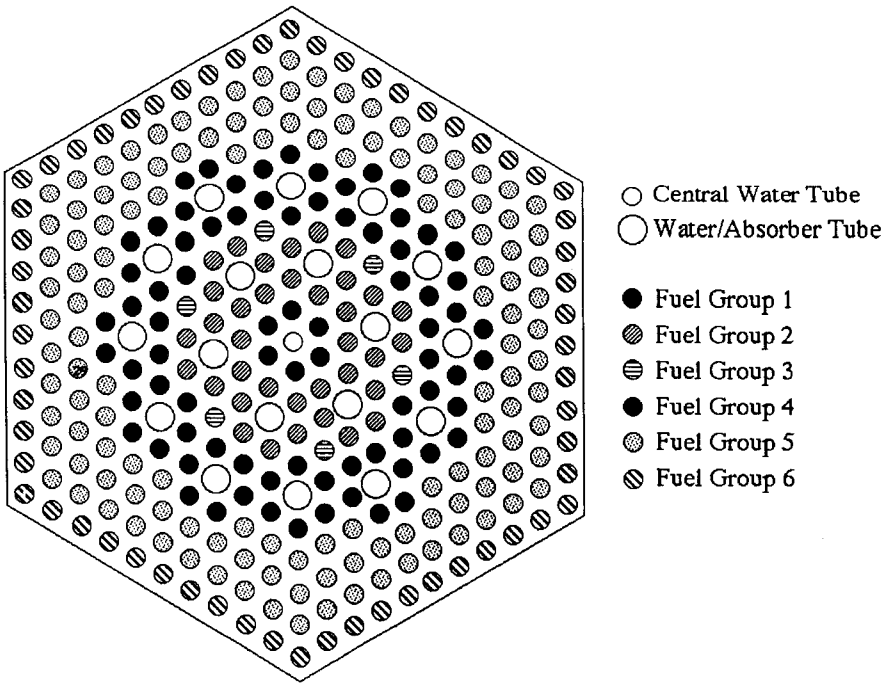


Figure 4.21. Fuel zones used in depletion modeling of Variants 11 and 12.

groups were used to represent fuel composition in the core (and consequently six sets of cross section data), individual pins were modeled in the KENO-VI input description so that pin-by-pin fluxes could be computed. The hexagonal core is comprised of 331 hexagonal cells; however, it was noted that the full core could be divided into 6 identical regions, each comprised of 56 hexagonal cells. Cell fluxes for each of the 56 unique positions were computed by averaging fluxes over each of the corresponding one-sixth core locations.

A utility code (DUSKVVER—**D**epletion **U**sing **S**AS2H and **K**ENO-VI for **VVER**) was developed to automate the process of coupling SAS2H and KENO-VI to perform assembly calculations. A flowchart of the logic built in to DUSKVVER for the single-pin depletion required in Variants 1, 2, and 10 is illustrated in Fig. 4.22. Similarly, Fig. 4.23 shows the logic and program flow required for the multipin depletion approach required for Variants 11 and 12.

Criticality calculations are limited to a subset of all nuclides physically present in spent fuel. Based on experience obtained in the modeling of reactor depletion with the SCALE system, a set of 66 nuclides were used to represent fuel composition, consisting of 16 actinides, 49 FPs, and oxygen. The nuclides included are listed in Table 4.80. For fresh fuel calculations, the nuclides given in the benchmark specification were included at the given density; the remaining nuclides were included at a density of 10^{-20} atoms/barn-cm so that cross sections were available for cell-weighted one-group cross sections.

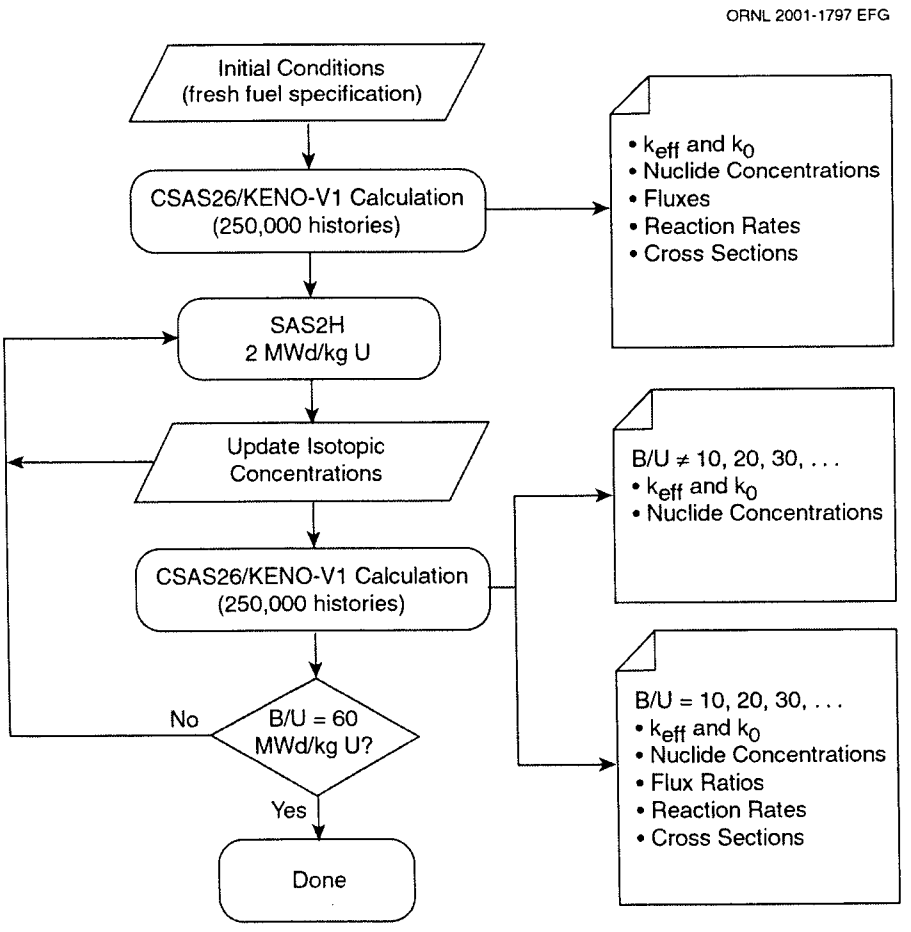


Figure 4.22. Calculational flowchart for pin-cell depletion models of Variants 1, 2, and 10.

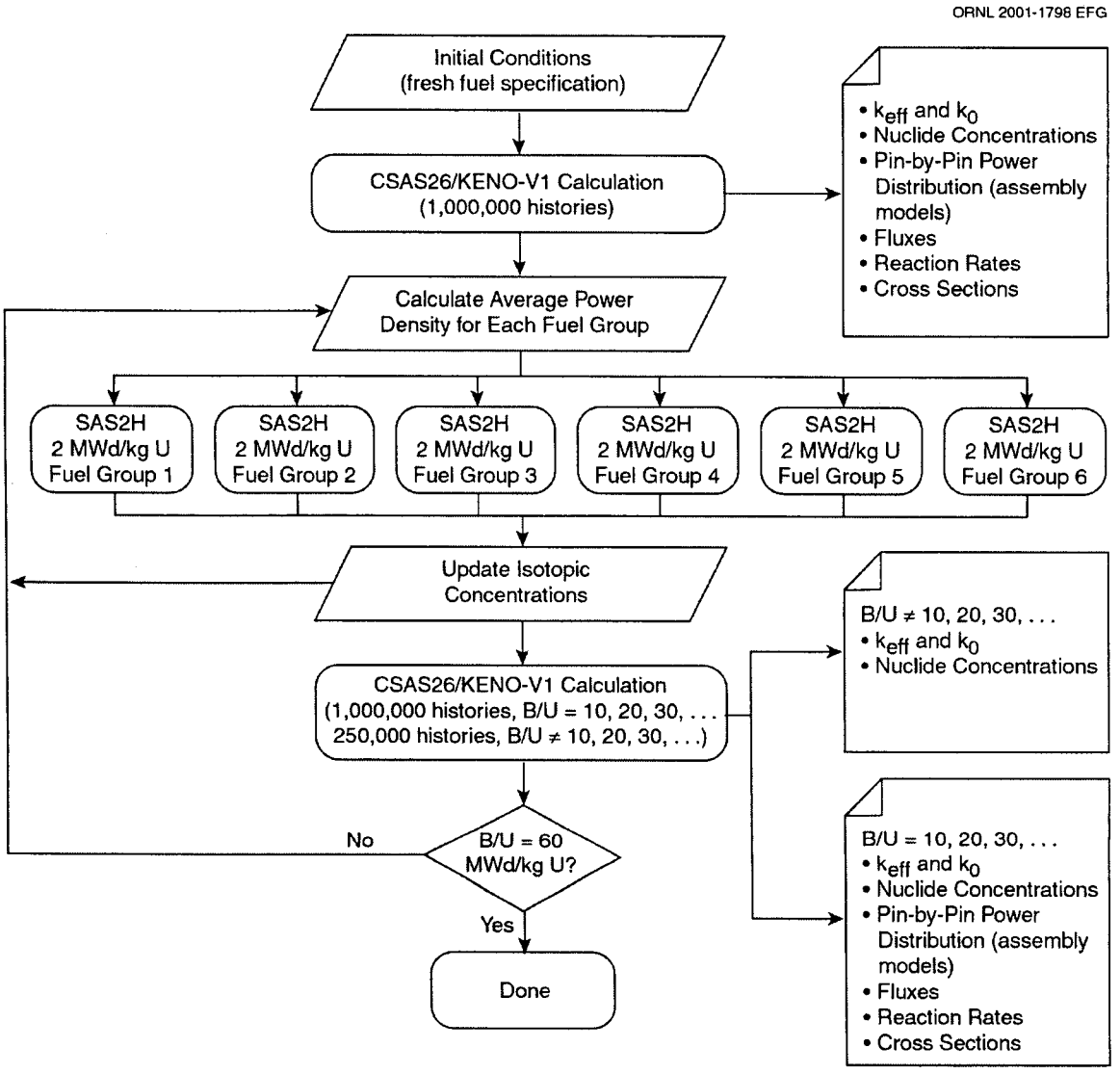


Figure 4.23. Calculational flowchart for multipin depletion models of Variants 11 and 12.

Table 4.80. Nuclides included in criticality calculations

^{234}U	^{235}U	^{236}U	^{238}U	^{237}Np
^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
^{241}Am	^{242m}Am	^{243}Am	^{242}Cm	^{243}Cm
^{244}Cm	^{83}Kr	^{85}Kr	^{89}Y	^{90}Sr
^{94}Nb	^{95}Mo	^{93}Zr	^{94}Zr	^{95}Zr
^{99}Tc	^{103}Rh	^{105}Rh	^{101}Ru	^{103}Ru
^{106}Ru	^{105}Pd	^{108}Pd	^{109}Ag	^{124}Sb
^{135}I	^{131}Xe	^{132}Xe	^{135}Xe	^{136}Xe
^{133}Cs	^{134}Cs	^{135}Cs	^{137}Cs	^{136}Ba
^{139}La	^{141}Pr	^{143}Pr	^{144}Ce	^{143}Nd
^{145}Nd	^{147}Nd	^{148}Nd	^{147}Pm	^{148}Pm
^{149}Pm	^{147}Sm	^{149}Sm	^{150}Sm	^{151}Sm
^{152}Sm	^{153}Eu	^{154}Eu	^{155}Eu	^{155}Gd
^{16}O				

Note that for State 6 calculations, nuclides ^{135}Xe and ^{149}Sm were omitted, as specified in the benchmark description. Additionally, although many of these nuclides are not important in terms of their reactivity worth in spent fuel, they are important for accurate depletion modeling (as described later in Sect. 4.4.2.2) and are included in the criticality model simply for consistency.

SAS2H models

The SAS2H sequence links the BONAMI, NITAWL-II, COUPLE, XSDRNPM, and ORIGEN-S codes to automate depletion modeling of fuel assemblies. SAS2H uses a two-pass approach: the first pass is used to calculate weighted cross sections for a single 1-D pin cell; the second pass performs depletion calculations using fluxes computed for an expanded pin-cell. The expanded pin cell, although still a 1-D approximation, allows the user to treat the effects of the nonuniform lattice (e.g., water holes). For single-pin depletion (Variants 1, 2, and 10), both passes are based on the same pin-cell model. For the larger assembly calculations, this pin-cell model was applied in the first pass only; the second pass model accounted for the nonfuel structure associated with each fuel-pin type. As described earlier and as shown in Fig. 4.21, six fuel types were identified. Each fuel group was selected as a collection of fuel pins having roughly the same local conditions; local conditions of a given pin were defined by its immediate neighbors and its position relative to the center of the assembly. Each SAS2H assembly model was developed based on the local conditions for each group. For group 1, the model assumed an infinite lattice comprised of six fuel cells for each central water tube; similarly, groups 2 and 4 were based on a lattice comprised of six fuel cells for each vacant (water-filled) absorber tube; groups 3 and 5 were modeled as an infinite lattice of pin cells; and group 6 was modeled as an infinite lattice of pin cells with an extra moderator region to account for interassembly spacing.

Following each KENO-VI calculation, the specific power for each fuel group was calculated by averaging the fission densities of all fuel pins in each fuel group. The average was then renormalized such that the core-averaged specific power remained constant at the value specified in the benchmark description. Each depletion case was run for a single step of 2 MWd/kg of uranium, using as a starting point the isotopic concentrations obtained from the previous depletion calculation for that fuel group (or by fresh-fuel specifications for the first depletion case).

The ORIGEN-S depletion calculations use the more than 1500 nuclides included in the ORIGEN-S data libraries. However, to improve accuracy, specific nuclides may be specified in the SAS2H input for burnup-dependent updating by using assembly fluxes at each burnup step. Many important nuclides are automatically updated by SAS2H; however, other nuclides must be explicitly specified. Table 4.80 includes all nuclides that are thought to require cross-section updating in reactor fuel depletion modeling. Thus, all of the nuclides listed in Table 4.80 are also included in SAS2H input files. Note, however, that

depletion of oxygen is not tracked in the SAS2H models, and it is assumed to remain at its initial concentration for all burnup steps.

4.4.1.2 Results of computations

For all depletion calculations, values of k_{eff} and k_0 (k-infinity computed with a buckled spectrum) were reported at burnup intervals of 2 MWd/MT of uranium. The migration area (M^2) was not reported because this value is not readily computed from the results of a KENO-VI calculation. Also reported at each 2-MWd/kg uranium burnup step for State 1 were depletion calculations; concentrations of ^{235}U, ^{236}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{135}Xe, ^{149}Sm; and "Total Fission Products." "Total Fission Products" concentrations were computed as the sum of all nuclide concentrations for all 49 fission products listed in Table 4.80.

Additional data were requested for State 1 depletion calculations for burnups of 0, 10, 20, 30, 40, 50, and 60 MWd/kg of uranium. Furthermore, for Variants 11 and 12, a pin-by-pin power distribution was given at each interval. The power distribution was determined from fission densities computed by KENO for each pin location; each fission density has an associated one standard deviation error of roughly 1% (for 1,000,000 neutron histories). Pin powers (fission densities) were normalized for an average power of 1.0 across the assembly. Cell fluxes and one-group macroscopic cross sections were computed for the single pin in Variants 1, 2, and 10 and for pins 1, 29, and 72 in Variants 11 and 12. Macroscopic cross sections Σ were computed using the formula:

$$\Sigma = \sum_R \frac{\sum_{g=1}^{G} \phi_g^R \sum_{n_R} N_{n_R}^R \sigma_{g,n_R}^R}{\sum_{g=1}^{G} \phi_g^R},$$

where R represents fuel, clad, and moderator; G = 44; n_R represents the 66 nuclides of Table 4.80 for fuel, zirconium (clad), H, O, ^{10}B, and ^{11}B for the moderator; and $N_{n_R}^R$ is the number density of nuclide n in region R. Note that summing over all regions was performed only for absorption, because σ_f is 0.0 for clad and moderator nuclides. One-group microscopic cross sections were determined for nuclides ^{235}U, ^{236}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{135}Xe and ^{149}Sm by the formula:

$$\bar{\sigma} = \frac{\sum_{g=1}^{G} \phi_g \sigma_g}{\sum_{g=1}^{G} \phi_g}.$$

The effective "Total Fission Products" microscopic cross-section was computed as

$$\bar{\sigma}_{FP} = \frac{\sum_{g=1}^{G} \phi_g \dfrac{\sum_n N_n \sigma_{g,n}}{\sum_n N_n}}{\sum_{g=1}^{G} \phi_g},$$

where n represents all 49 FPs listed in Table 4.80. Finally, reaction rates for each of these nuclides were computed as:

$$RR = N\overline{\sigma} \ .$$

Table 4.81 lists multiplication factors computed for all variants and states. All reported values of k_{eff} have a corresponding uncertainty of ±0.0016 or less. For Variants 1, 2, and 10–12, for which depletion calculations were performed, k_{eff} values are listed in intervals of 10 MWd/kg of uranium for the full depletion range of 0 to 60 MWd/kg of uranium. Full results for all variants and states are listed in Appendix A, in the form of DUSKVVER output. The form of the output varies for each variant and state, depending on the information requested for each in the original problem specification.

4.4.1.3 DUSKVVER output

Appendix A provides the output of the utility code DUSKVVER for each of the variants and states considered in these analyses. Depending on the output requirements provided in the problem specification, the results for each variant/state combination will range from terse to verbose. All output listings are provided; the current case description (variant and state) is listed in a header at the top of each page to facilitate identification of the case output.

4.4.2 Diffusion Theory Calculations Using VENTURE (I. Remec, J. J. Yugo, and J. D. Drischler)

Variants 11, 12, and 13 were calculated with the diffusion-theory-based program, BOLD VENTURE (simply referred to as VENTURE).

4.4.2.1 Cross-section preparation for the VENTURE calculations

The VENTURE calculations used the cross sections from the SCALE 44-group ENDF/B-V based cross-section library. The version of SCALE was 4.3r, the archived, configuration-controlled version for FMDP studies. The main SCALE modules used in the cross-section processing were CSASN and XSDRNPM. The module CSASN runs BONAMI and NITAWL-II and generates a working format resonance-corrected cross-section library. XSDRNPM was used to perform 1-D discrete ordinates cell calculations in cylindrical geometry, and the fluxes from the cell k_{eff} calculations were used to cell-weight the microscopic cross sections, which were used in VENTURE. Three cell models were used: a fuel cell, an instrument tube supercell, and a BP supercell. To take into account the change of fuel isotopics with burnup, the cross sections were regenerated after each burnup step in VENTURE, which was typically 2 MWd/kg (U + Pu). VENTURE provided pin-by-pin isotopics; however, for the purpose of cross-section preparation, all the fuel cells in the fuel assembly model were grouped together and the average isotopic composition was calculated. This average composition was then used to prepare the microscopic cross sections for the fuel cell.

To automate the procedure of cross-section generation, a FORTRAN code was written that reads the nuclide densities calculated by VENTURE, calculates averages over the ranges of zones (e.g. fuel cells), and prepares new input for SCALE modules BONAMI, NITAWL, and XSDRNPM. A script is then used to cycle through this code, SCALE, and VENTURE until the desired burnup is reached.

4.4.2.2 VENTURE geometric model

In support of the benchmark calculations of the VVER reactor with the BOLD VENTURE code system, a set of subroutines was built to assist in the creation and checking of geometrical models. The benchmark VVER fuel assembly model matched closely the specifications mutually agreed to by Russian and U.S. participants and is shown in Fig. 4.16, hereafter referred to as the generic fuel assembly model. VENTURE models for two geometrical variations were constructed. Variants 11 and 12 are portions of a single assembly with a single fuel type, either LEU or MOX. Rotational symmetry is invoked on two of the

Table 4.81. KENO-VI-computed values of k_{eff} for all variants and states

Variant	Burnup (MWd/kg U)	State					
		1	2	3	4	5	6
1	0	1.0617		1.1094	1.1021	1.1156	1.2166
1	10	0.9764		1.0186	0.9764	0.9909	1.0840
1	20	0.9098		0.9442	0.9098	0.9217	1.0102
1	30	0.8484		0.8828	0.8484	0.8598	0.9433
1	40	0.7986		0.8300	0.7986	0.8102	0.8824
1	50	0.7505		0.7845	0.7505	0.7633	0.8286
1	60	0.7097		0.7436	0.7097	0.7249	0.7809
2	0	1.0259		1.0482	1.0437	1.0606	1.1849
2	10	0.9231		0.9407	0.9231	0.9373	1.0330
2	20	0.8615		0.8845	0.8615	0.8744	0.9658
2	30	0.8124		0.8374	0.8124	0.8248	0.9102
2	40	0.7721		0.7995	0.7721	0.7847	0.8612
2	50	0.7386		0.7636	0.7386	0.7508	0.8192
2	60	0.7091		0.7362	0.7091	0.7238	0.7845
3	0	0.9140		0.9519	0.9491	0.9615	1.0572
4	0	0.8570		0.8897	0.8849	0.9013	0.9939
7	0	1.0983		1.1254	1.1169	1.1339	1.2544
8	0	0.9178		0.9620	0.9579	0.9755	1.0746
9	0	1.2918		1.3220	1.3134	1.3313	1.4396
10	0	0.9540		0.9656	0.9591	0.9754	1.0819
10	10	0.9181		0.9288	0.9181	0.9332	1.0265
10	20	0.8980		0.9078	0.8980	0.9117	1.0074
10	30	0.8785		0.8871	0.8785	0.8918	0.9847
10	40	0.8569		0.8707	0.8569	0.8727	0.9658
10	50	0.8406		0.8496	0.8406	0.8512	0.9453
10	60	0.8245		0.8324	0.8245	0.8372	0.9272
11	0	1.0685	0.8331	1.1238	1.1105	1.1230	1.2151
11	10	0.9876	0.7729	1.0345	0.9865	0.9993	1.0852
11	20	0.9126	0.7139	0.9599	0.9107	0.9236	1.0065
11	30	0.8465	0.6642	0.8916	0.8465	0.8591	0.9308
11	40	0.7867	0.6122	0.8315	0.7891	0.8001	0.8616
11	50	0.7342	0.5673	0.7767	0.7367	0.7452	0.7952
11	60	0.6807	0.5258	0.7239	0.6810	0.6905	0.7266
12	0	1.0429	0.8492	1.0744	1.0603	1.0773	1.1981
12	10	0.9288	0.7576	0.9558	0.9294	0.9412	1.0418
12	20	0.8628	0.6966	0.8923	0.8638	0.8750	0.9606
12	30	0.8070	0.6488	0.8365	0.8057	0.8193	0.8916
12	40	0.7580	0.6045	0.7886	0.7570	0.7706	0.8342
12	50	0.7186	0.5689	0.7516	0.7152	0.7282	0.7801
12	60	0.6825	0.5381	0.7183	0.6844	0.6936	0.7363
13	0						1.1702

boundaries. Variant 13 is a multiassembly model. The arrangement of MOX and LEU fuel assemblies for Variant 13 is shown schematically in Fig. 4.17.

The VENTURE geometrical models were constructed to provide the maximum flexibility within each model so that future calculations could be accommodated without creating new geometry models. To this end, more material types and groupings of overlay zones were built into the model than were actually used for this set of calculations. Ten materials were defined in the model to allow adjustments of material properties near structures that might be either imprecisely represented by the model or might be affected by the presence nearby objects. Principal differentiated regions follow:

1. In the central region, two rows of guide tubes encircle a central tube. Each of the three (i.e., central, middle, and outer) is assigned a separate material type, although they were all modeled as water in these cases.
2. Overlay zones adjoining each group of guide tubes are also assigned separate material types to allow adjustment of their material parameters, if necessary.
3. At the assembly edges, overlay zones in the corners of the assembly have a separate material type to allow compensation for their unique location with water boundary zones on three sides.
4. Other overlay zones bordering the water boundary of the assembly form another material type as does the water boundary itself.
5. The balance of the zones are defined as fuel with no special considerations due to their geometry or placement.

Figure 4.24 shows a generic fuel assembly model with material types identified. Table 4.82 lists the material types and descriptions in the generic fuel assembly model.

In the VENTURE code, the geometry option most closely matched to the actual geometry is the 120° triangular geometry option. This option models a parallelogram with a 120° lower right-hand corner that is the center of rotational symmetry. The parallelogram is covered with equilateral triangular elements which can be grouped into hexagonal subassemblies needed for the description of the fuel cells. Figure 4.25 shows this geometrical option as it was used in the VENTURE model for Variants 11 and 12 (single fuel assembly models).

Water Boundary

To most accurately represent the VVER fuel assembly in the VENTURE calculations, a layer of triangular elements, representing the water layer between adjacent assemblies, was incorporated into the model. These elements were grouped into a single overlay zone. Preliminary calculations, not reported on here, were based on VENTURE simulations that did not have this feature, but rather adjusted the material properties of edge assembly elements to account for the water present in adjacent regions in the actual assembly.

The cross-sectional area in the elements comprising the water boundary was found to be less than the actual water cross-sectional area by approximately 15%. This difference was compensated for by adjusting the material density of the water elements.

Symmetries

The generic VVER fuel assembly has a sixfold rotational symmetry of a 60° sector that can be exploited in the construction of a model. Figure 4.26 shows the smallest possible symmetrical sector. This sector, rotated about the lower right corner yields the complete assembly model shown in Fig. 4.24.

Figures 4.27 and 4.28 illustrate the reflective symmetry problem with the model, for reflection about a diameter or about an edge. As demonstrated, neither type of reflection preserves the symmetry of the middle row of guide tubes.

Unless approximations and simplifications are made, reflective symmetry will be invalid, and the assembly model can only have rotational symmetry. Reflective symmetry can be made valid by converting at least the middle row of water-filled guide tubes into fuel.

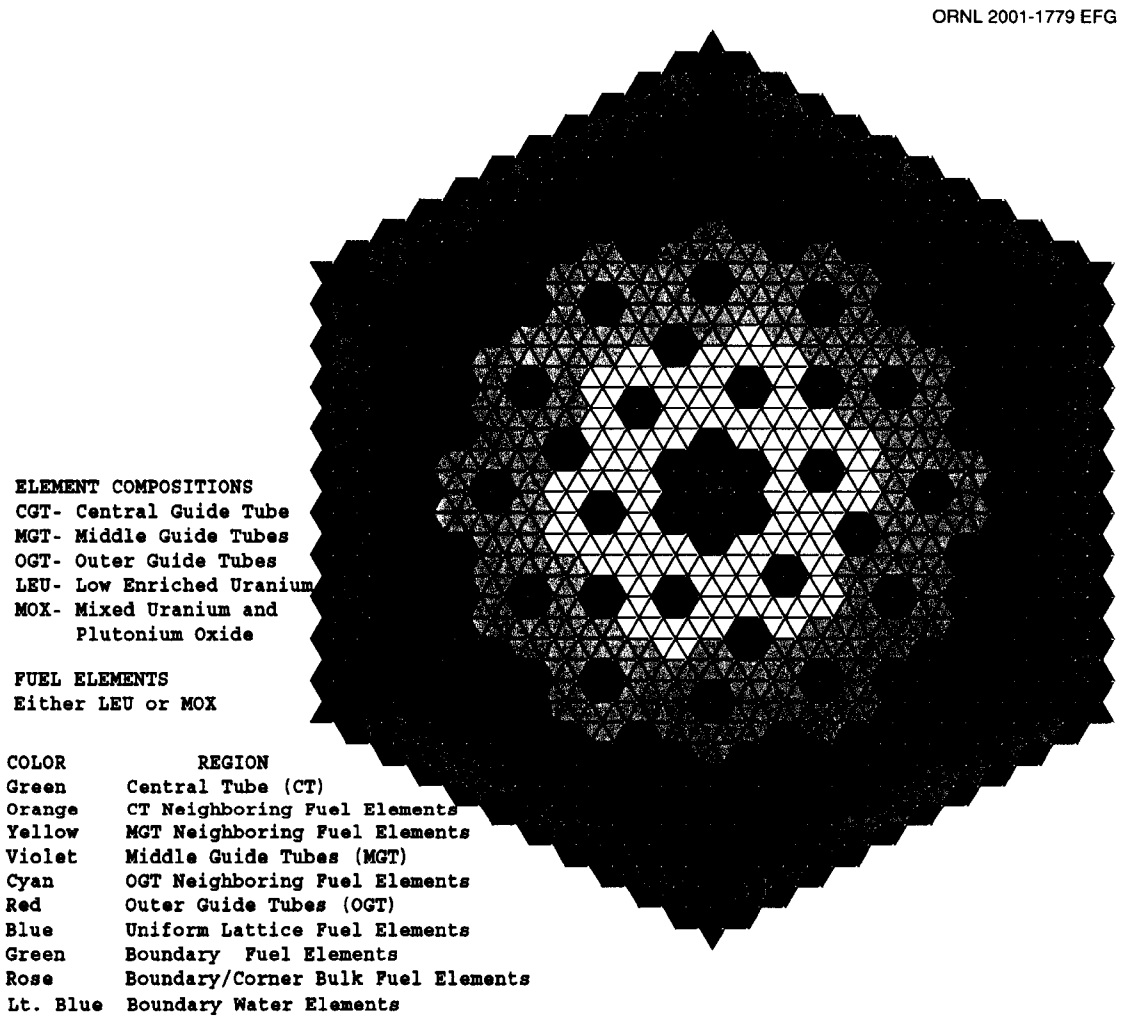


Fig. 4.24. VVER fuel assembly model.

Table 4.82. Material type and overlay zone identifications

Material type	Material	Component description	Number of overlay zones
1	Water	Central water tube	1
2	LEU or MOX (adjusted)	Fuel pins neighboring the central water tube	6
3	LEU or MOX (adjusted)	Fuel pins neighboring the middle ring of water tubes	36
4	Water	Middle ring of water tubes	6
5	LEU or MOX (adjusted)	Fuel pins neighboring the outer ring of water tubes	72
6	LEU or MOX	Bulk (nonspecial) fuel pins	138
7	Water	Outer ring of water tubes	12
8	LEU or MOX (adjusted)	Fuel pins neighboring the outer water boundary	54
9	Water	Outer water boundary	1
10	LEU or MOX (adjusted)	Outer corner fuel pins (neighboring outer water boundary)	6
		Total assembly model overlay zones	332

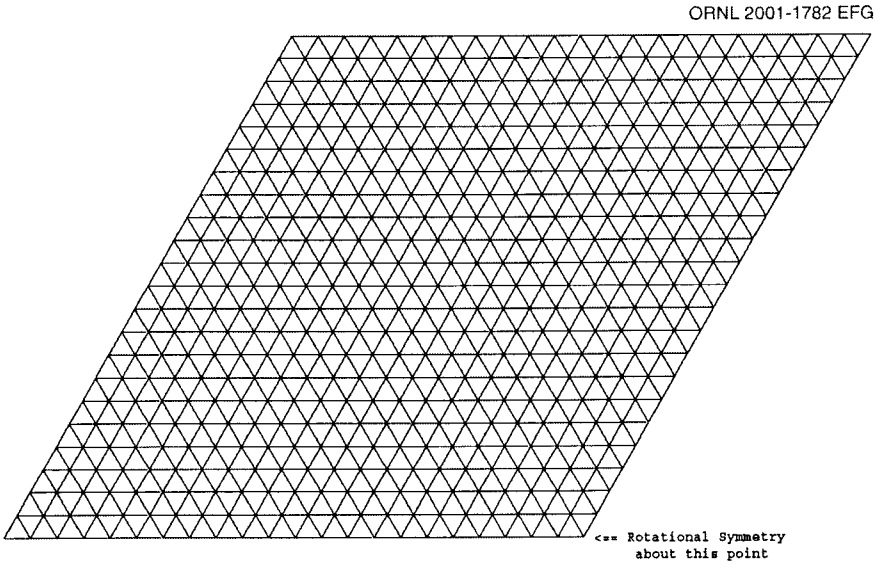


Fig. 4.25. VENTURE 120° parallelogram geometry option used in single fuel assembly model (Variants 11 and 12).

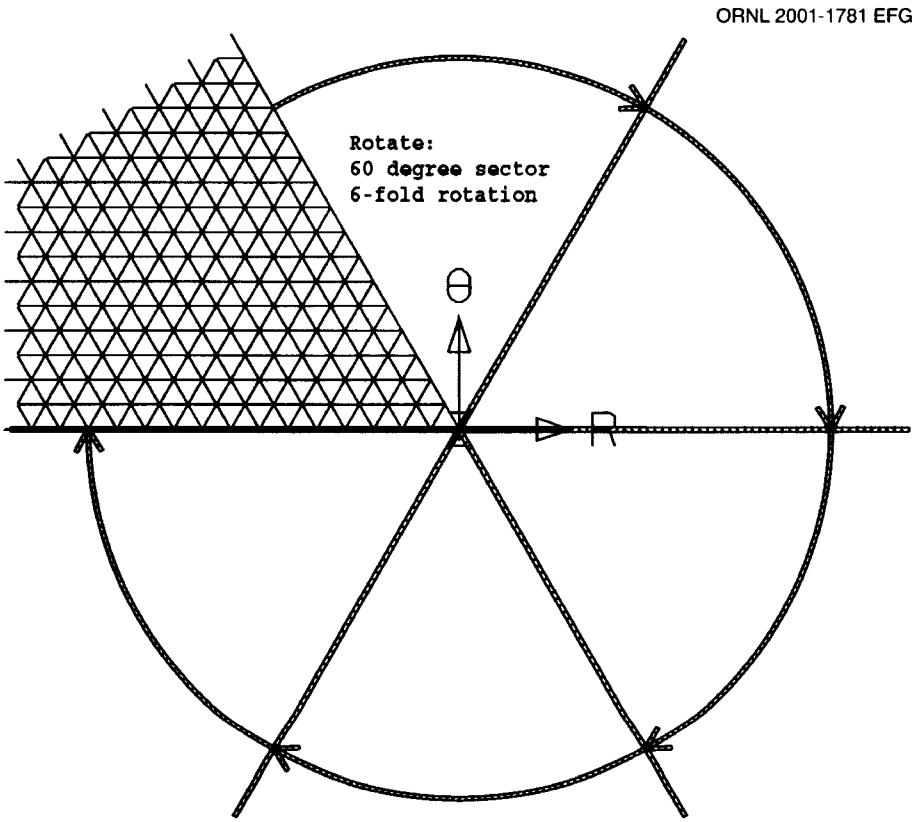


Fig. 4.26. A 60° sector of VVER fuel assembly model from which complete assembly model was constructed.

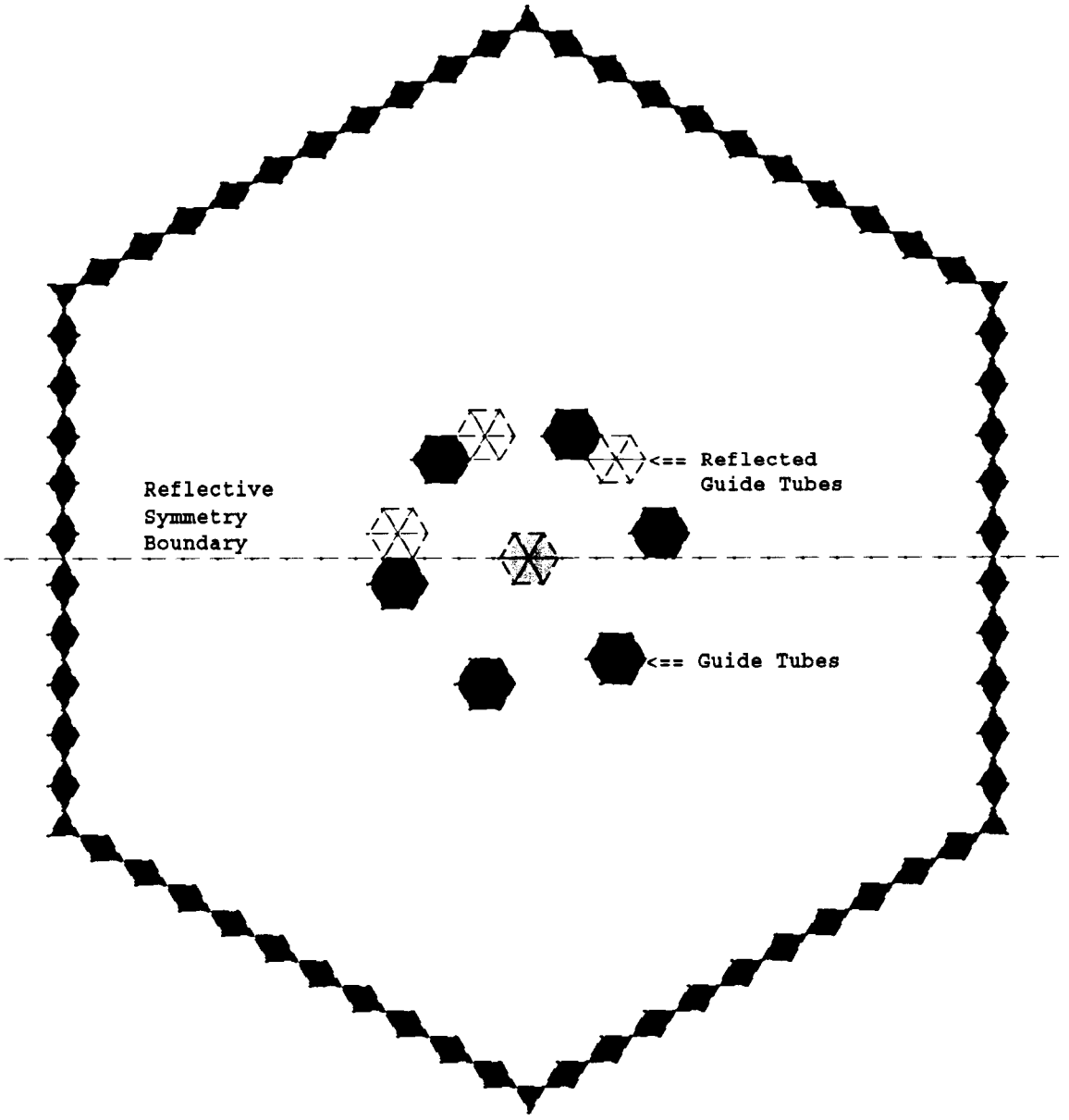


Fig. 4.27. Illustration of lack of reflective symmetry about an assembly diameter. The middle row of guide tubes is shown.

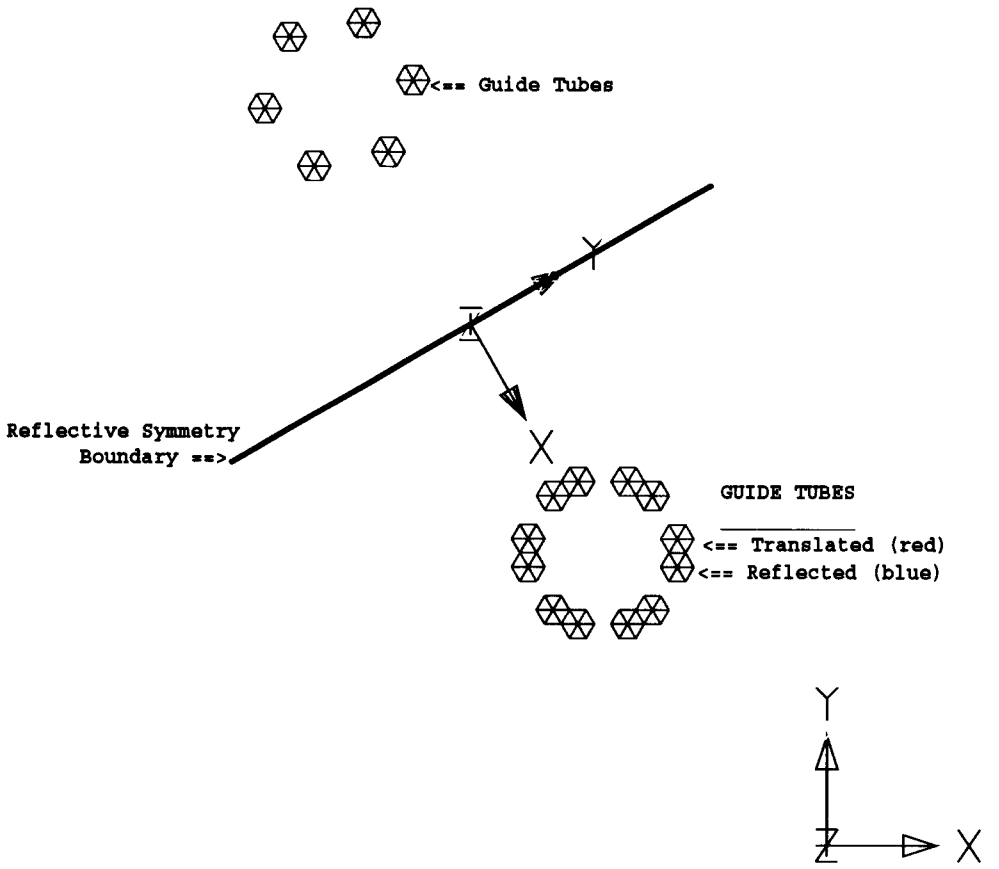


Fig. 4.28. Illustration of lack of reflective symmetry about an assembly edge. The middle row of guide tubes is shown.

Overlay zone numbering

The VVER assembly model created by the Russians (shown in Fig. 4.16), used a specific numbering that was not desirable for the VENTURE calculations because it did not group similar material types together. Their numbering scheme would have required repetition of the overlay zone material properties numerous times in the VENTURE input file. To overcome this problem, the VENTURE models were constructed with overlay zones numbered sequentially within each material type. This allowed specification of material properties only once for each group of overlay zones within each of the ten material types. VENTURE output is compared to Russian results by extracting the relevant overlay zones from the VENTURE model and using a correlation list to extract the overlay zones that are equivalent to the overlay zones in the Russian model.

A subroutine was constructed to use the assigned material number for each overlay zone and the periodicity of the overlay zone arrangement in the model to automatically assign sequential overlay zone numbers within each separate material type.

Model dimensions

The generic VVER fuel assembly model is hexagonal and is made up of hexagonal overlay zones, each representing one fuel pin. Each fuel pin is modeled by six triangular elements, grouped together to form one model overlay zone of a single material type. Tables 4.83 and 4.84 give the physical dimensions of the hexagonal fuel assembly and of the hexagonal overlay zone representing each fuel pin. The water boundary surrounding each fuel assembly is modeled with a string of triangular elements explicitly and is grouped into a single overlay zone. This eliminates the need to combine the water material with the boundary fuel materials, as had been done in previous models. A comparison of the dimensions of the water boundary in the generic assembly model and the VENTURE assembly model is given in Table 4.85.

Table 4.83. Single fuel-pin model dimensions[a]

Single fuel-pin model	Dimensions	Small hexagonal element
2r	1.275 cm	Flat-to-flat
2R	1.472244 cm	Point-to-point
Area	1.40783 cm^2	
S	0.736122 cm	Side length

[a]See, for example, Fig. 4.18.

Table 4.84. VVER fuel assembly model dimensions[a]

VVER fuel assembly model	Dimensions	Hexagonal assembly of 331 hexagonal elements
2r	23.60 cm	Flat-to-flat
2R	27.2509 cm	Point-to-point
Area	482.3415 cm^2	
S	13.6255 cm	Side length

[a]See Fig. 4.16.

Table 4.85. Water boundary dimensions

Water boundary (single overlay zone)	Dimensions
Actual area	16.34978 cm^2
Model area[a]	14.234768 cm^2
Actual area = Model area +14.86% of model area	

[a]String of triangular elements on assembly periphery.

4.4.2.3 Geometry modeling methodology

To minimize the development of specialized computer codes, some steps in the model generation were done using the Microsoft Excel spreadsheet program because it had the necessary functionality for those tasks. ASCII files were used to transfer data between subroutines and between the PC-based spreadsheet program and the IBM RISC 6000 workstations on which the VENTURE calculations were made.

To build either of the two VENTURE models that were required, a complete generic assembly model was first built that could be replicated, trimmed, and copied to form larger models. Utilizing the radial and azimuthal periodicity of materials, a FORTRAN routine was used to generate a model of the material types in a 60° sector of the fuel assembly. This step could also have been done manually within the Excel spreadsheet program. From the sector model, rotational symmetry was invoked to build a model of the material types in complete assembly. This model was then manipulated to construct both the Variant 12 and Variant 13 VENTURE geometry arrays. The model consists of a 2-D array containing the material types in each triangular element of the assembly, and a 2-D array containing the corresponding overlay zone numbers. Copying and trimming operations were usually done in the Microsoft Excel program but could also have been done in a FORTRAN routine.

Table 4.86 lists the principal steps in generating the VENTURE geometry model, and Fig. 4.26 shows the sector model and the rotational operation performed to generate the complete assembly model. To simplify identification of errors and their source in the process, each function was performed separately by the subroutines rather than incorporating them into a single code. In all cases, input and output files were ASCII, and at each step both input and output files were inspected and checked manually to locate errors that were not found by automatic checking procedures. If this code were further developed, the routines would be merged, and the internal checking would be relied on more fully once it was verified as being error-free.

4.4.2.4 VENTURE geometry models

Single Fuel Assembly Model Configuration (Variant 11 and 12 models)

The Variant 11 and 12 VENTURE models each contain one-third of a single assembly and as much of the surrounding area as necessary to make the model fit the VENTURE geometry option that was chosen. This model is shown in Fig. 4.29. In this model, all fuel elements are of a single type, either LEU or MOX, and all guide tubes are water-filled.

MOX–LEU assembly model configuration (Variant 13 model)

The VENTURE geometry option used in the Variant 13 model is shown in Fig. 4.30. Two options exist for the arrangement of LEU and MOX fuel assemblies in this model, both of which have a single MOX assembly surrounded by LEU assemblies. However, a difference exists in the two models in the ratio of the two fuel types. Figures 4.31 and 4.32 show the two possible arrangements in the VENTURE models. Tables 4.87 and 4.88 list the respective ratios of LEU to MOX fuel for the two configuration options. Figure 4.33 is the VENTURE model used for Variant 13, and Fig. 4.30 is the same model with rotational symmetry invoked. Figure 4.34 is the alternative fuel arrangement option, and Fig. 4.33 shows that model with rotational symmetry invoked.

The Variant 13 model contains portions of nine separate fuel assemblies. The model, as run in the VENTURE code, had rotational boundary conditions applied to two of its edges and reflective boundary conditions applied to the remaining two edges. The lower right corner of the model is the center of rotational symmetry. Figure 4.33 shows the configuration of this model. To compare VENTURE calculations to the simulations done by the Russians, it was necessary to convert the nonsymmetric, water-filled guide tubes to fuel so that the reflective boundary condition were valid (yielded a one pin error in fuel content.

Table 4.89 lists the final VENTURE geometry file names, checking file names, and the names of files used to extract the VENTURE output and correlate it with Russian results.

Table 4.86. Principal operations in the model building procedure

Step[a]	Purpose	Tool	Input	Output
1	Create an array representing a 60° sector of core assembly material types	Sector (FORTRAN)	Auto array generation using periodicity and symmetry	2-D ASCII array of material types
		or Excel (Windows)	Manual data input in a spreadsheet	
2	Create complete fuel assembly material type array (LEU)	Rotate (FORTRAN)	ASCII array of material types in a 60° sector	2-D ASCII array of material types—one complete assembly
3	Create second material type array (MOX)	Minc (FORTRAN)	2-D ASCII array of material types	2-D ASCII array of material types—one complete assembly
4	Create 9-assembly material type array—LEU + MOX	Excel (Windows)	2-D single assembly material type arrays (2)—ASCII	2-D ASCII array of material types for MOX + LEU array
5	Create an overlay zone array with overlay zones sequentially numbered within each material type	Number (FORTRAN)	2-D material type array	(a) Overlay zone number array. (b) Diagnostic file
6	Build nine independent overlay zone number arrays for nine-assembly model Increment overlay zone number array within material types	Zinc (FORTRAN)		(a) Overlay zone number array (b) Material type array (c) VENTURE geometry input file (d) Geometry model checking file (e) Geometry model diagnostic file
7	Compress overlay zone numbers within each material type or compress overlay zone numbers regardless of material type	Compress (FORTRAN)	Overlay zone number array with numbering gaps	Overlay zone number array with (or without) numbering gaps Overlay zone number index showing range of overlay zones associated with each material type
8	Write VENTURE geometry input file	Bigventure (FORTRAN)	Overlay zone number array Material type array	

[a]At each step, diagnostic files are written and checked both automatically and manually to identify errors.

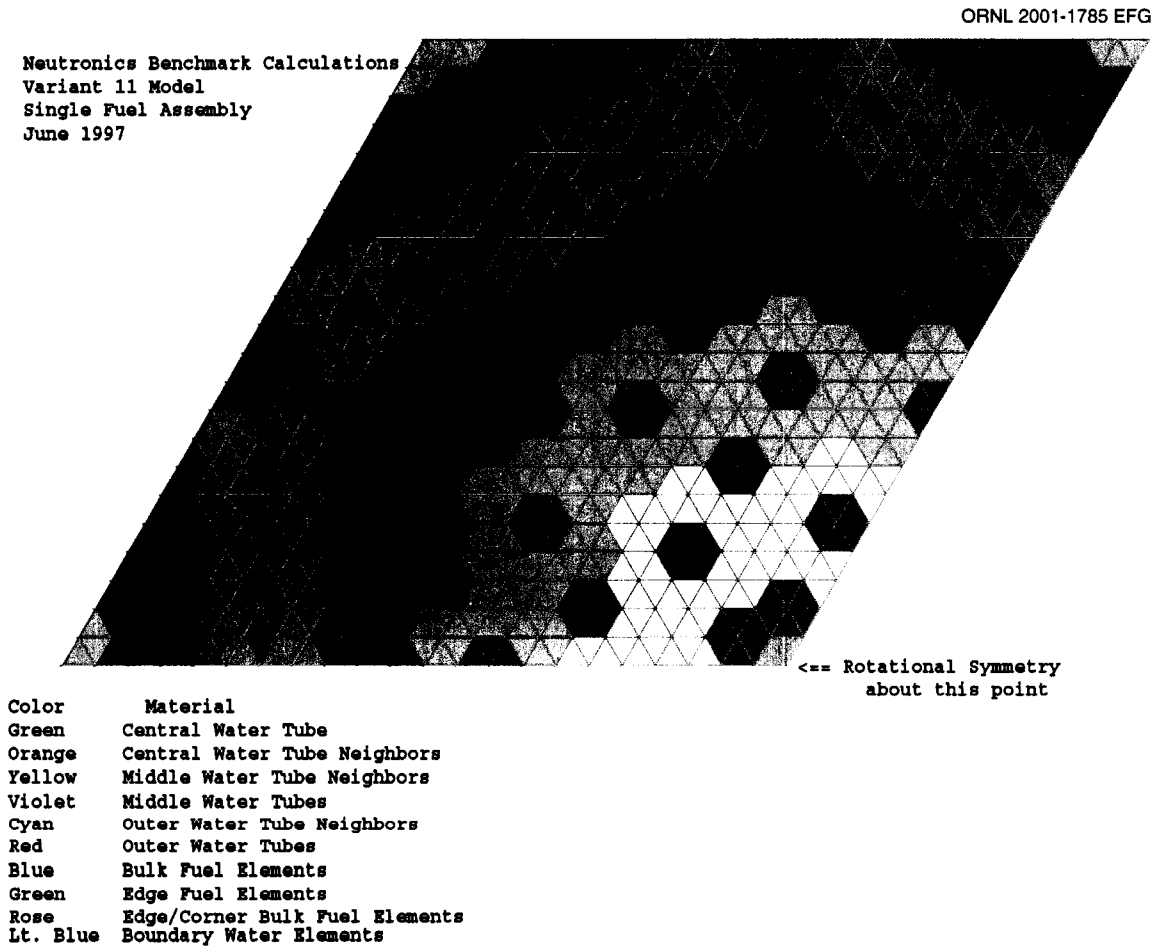


Fig. 4.29. Single VVER fuel assembly model geometry for VENTURE calculations. Model has threefold rotational symmetry about lower corner and was modeled using reflective symmetry about the two opposite edges.

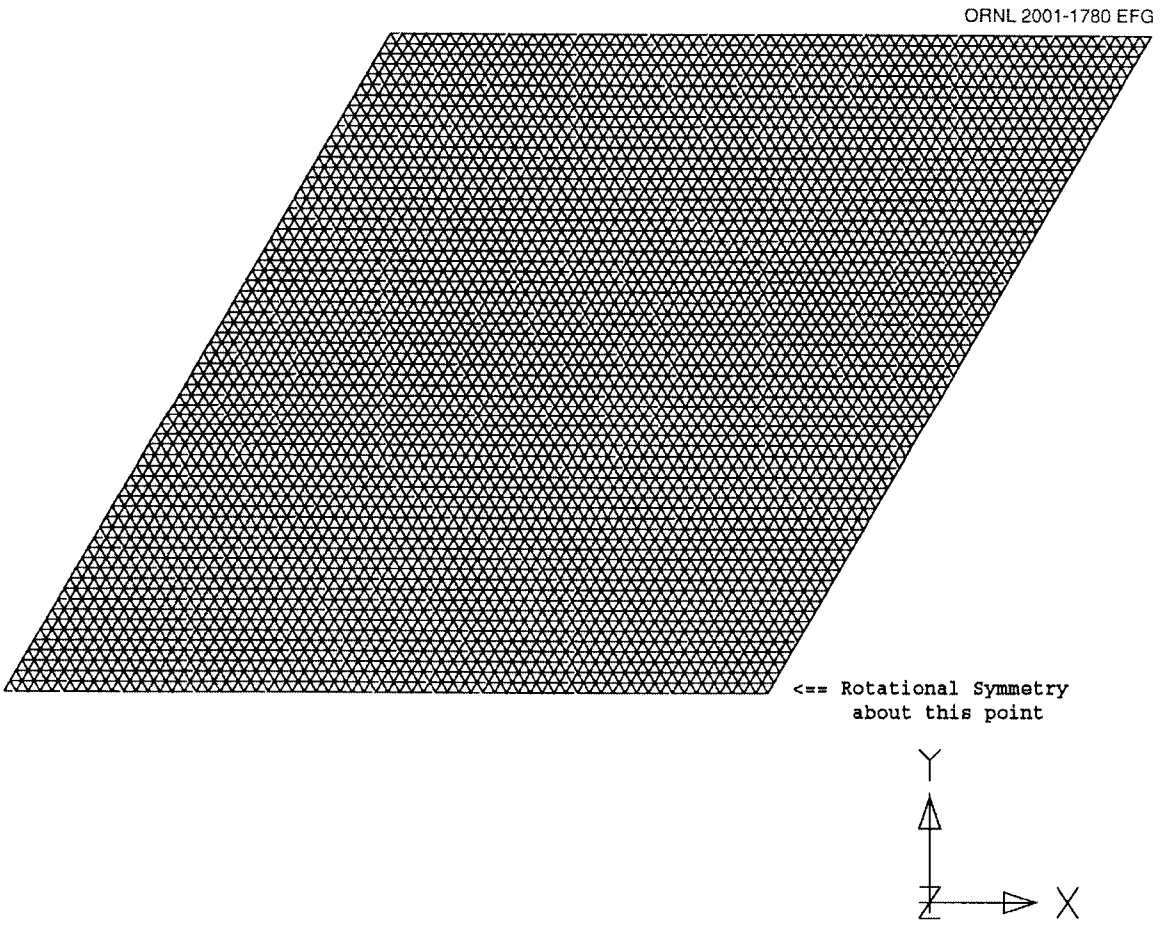


Fig. 4.30. VENTURE 120° parallelogram geometry model option used in the multifuel assembly model (Variant 13).

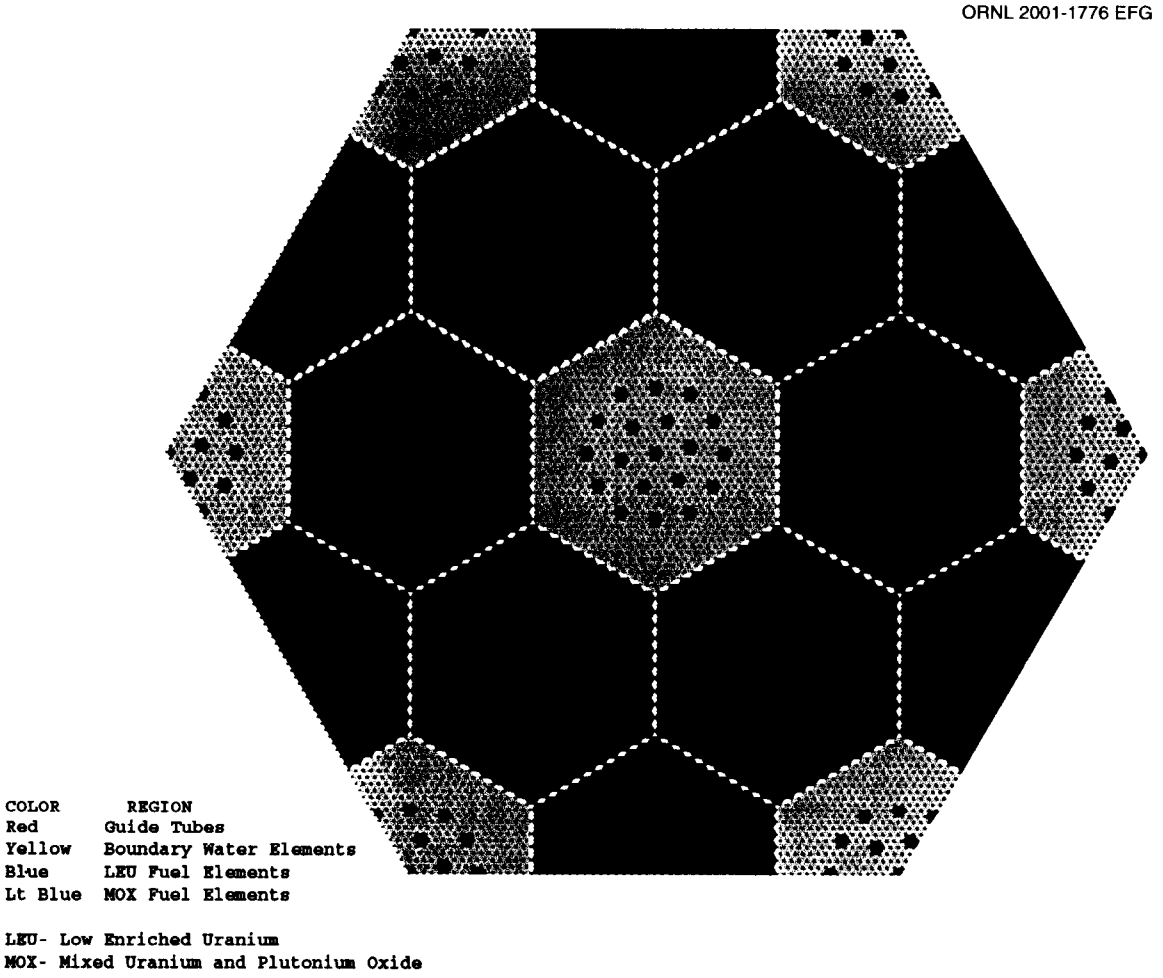
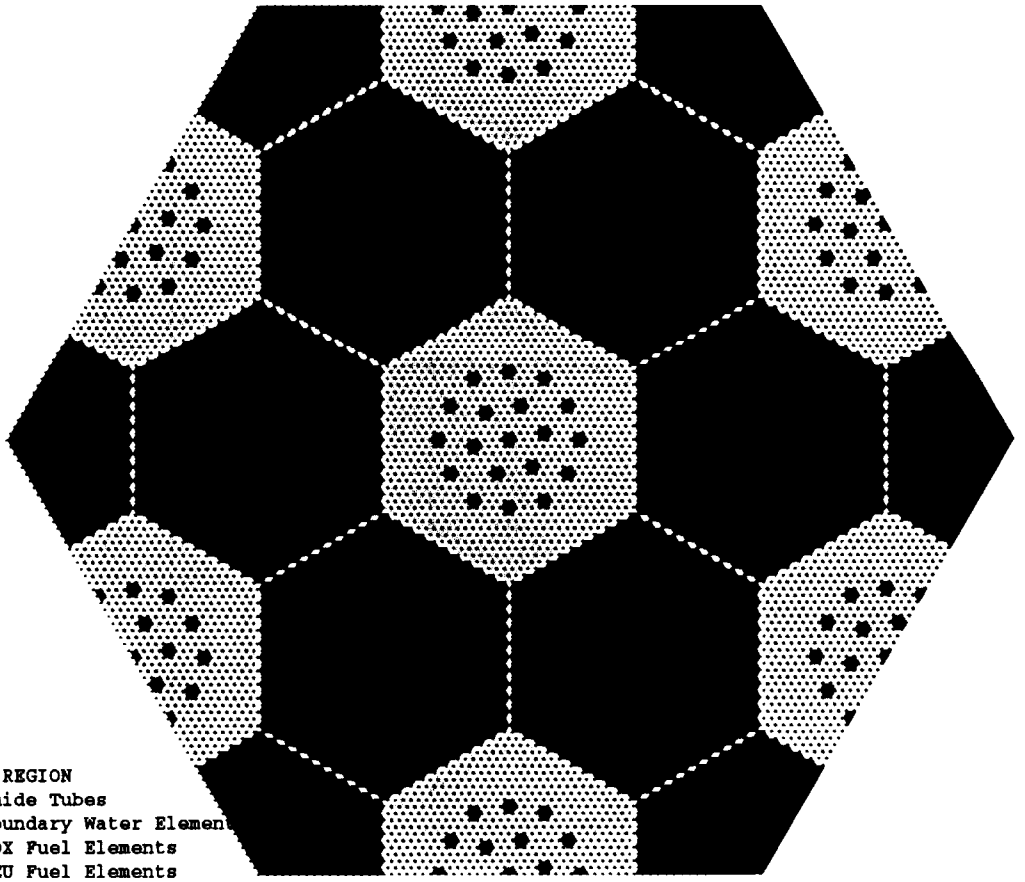


Fig. 4.31. Alternative configuration of MOX and LEU fuel assemblies for the multifuel assembly VENTURE model (Variant 13).

ORNL 2001-1778 EFG



COLOR	REGION
Red	Guide Tubes
Yellow	Boundary Water Elemen
Blue	MOX Fuel Elements
Lt Blue	LEU Fuel Elements

LEU- Low Enriched Uranium
MOX- Mixed Uranium and Plutonium Oxide

Fig. 4.32. Alternative configuration model rotated about its symmetry point (Variant 13).

Table 4.87. LEU–MOX fuel assembly arrangement—option 1 (Fig. 4.33)

Option 1	VENTURE model (as run)	VENTURE model (including threefold rotational symmetry)
LEU assemblies	3.0	9.0
MOX assemblies	1.0	3.0
LEU–MOX ratio	3:1	

Table 4.88. LEU–MOX fuel assembly arrangement—option 2 (Fig. 4.34)

Option 2	VENTURE model	VENTURE model (including threefold rotational symmetry)
LEU assemblies	8/3	8.0
MOX assemblies	4/3	4.0
LEU–MOX ratio	2:1	

Table 4.89. Model geometry and data summation output files

File name	File description	Case
vver-v12-geom	VENTURE geometry input file Variant 12 model (single assembly)	LEU model
vver-v13-geom	VENTURE geometry input file Variant 13 model (multiple assemblies)	LEU–MOX model nonsequentially-numbered overlay zones
vver-v13b-geom	VENTURE geometry input file Variant 13 model (multiple assemblies)	LEU–MOX model sequentially-numbered overlay zones
Zindex-n1 Zindex-n2 Zindex-n3 Zindex-n4	Generic-model overlay zone correlation list for selected overlay zone regions. For nonsequentially numbered overlay zones "-n1"	LEU–MOX model nonsequentially-numbered overlay zones
Zindex-s1 Zindex-s2 Zindex-s3 Zindex-s4	Generic-model overlay zone correlation file for sequentially numbered overlay zones "-s1"	LEU-MOX model sequentially-numbered overlay zones

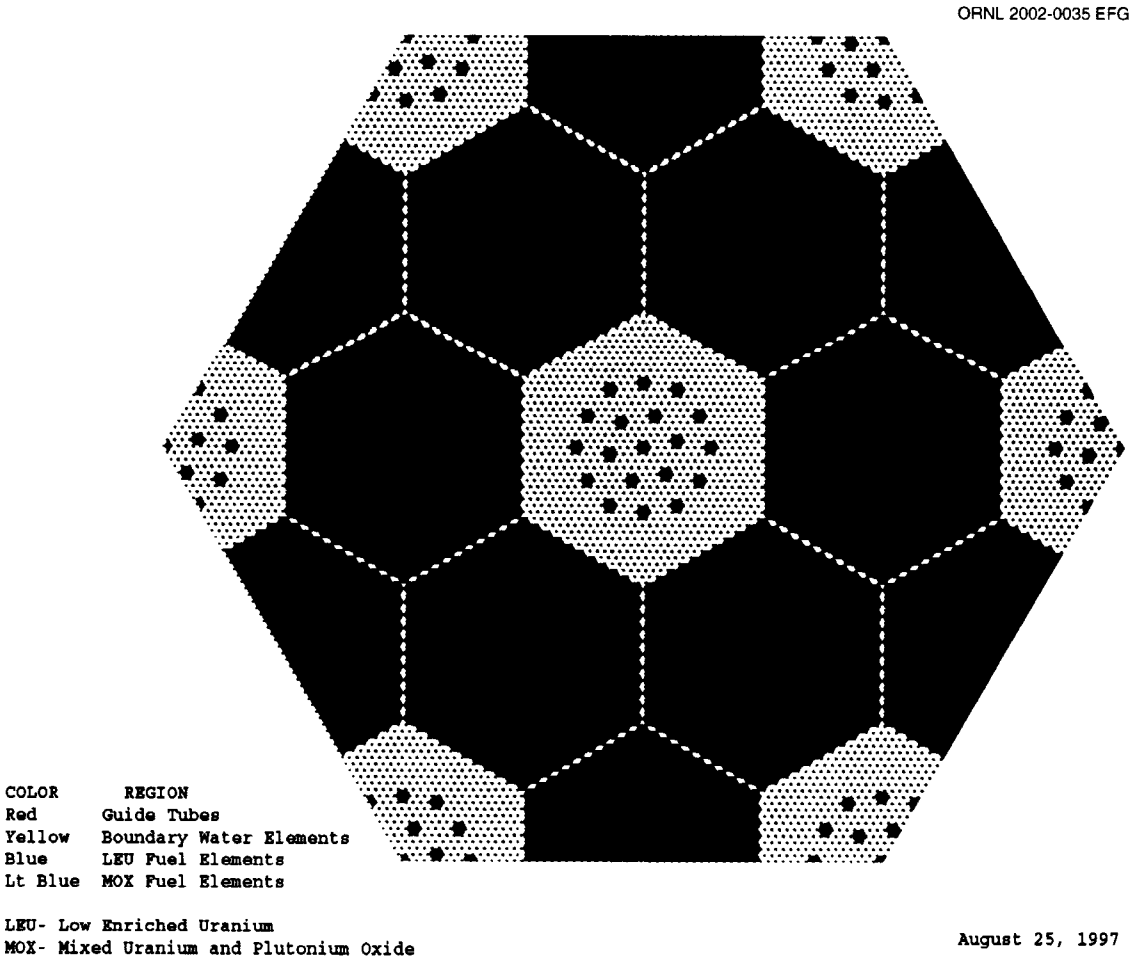


Fig. 4.33. VENTURE model used for Variant 13.

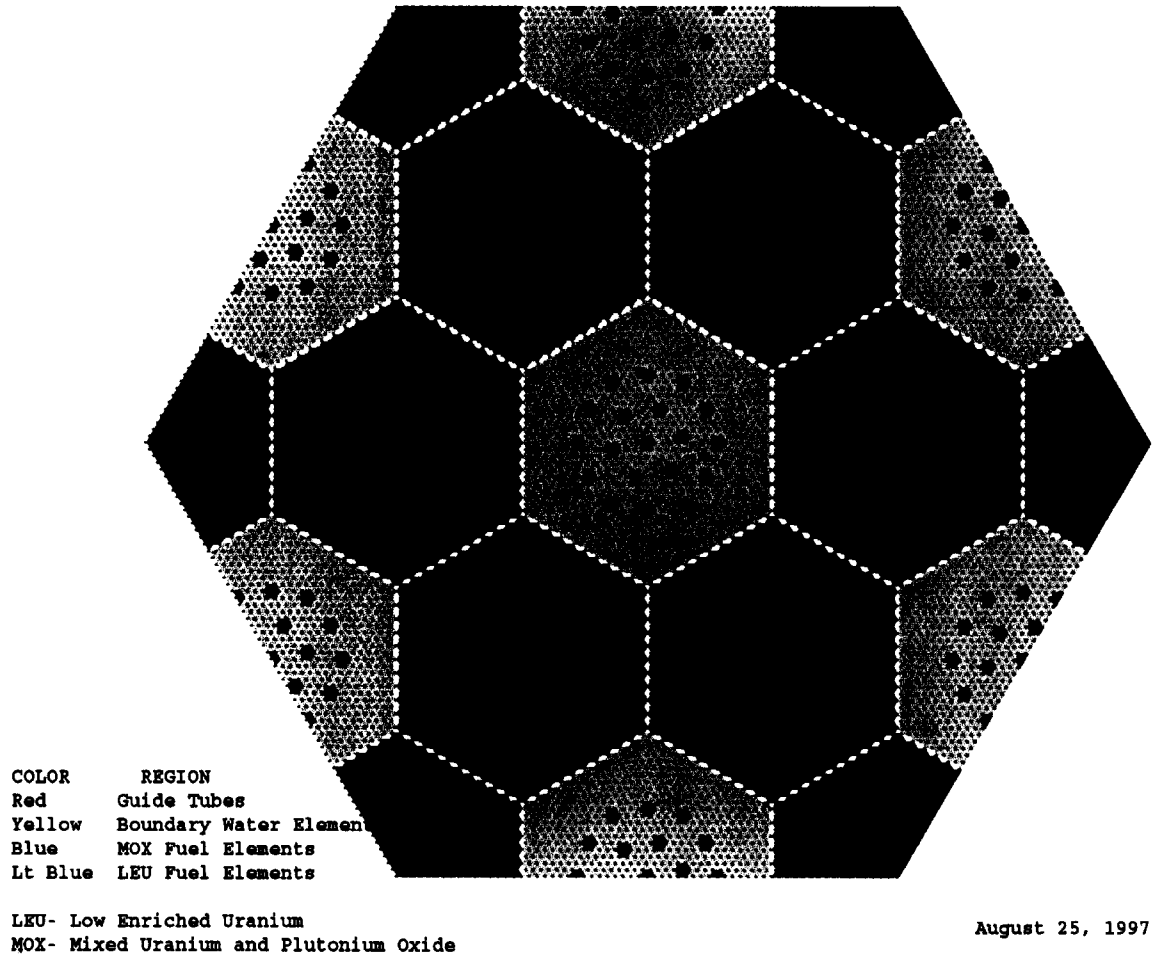


Fig. 4.34. VENTURE alternative fuel arrangement option for Variant 13.

4.4.2.5 Analysis of Variants 11 and 12 using the VENTURE code

Multiplication factors for the states defined in Sect. 4.3 are presented in Tables 4.90–4.93. Calculated power distributions are provided in Figs. 4.35 through 4.104.

Table 4.90. Multiplication factors for Variant 11

State	Burnup (GWd/tU)						
	0	10	20	30	40	50	60
S1	1.105951	0.980864	0.907512	0.844966	0.789228	0.739943	0.698068
S2	0.828846	0.748124	0.693865	0.645582	0.601749	0.562760	0.529655
S3	1.164911	1.027127	0.950239	0.885659	0.828520	0.778122	0.735285
S4	1.065574[a]	1.019019	0.942713	0.877311	0.818770	0.766841	0.722629
	1.105951[b]						
S5	1.118205	1.031235	0.955481	0.890006	0.830991	0.778426	0.733575
S6	1.210069	1.122984	1.042845	0.969425	0.900638	0.837753	0.783258

[a]Xe, Sm as specified.
[b]No Xe, Sm.

Table 4.91. Time-dependent multiplication factors for Variant 11, State 1, big model

Burnup (GWd/MT)	k_{eff}	Burnup (GWd/MT)	k_{eff}
0.0	1.105951	28.0	0.856873
0.150	1.069060	30.0	0.844966
0.500	1.062777	32.0	0.833319
1.0	1.057472	34.0	0.821926
2.0	1.049494	36.0	0.810778
4.0	1.032518	38.0	0.799879
6.0	1.014847	40.0	0.789228
8.0	0.997514	42.0	0.778833
10.0	0.980864	44.0	0.768697
12.0	0.964952	46.0	0.758832
14.0	0.949734	48.0	0.749243
16.0	0.935142	50.0	0.739943
18.0	0.921089	52.0	0.730939
20.0	0.907512	54.0	0.722242
22.0	0.894341	56.0	0.713859
24.0	0.881536	58.0	0.705798
26.0	0.869057	60.0	0.698068

Table 4.92. Multiplication factors for Variant 12

State	Burnup (GWd/tU)						
	0	10	20	30	40	50	60
S1	1.058220	0.928304	0.862648	0.809003	0.763619	0.725461	0.693950
S2	0.843165	0.741083	0.685049	0.638453	0.598705	0.565195	0.537543
S3	1.088596	0.955573	0.890482	0.837683	0.793198	0.755872	0.725066
S4	1.040597[a] 1.058220[b]	0.959144	0.892277	0.837204	0.790275	0.750583	0.717655
S5	1.073000	0.973230	0.905510	0.849767	0.802300	0.762148	0.728812
S6	1.192680	1.078783	0.998899	0.931478	0.873387	0.824014	0.782958

[a]Xe, Sm as specified.
[b]No Xe, Sm.

Table 4.93. Burnup-dependent multiplication factors for Variant 12, State 1

Burnup (GWd/Mt)	k_{eff}	Burnup (GWd/Mt)	k_{eff}
0.0	1.058220	28.0	0.819016
0.150	1.028863	30.0	0.809003
0.500	1.021152	32.0	0.799316
1.0	1.012697	34.0	0.789942
2.0	0.999684	36.0	0.780872
4.0	0.978860	38.0	0.772099
6.0	0.960527	40.0	0.763619
8.0	0.943805	42.0	0.755430
10.0	0.928304	44.0	0.747522
12.0	0.913790	46.0	0.739895
14.0	0.900080	48.0	0.732543
16.0	0.887044	50.0	0.725461
18.0	0.874592	52.0	0.718647
20.0	0.862648	54.0	0.712092
22.0	0.851152	56.0	0.705794
24.0	0.840068	58.0	0.699751
26.0	0.829363	60.0	0.693950

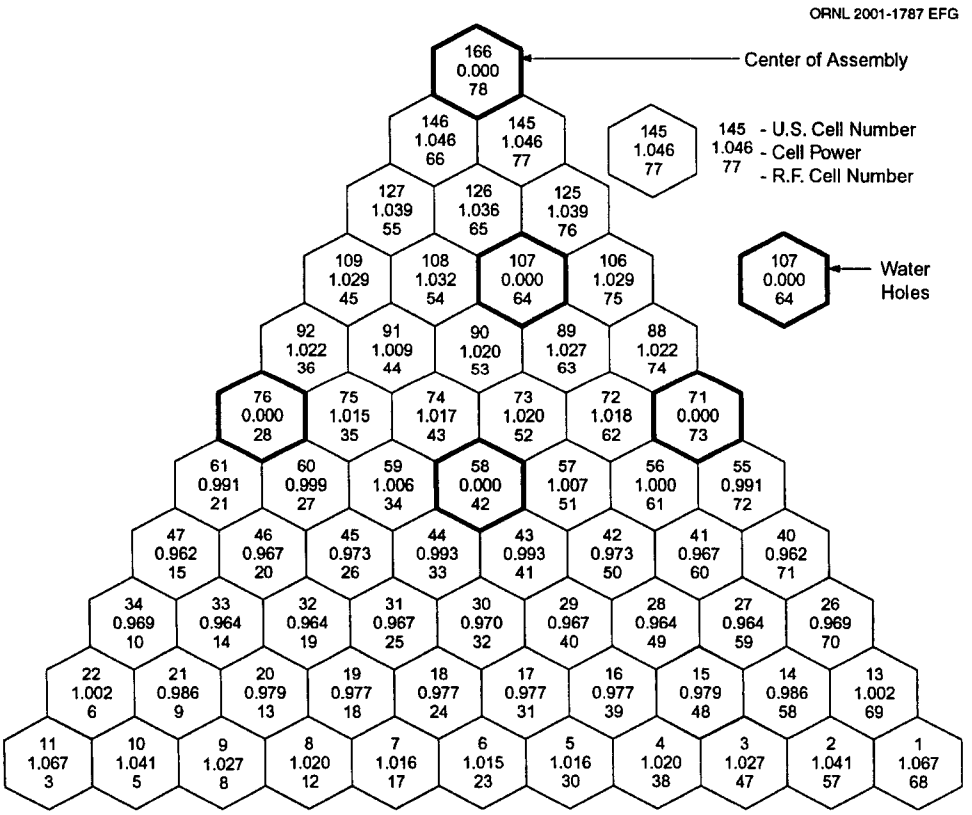


Fig. 4.35. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 11, State 1). NOTE: Results reported from Russia did not conform to numbering scheme in Fig. 4.16. U.S. cell numbers correspond to Fig. 4.16.

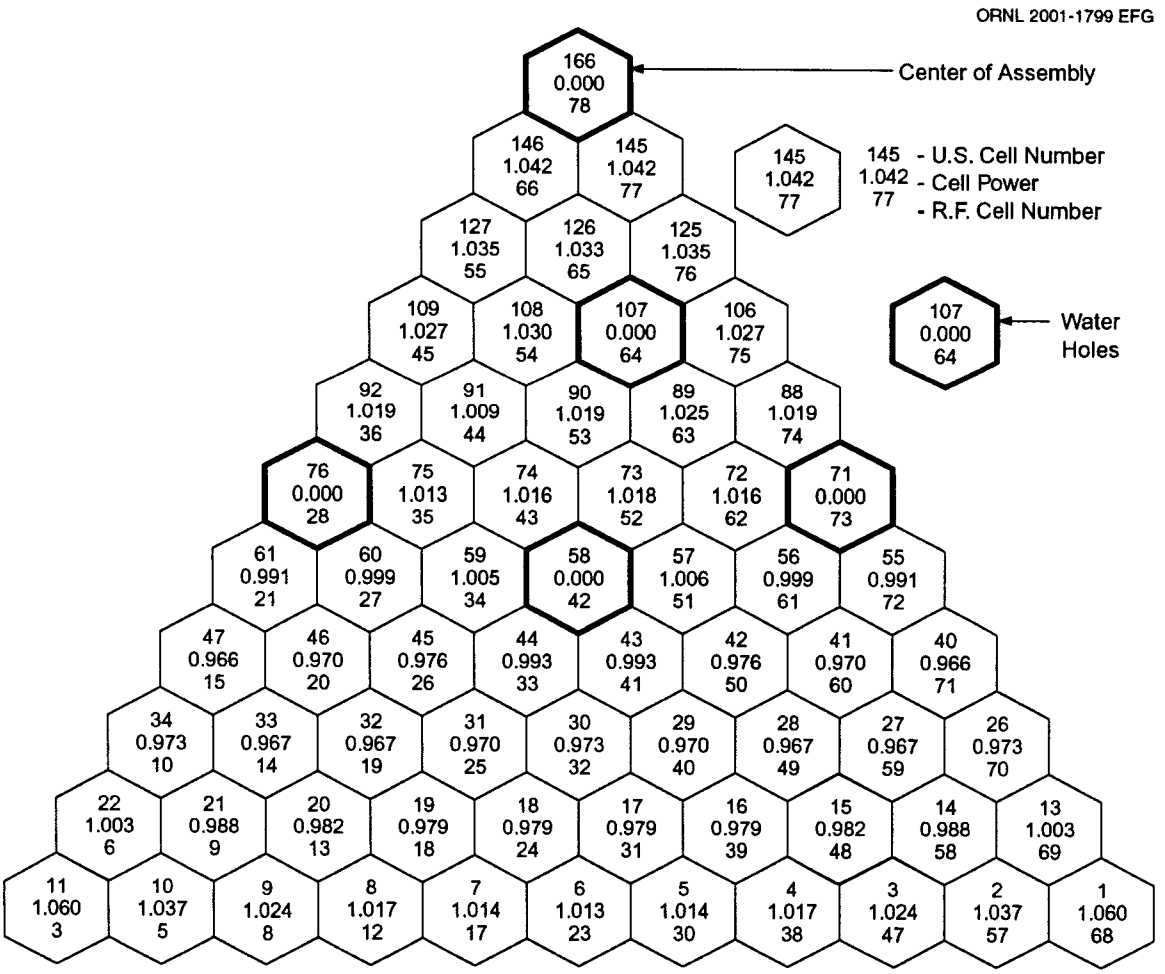


Fig. 4.36. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 11, State 1).

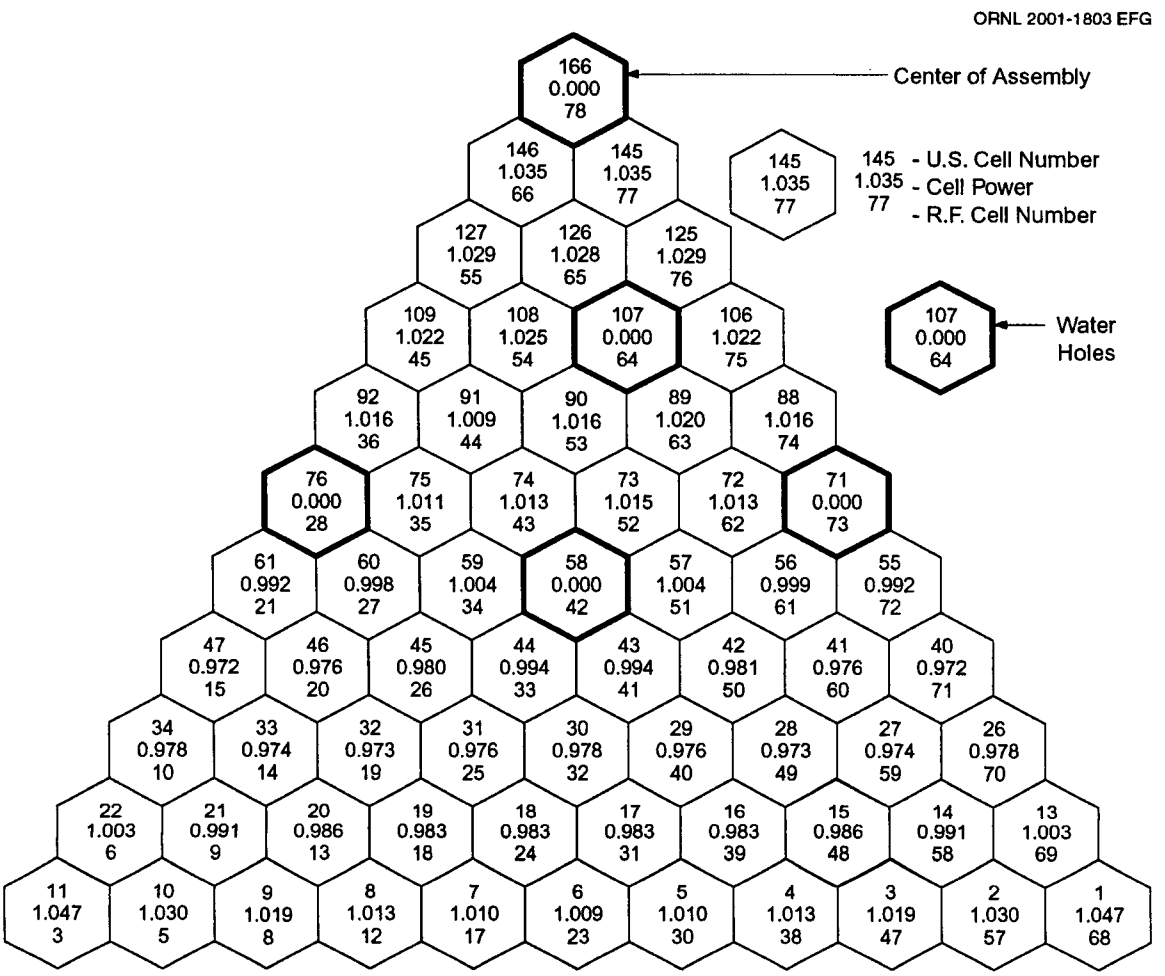


Fig. 4.37. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 11, State 1).

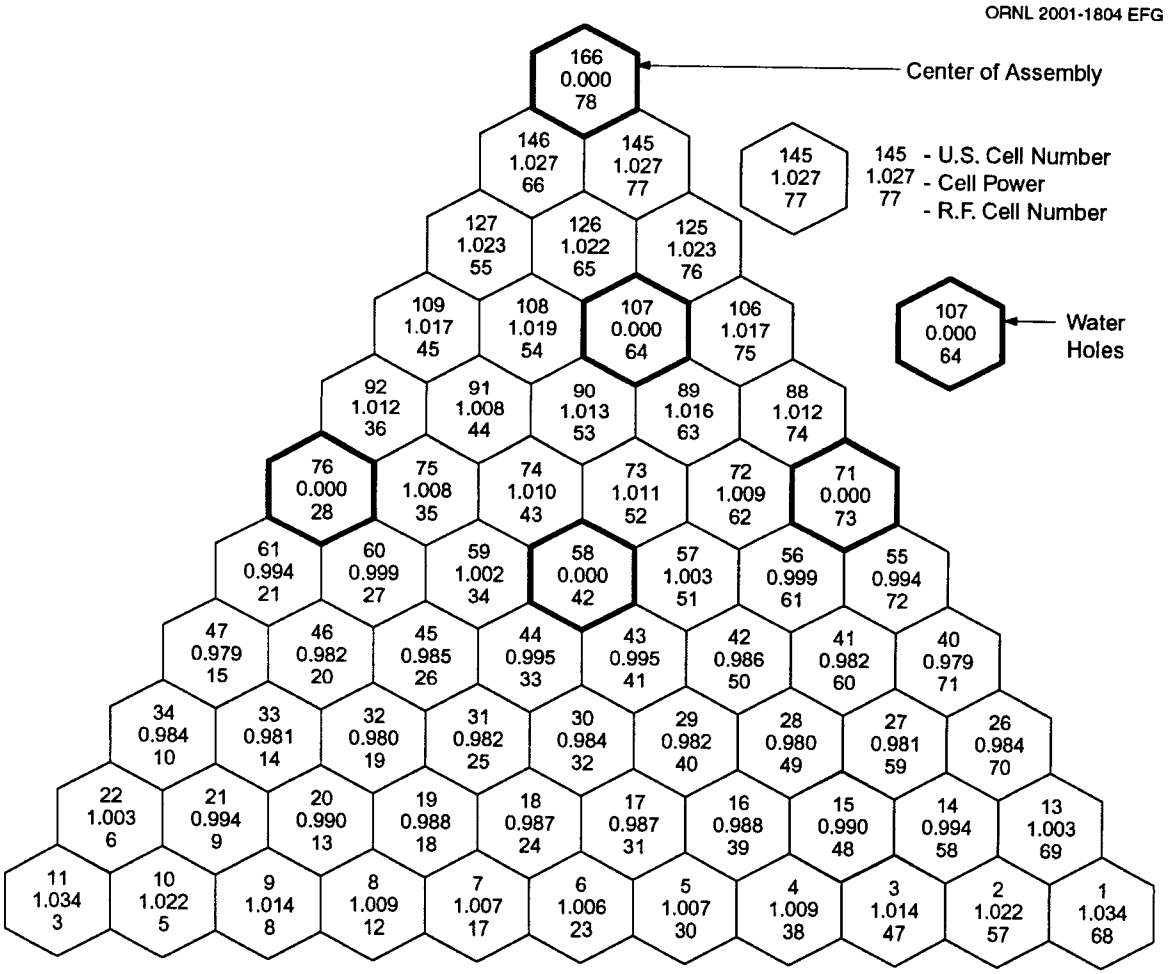


Fig. 4.38. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 11, State 1).

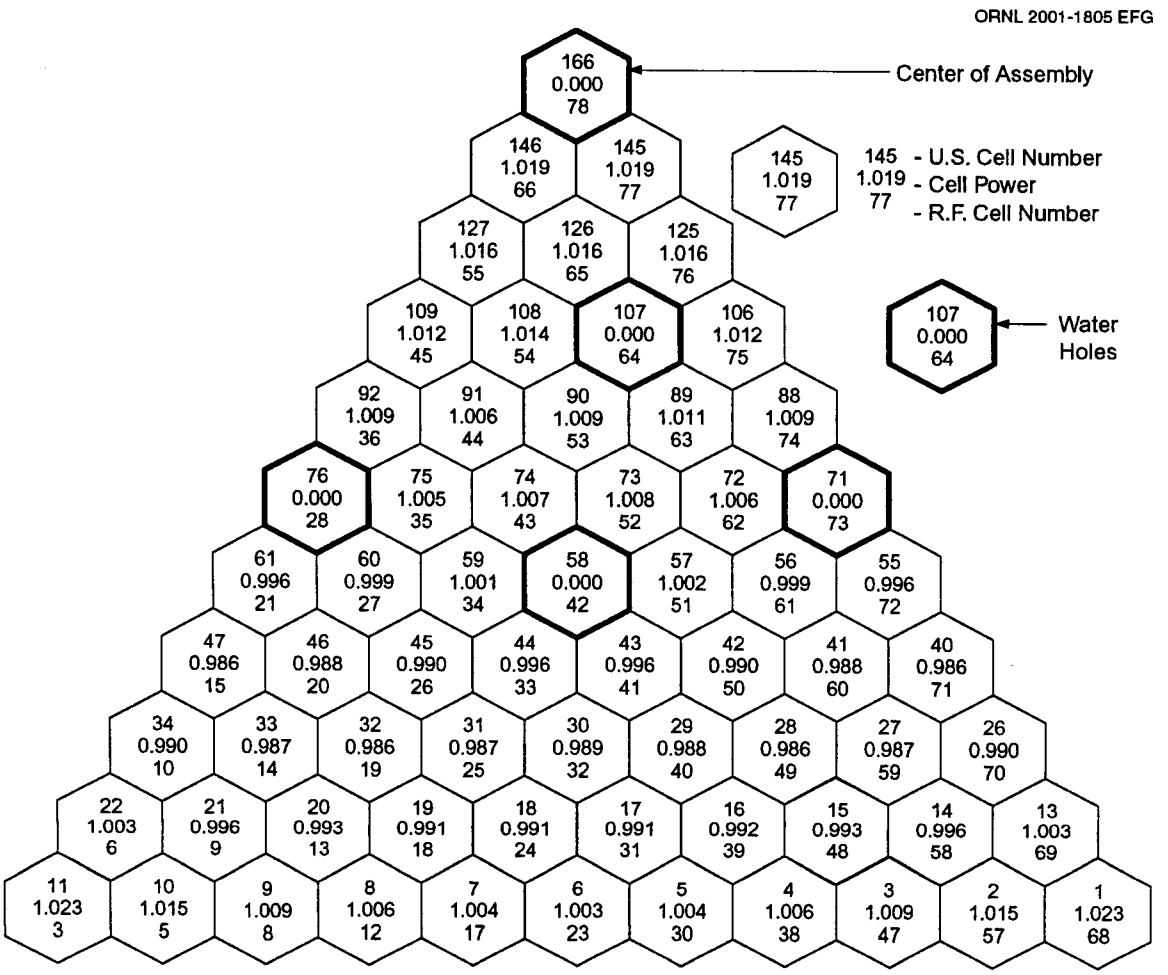


Fig. 4.39. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 11, State 1).

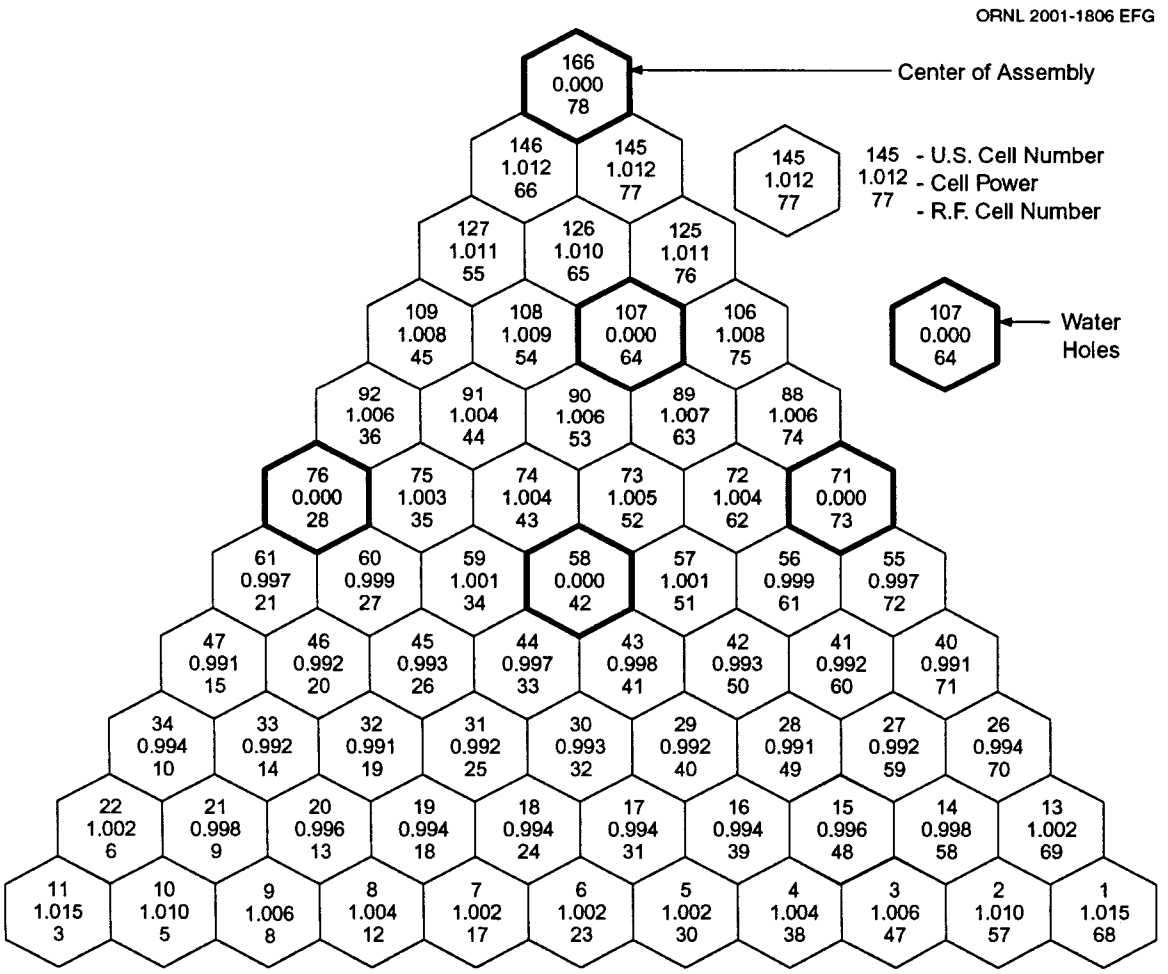


Fig. 4.40. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 11, State 1).

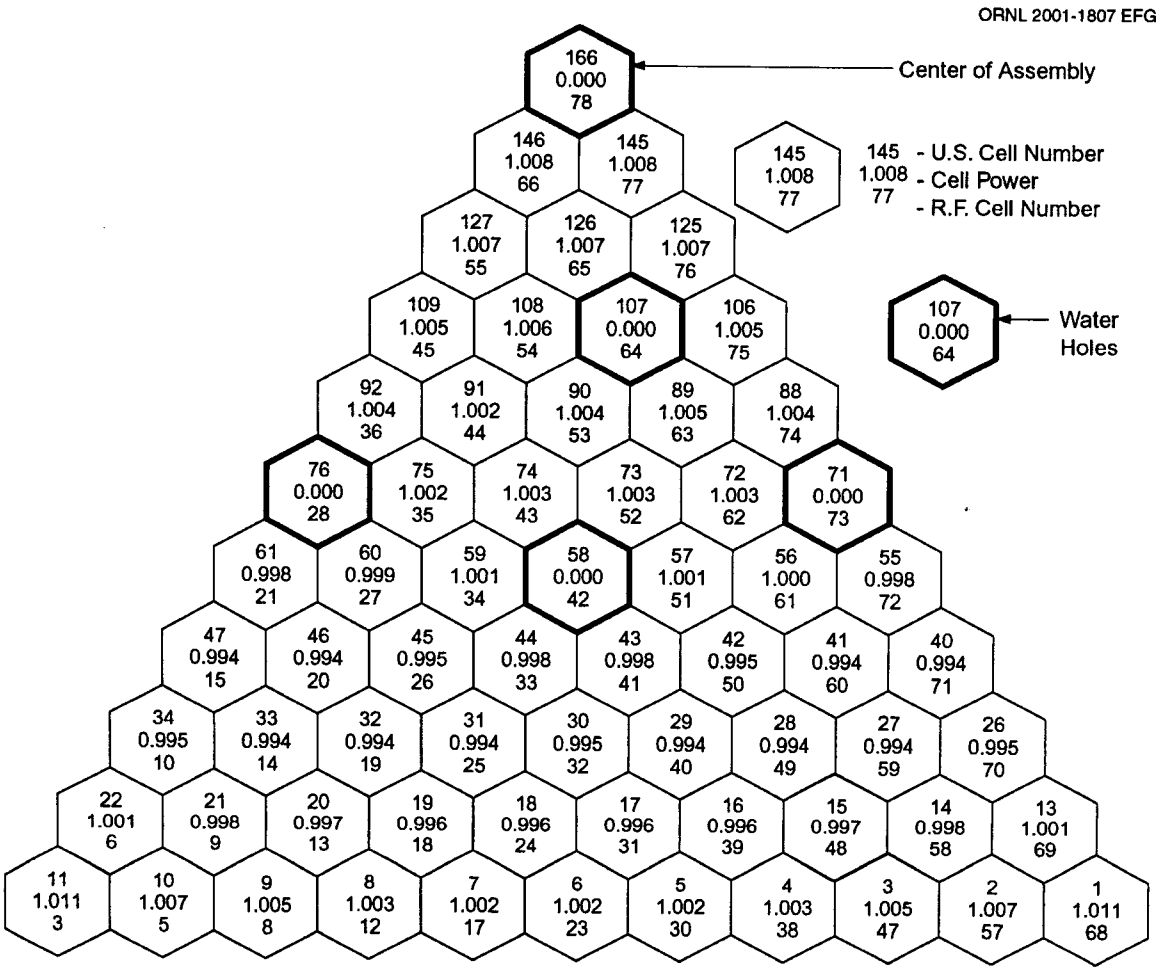


Fig. 4.41. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 11, State 1).

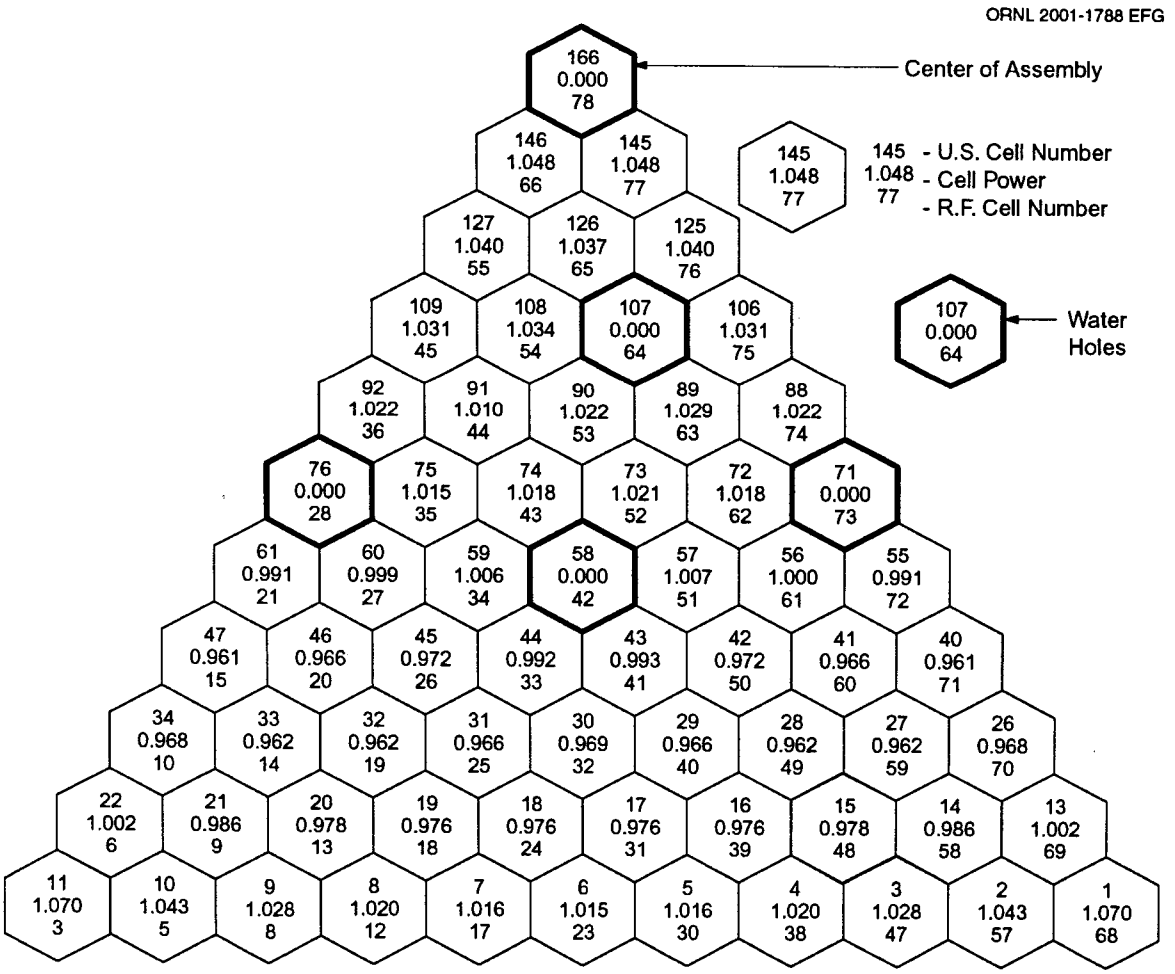


Fig. 4.42. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 11, State 3).

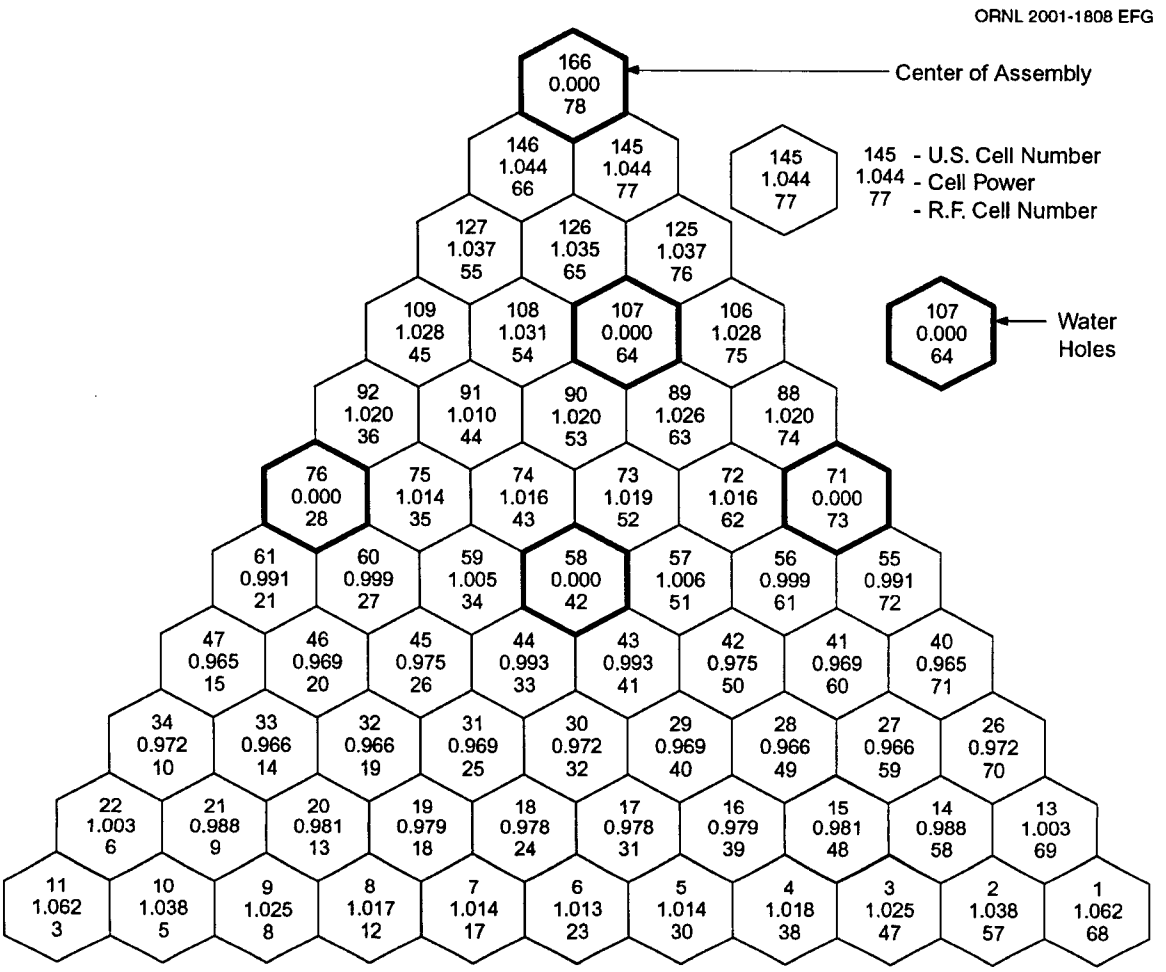


Fig. 4.43. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 11, State 3).

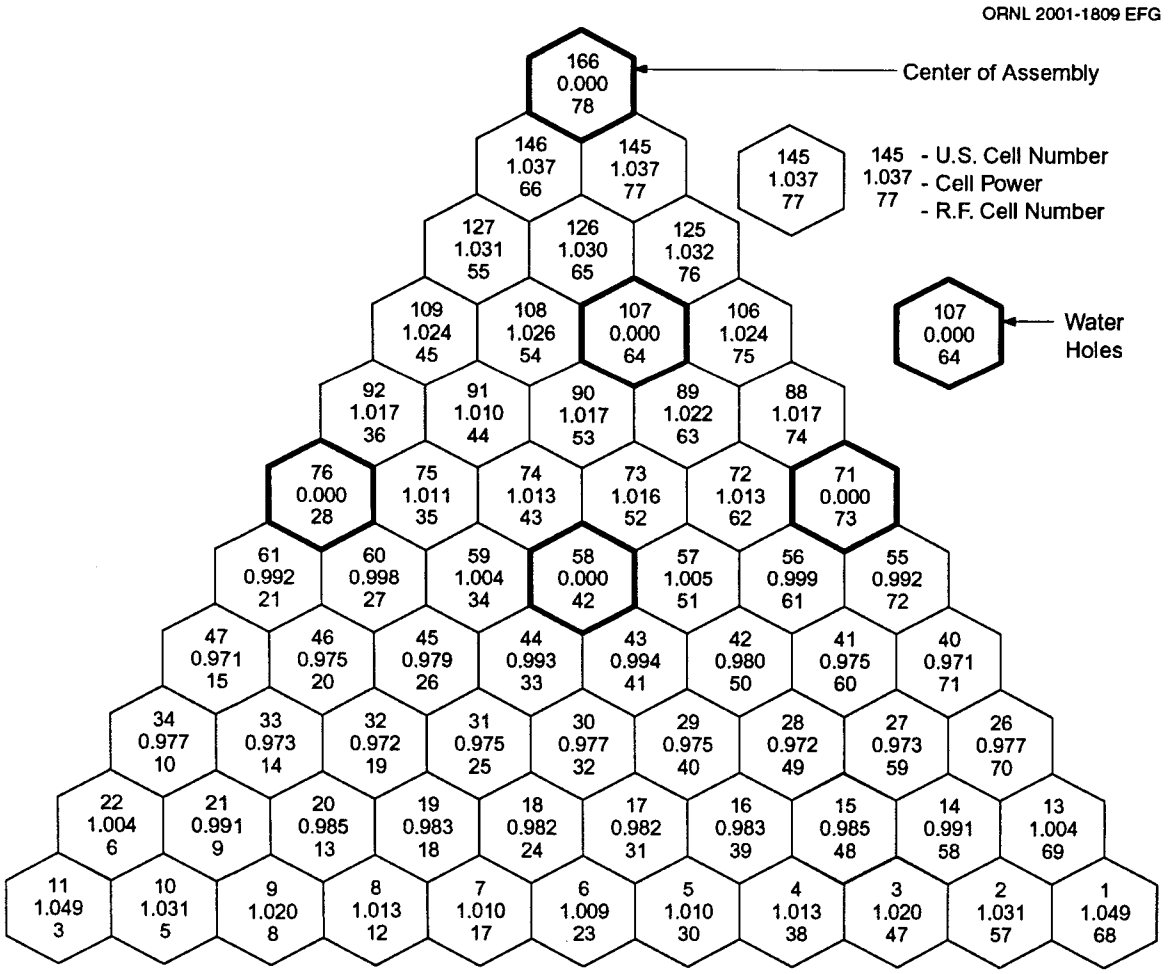


Fig. 4.44. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 11, State 3).

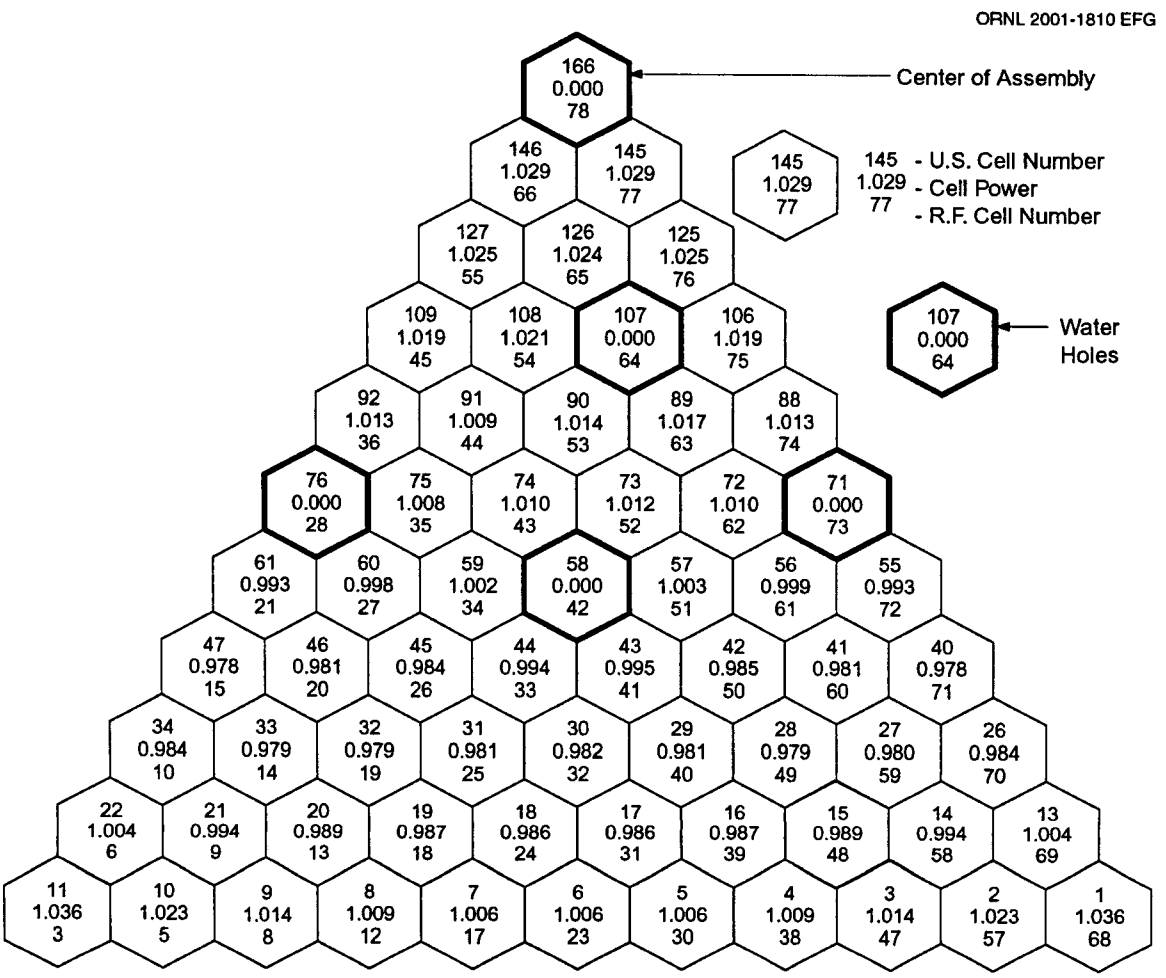


Fig. 4.45. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 11, State 3).

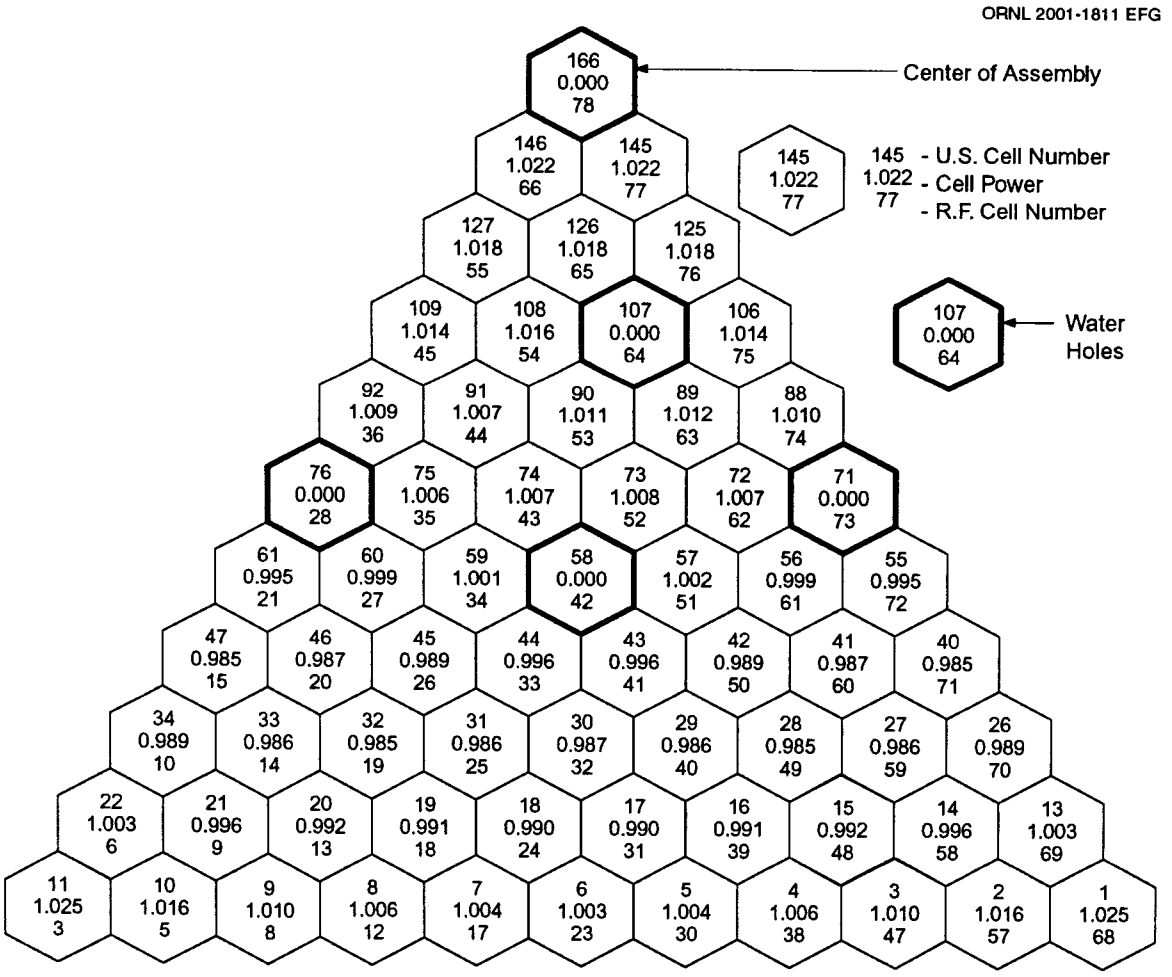


Fig. 4.46. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 11, State 3).

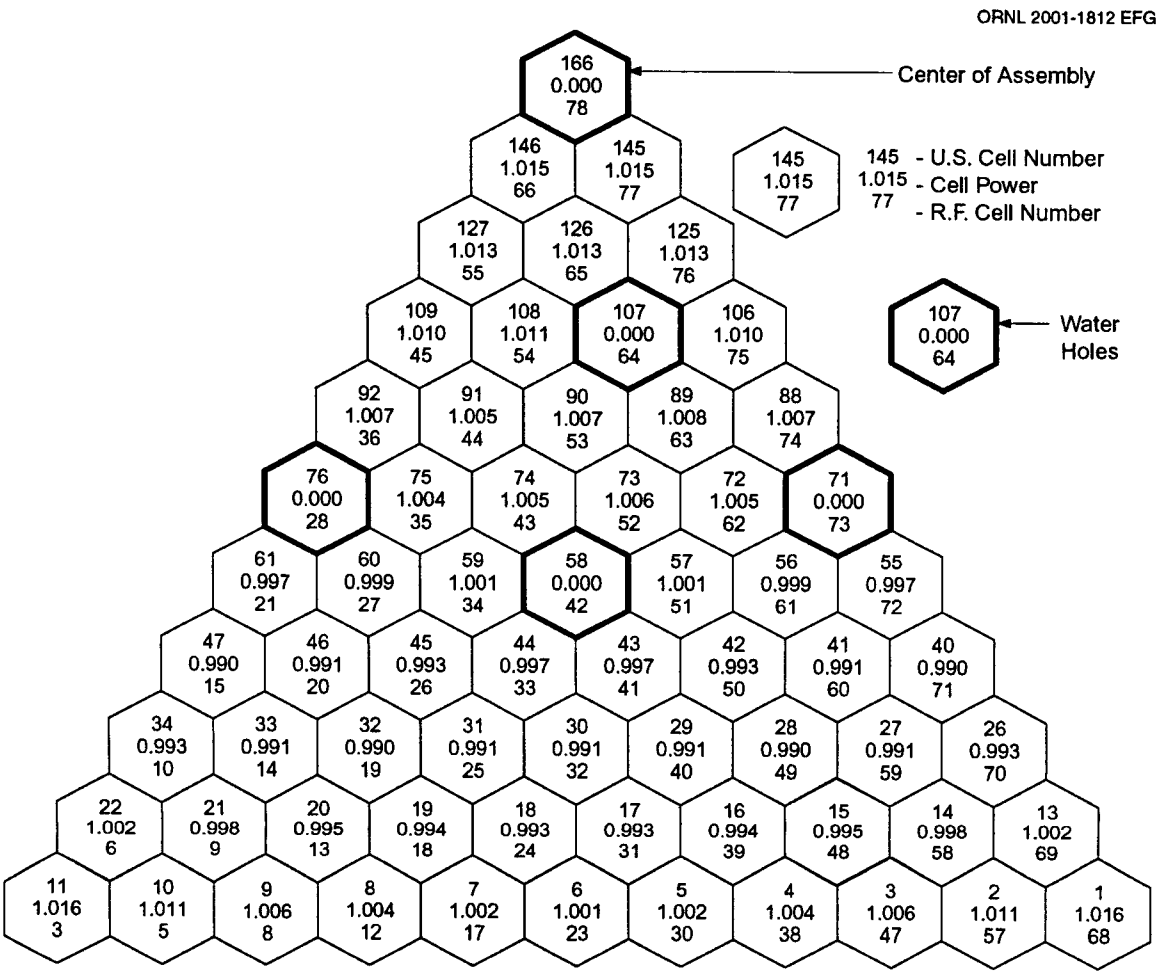


Fig. 4.47. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 11, State 3).

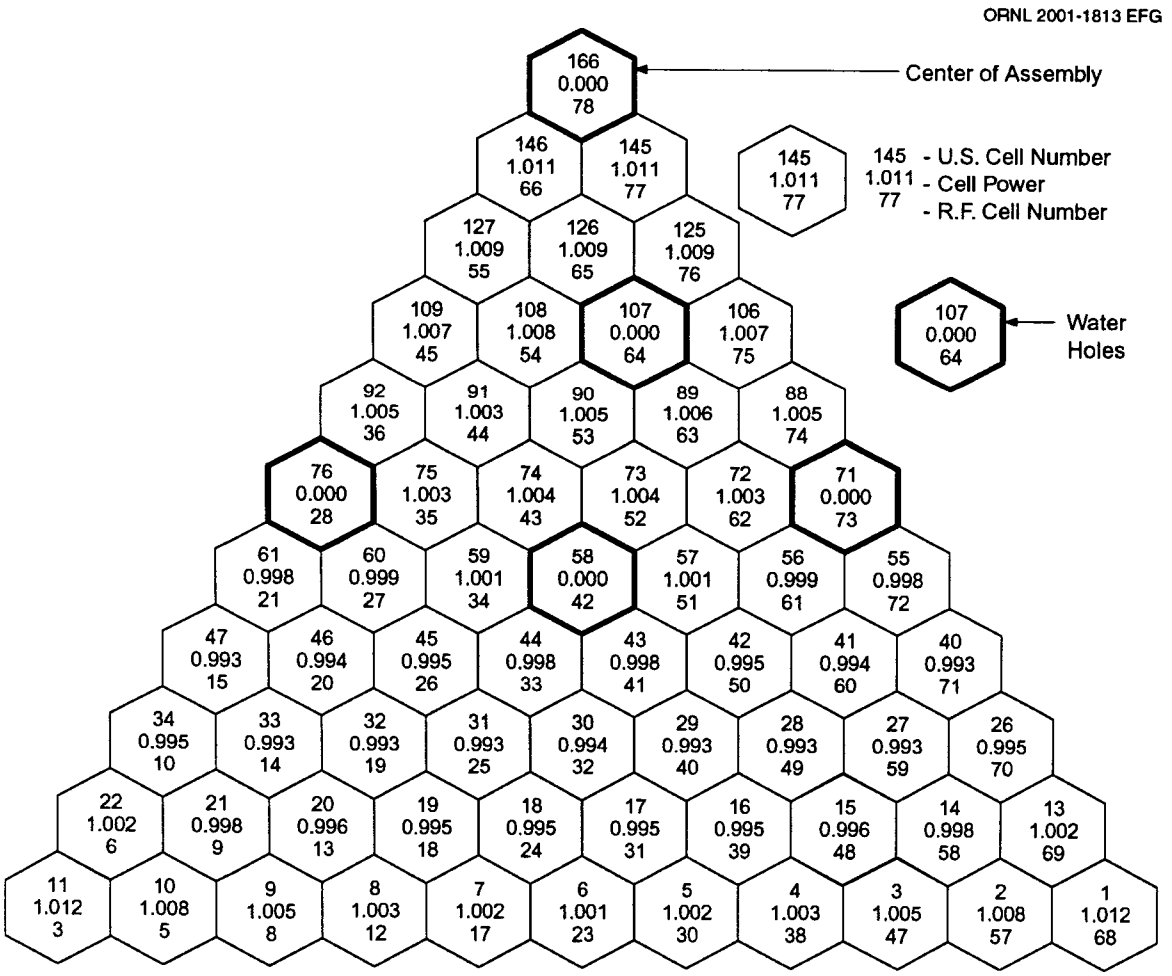


Fig. 4.48. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 11, State 3).

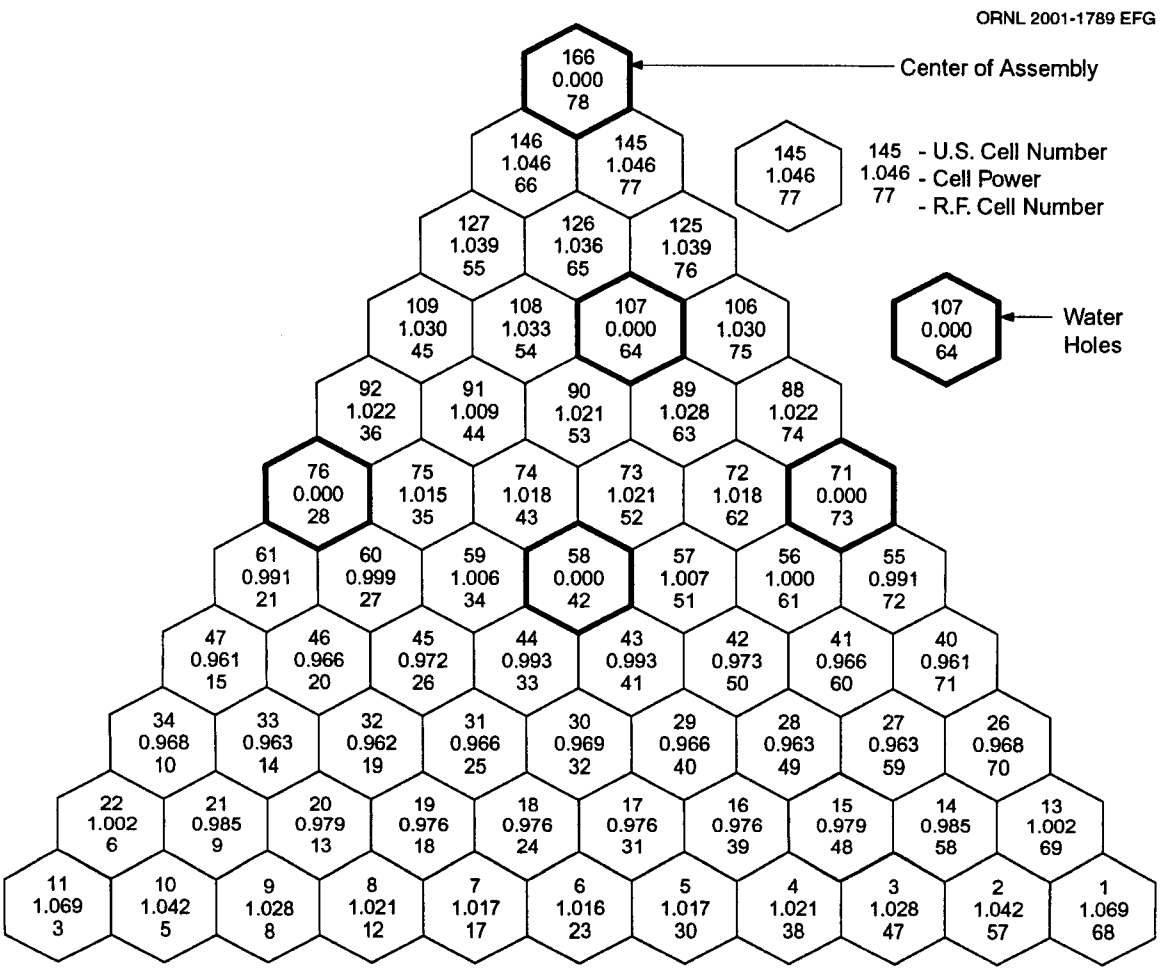


Fig. 4.49. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 11, State 4).

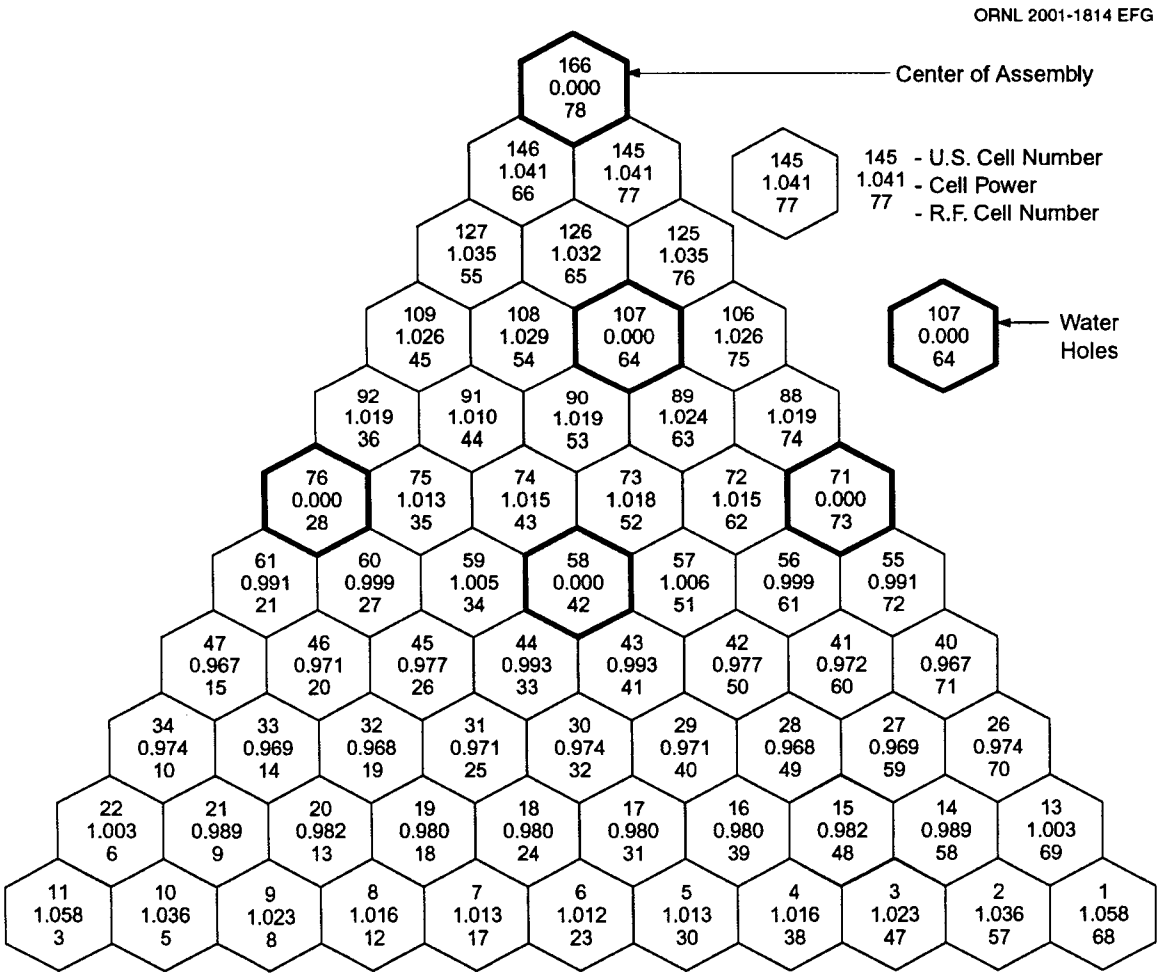


Fig. 4.50. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 11, State 4).

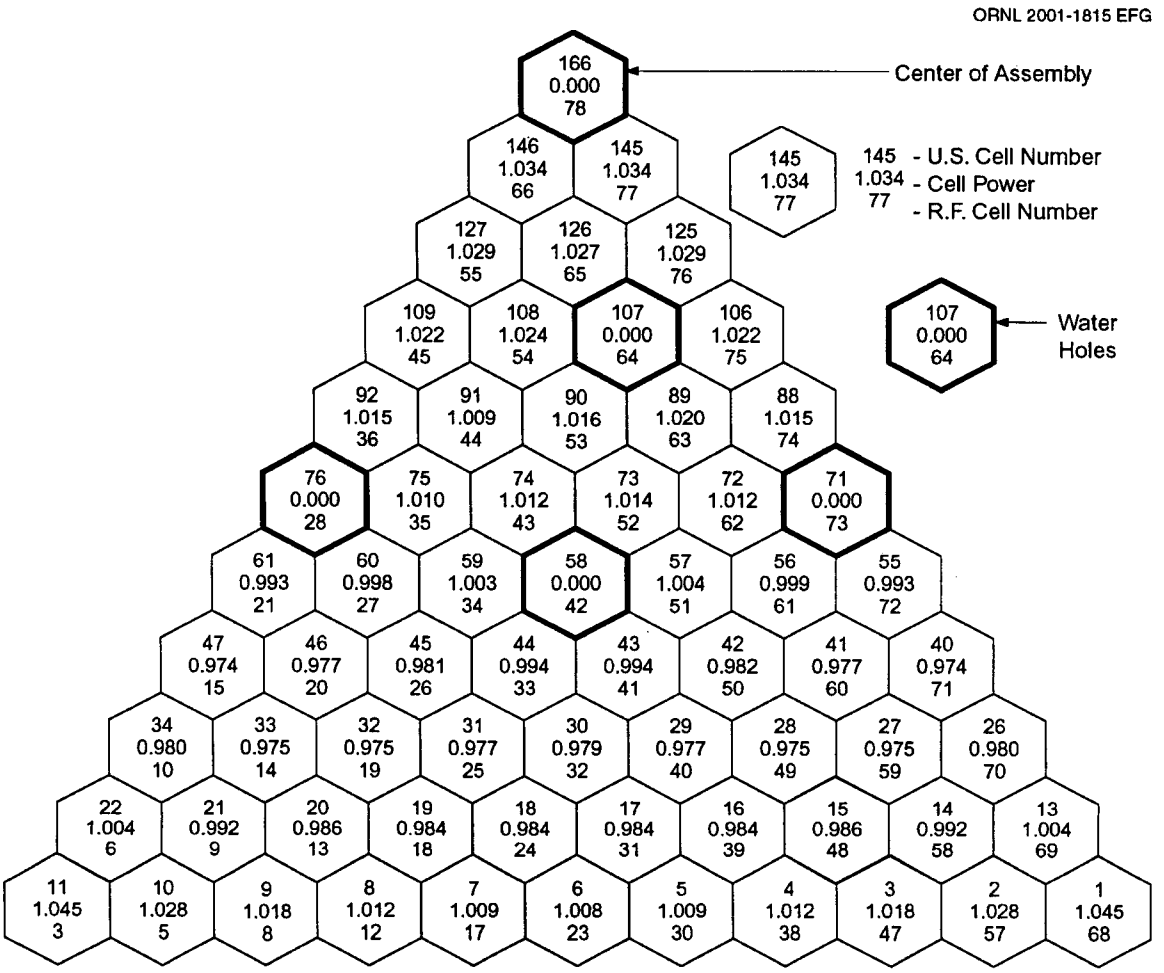


Fig. 4.51. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 11, State 4).

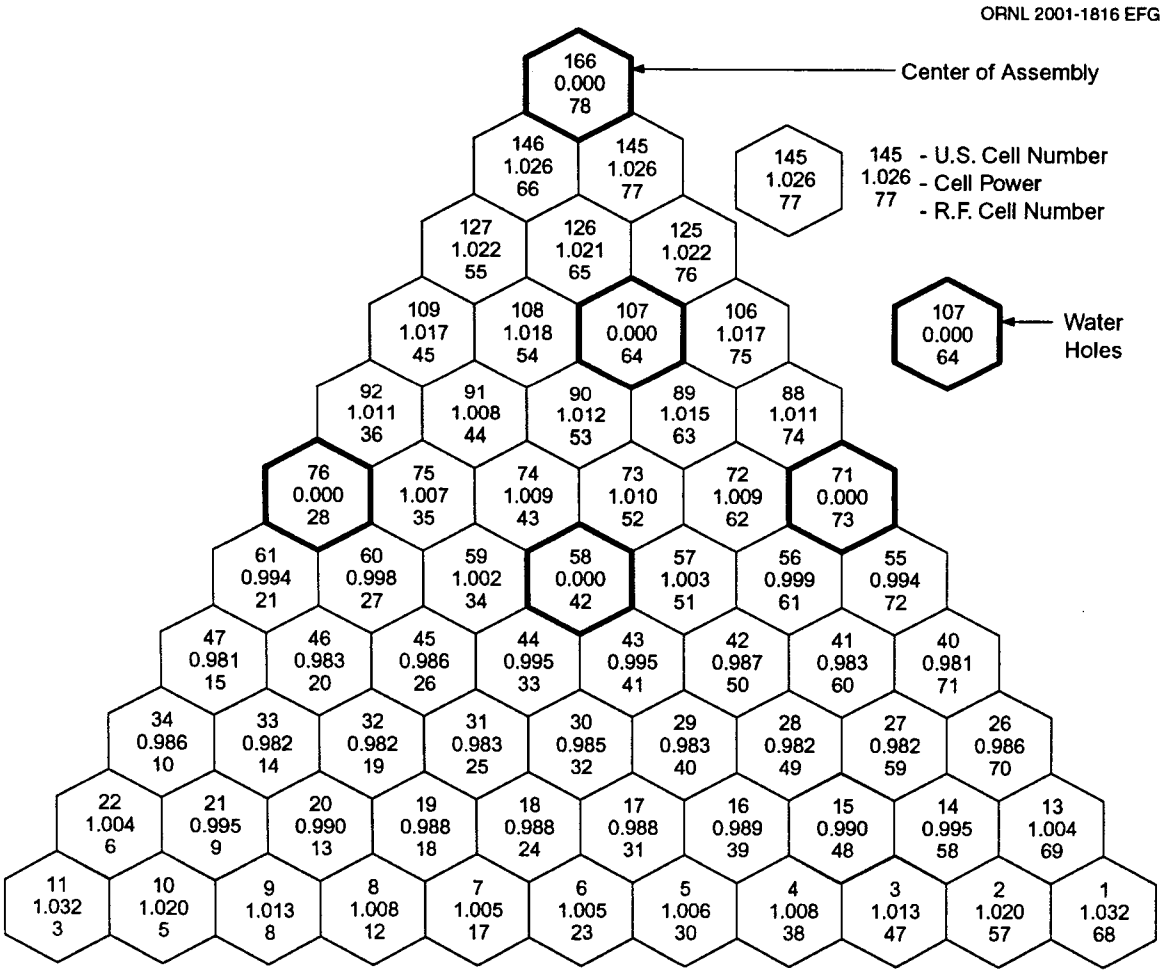


Fig. 4.52. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 11, State 4).

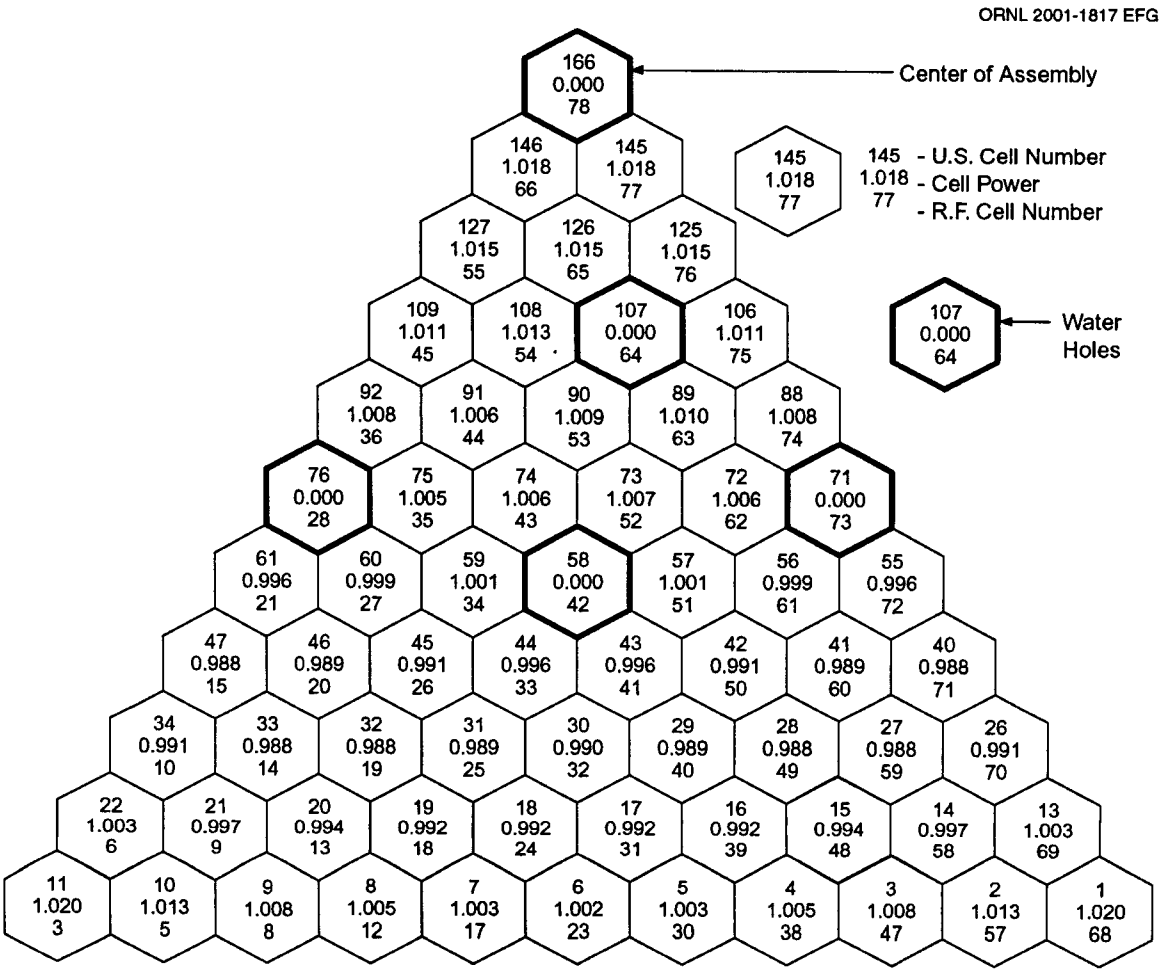


Fig. 4.53. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 11, State 4).

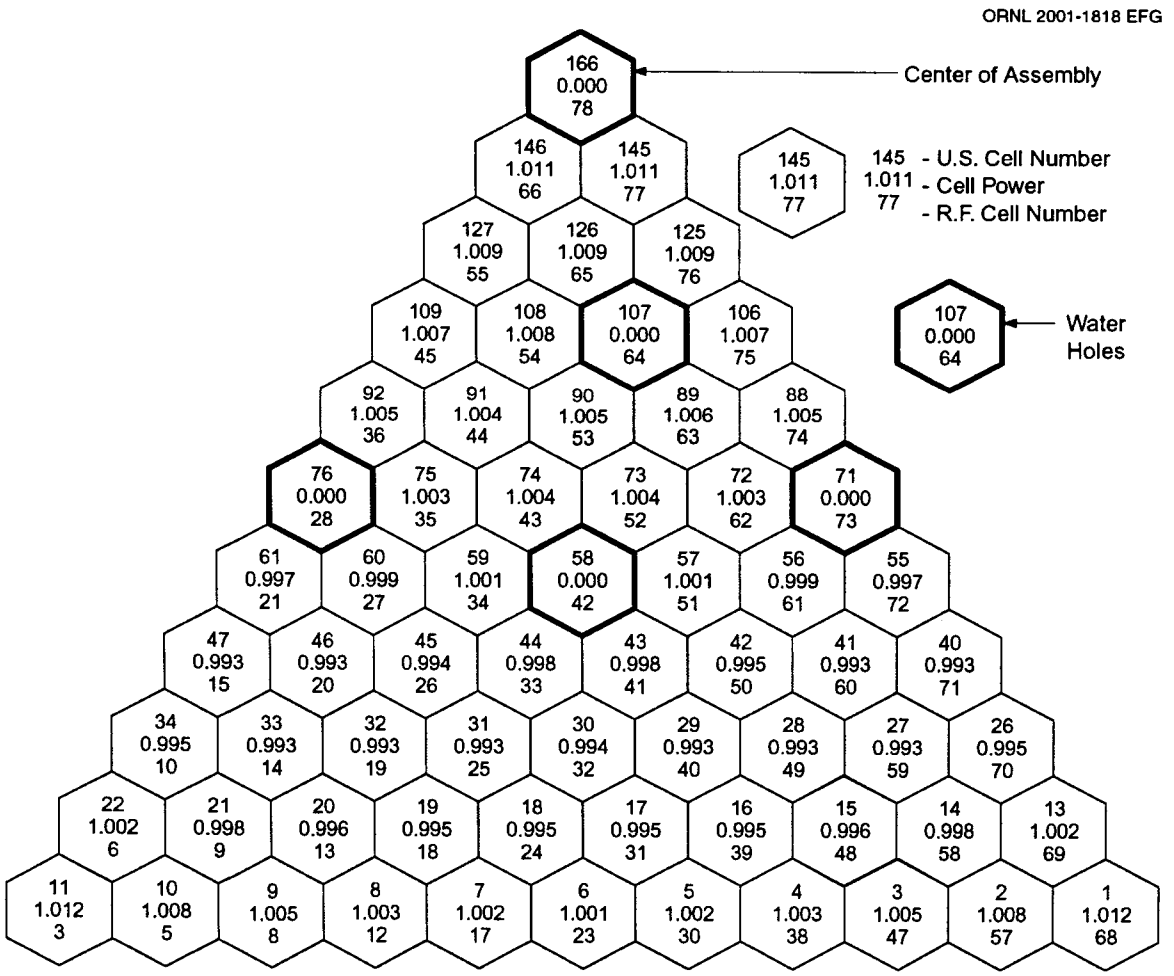


Fig. 4.54. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 11, State 4).

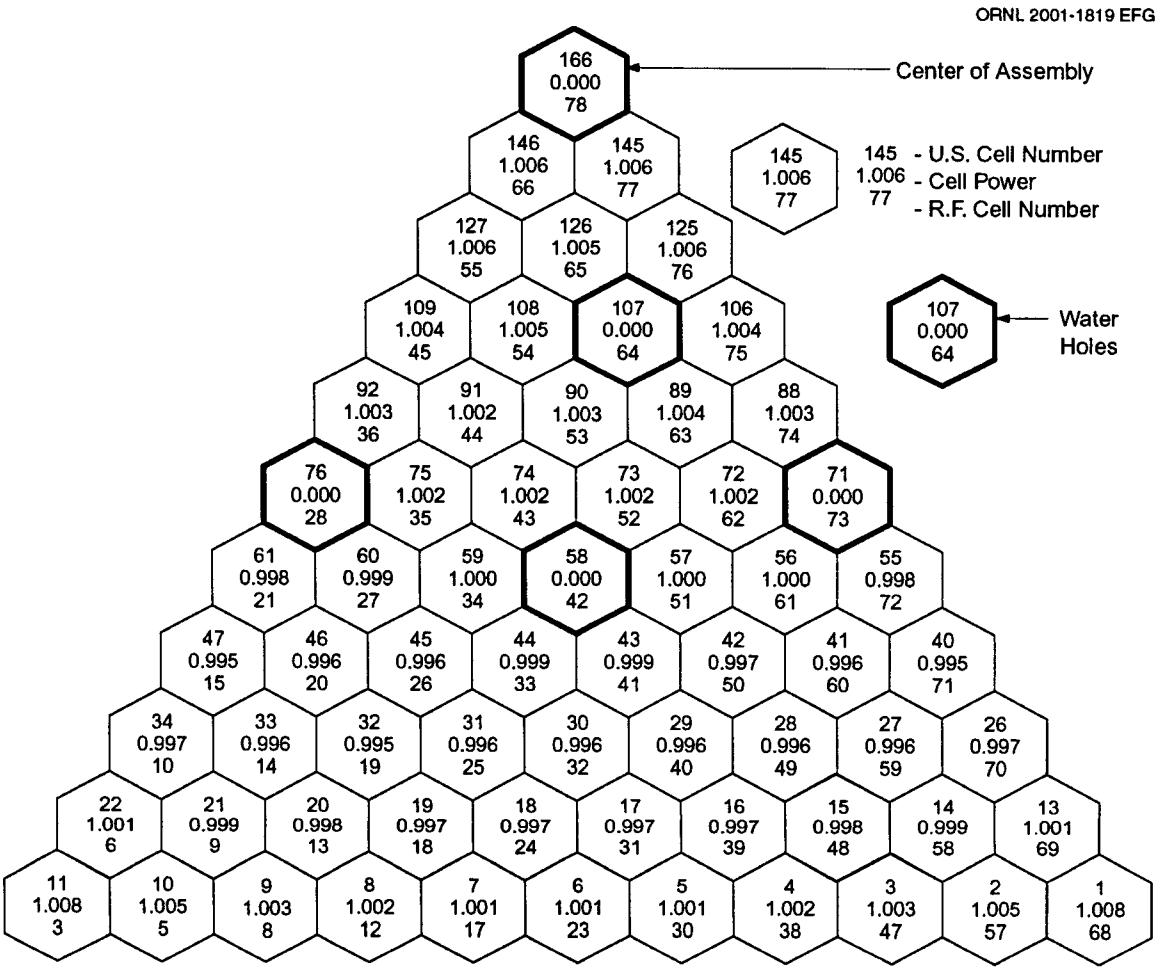


Fig. 4.55. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 11, State 4).

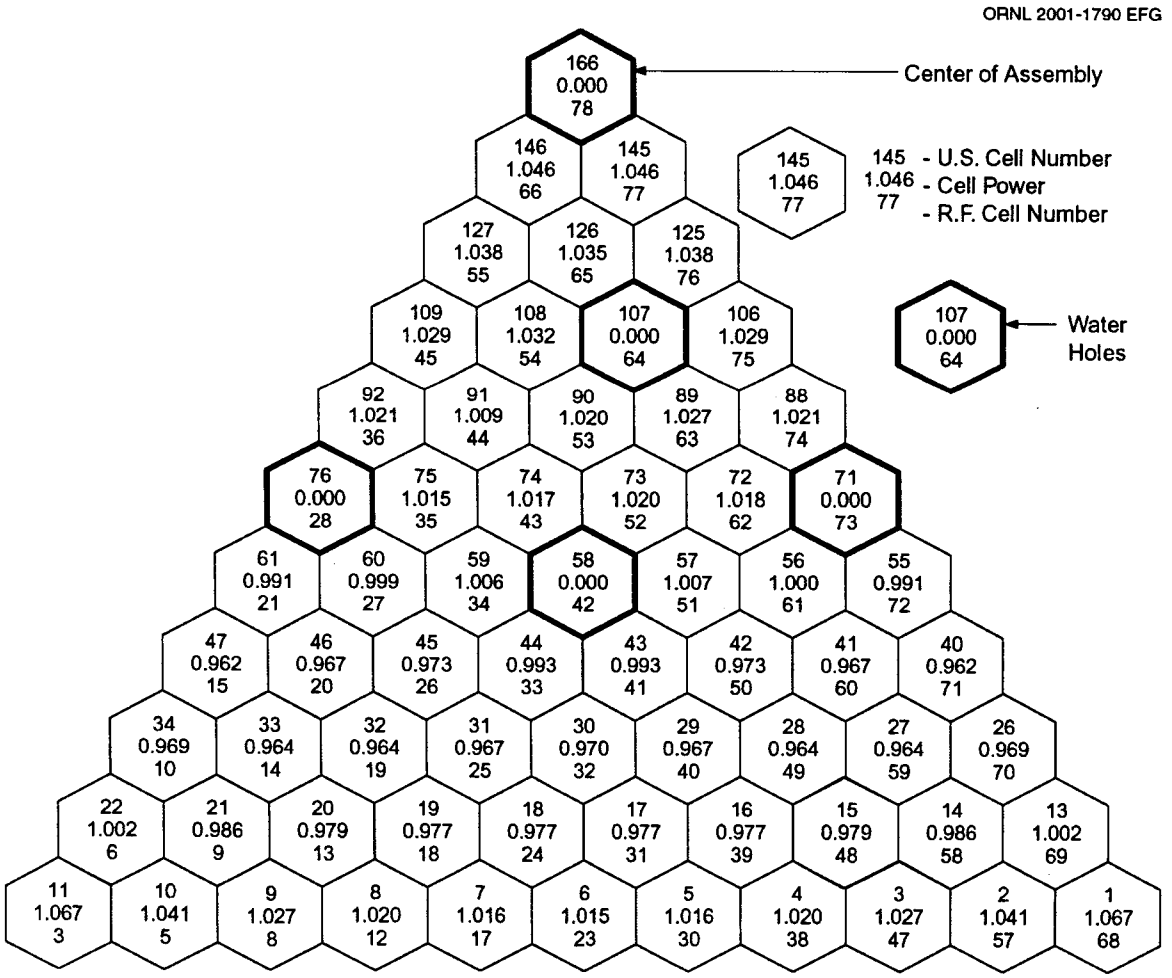


Fig. 4.56. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 11, State 5).

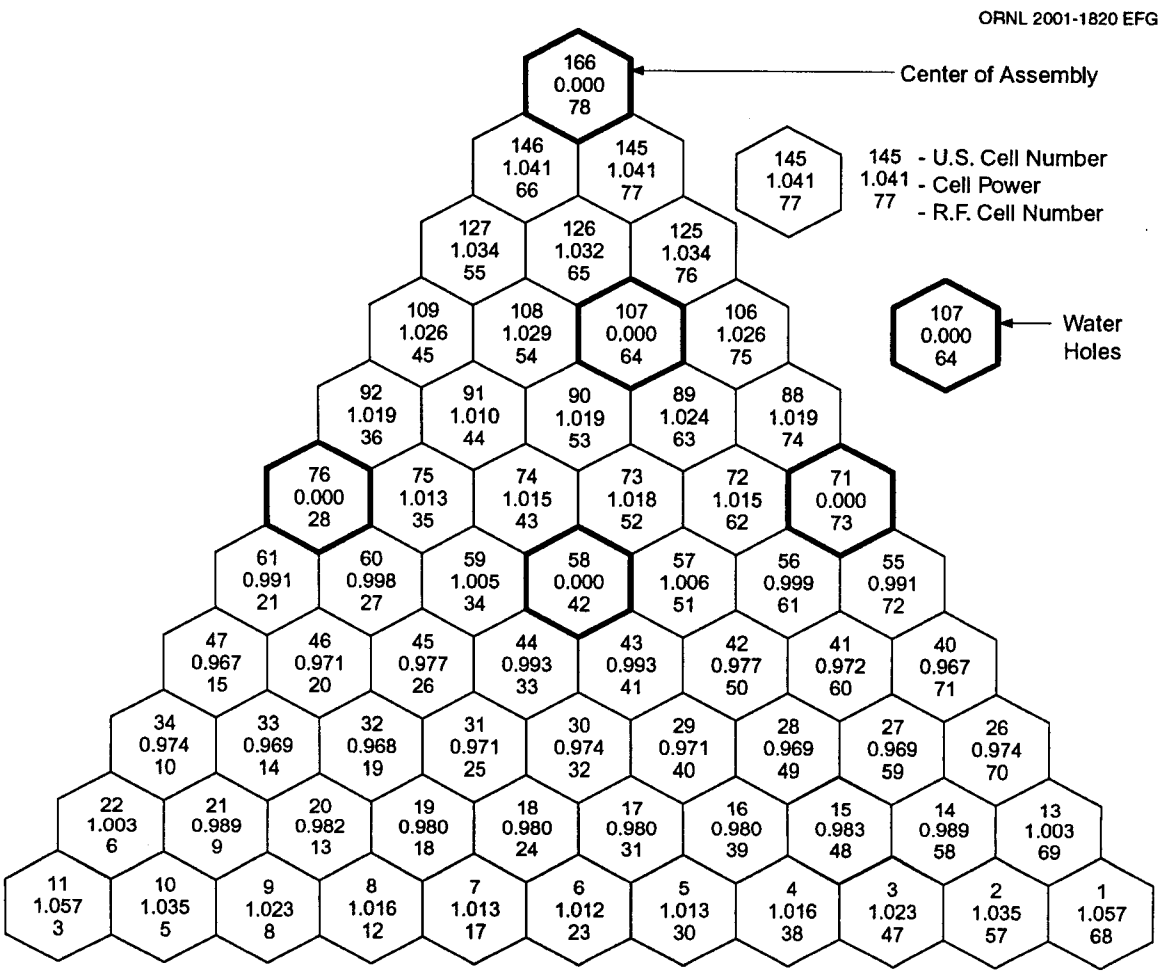


Fig. 4.57. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 11, State 5).

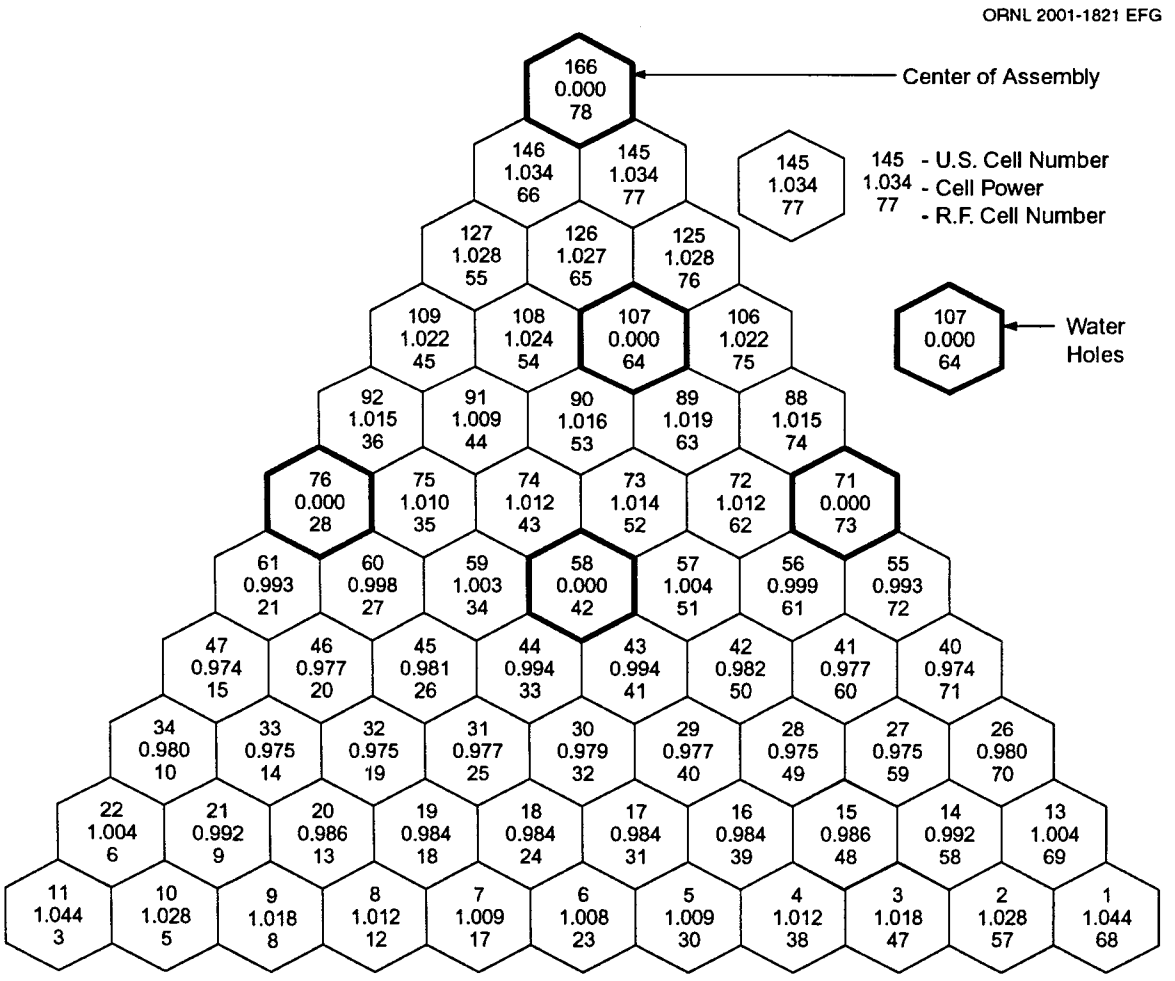


Fig. 4.58. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 11, State 5).

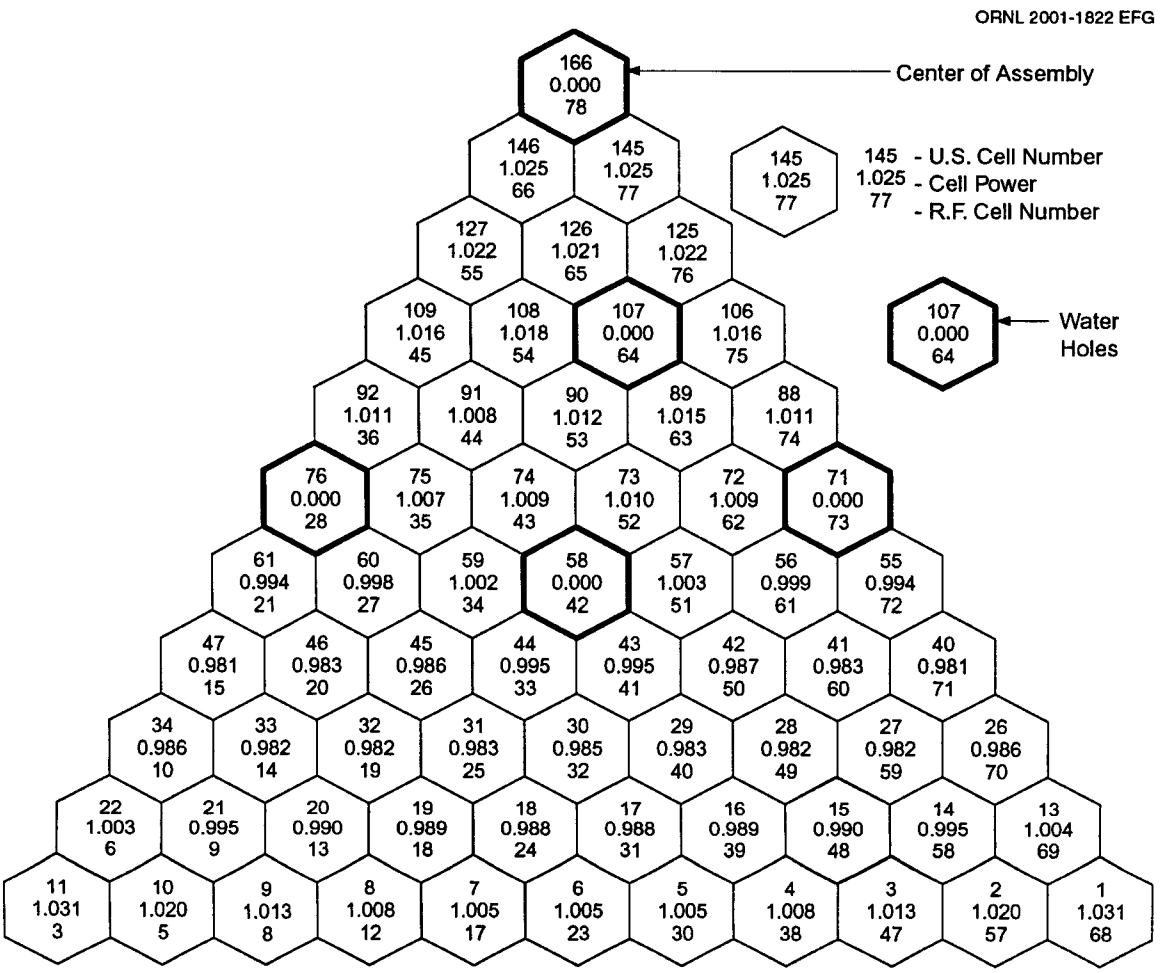


Fig. 4.59. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 11, State 5).

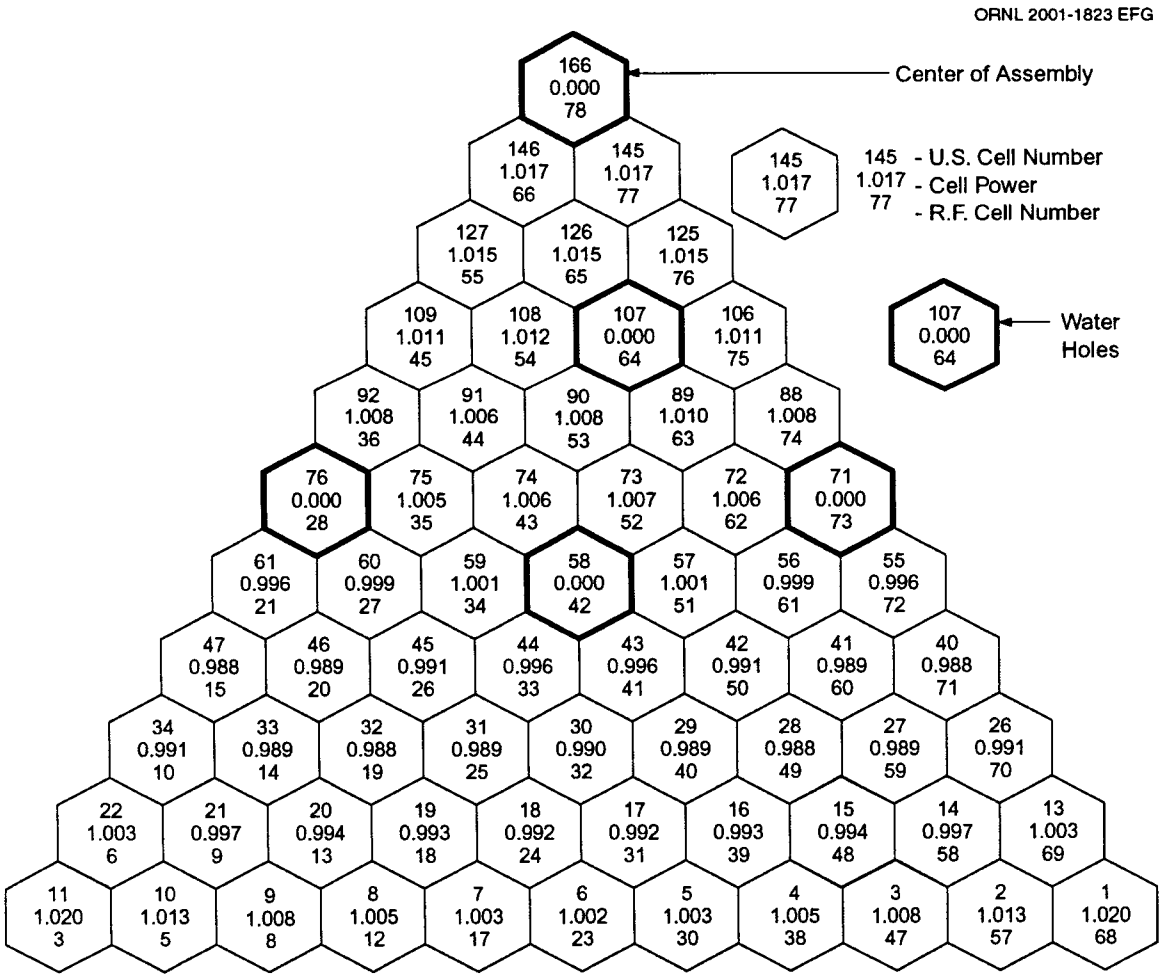


Fig. 4.60. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 11, State 5).

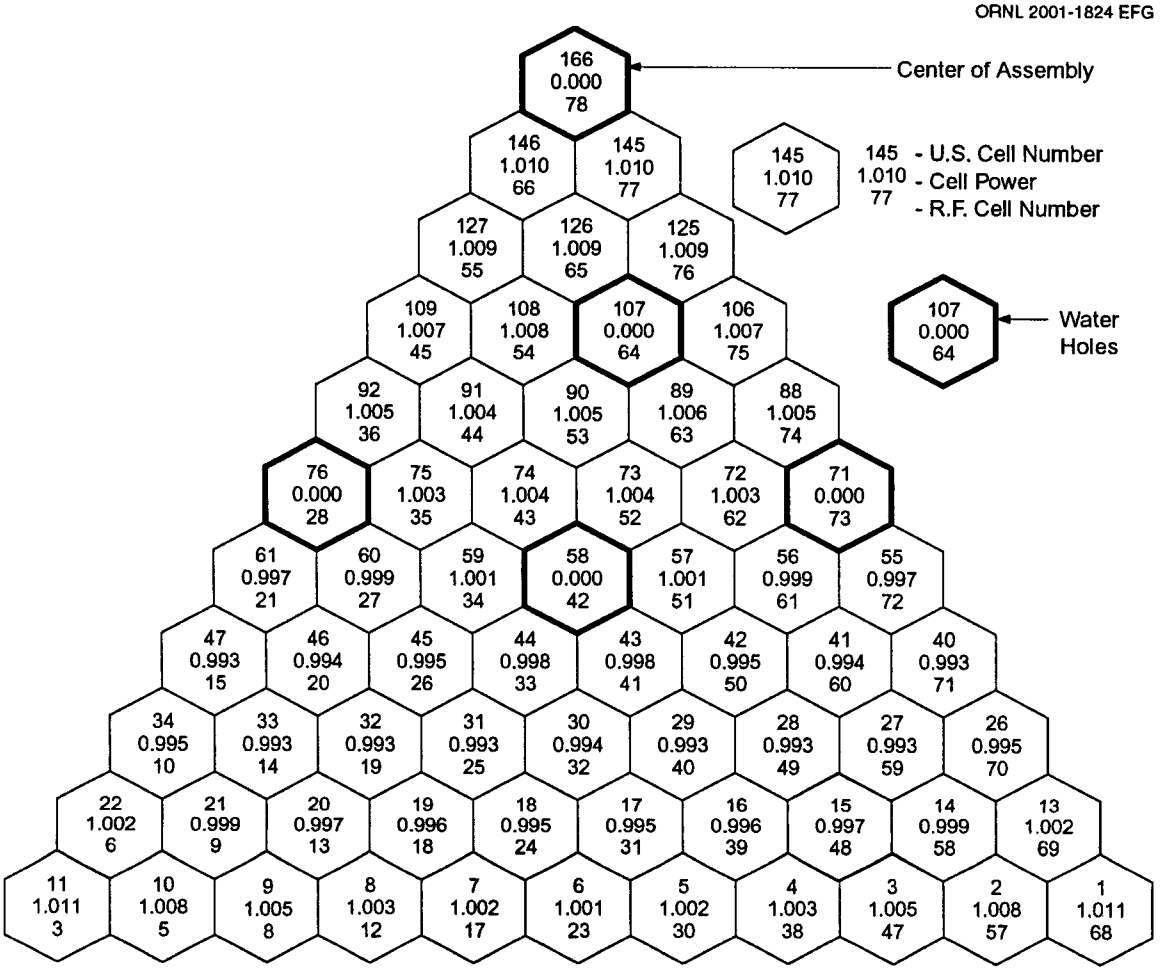


Fig. 4.61. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 11, State 5).

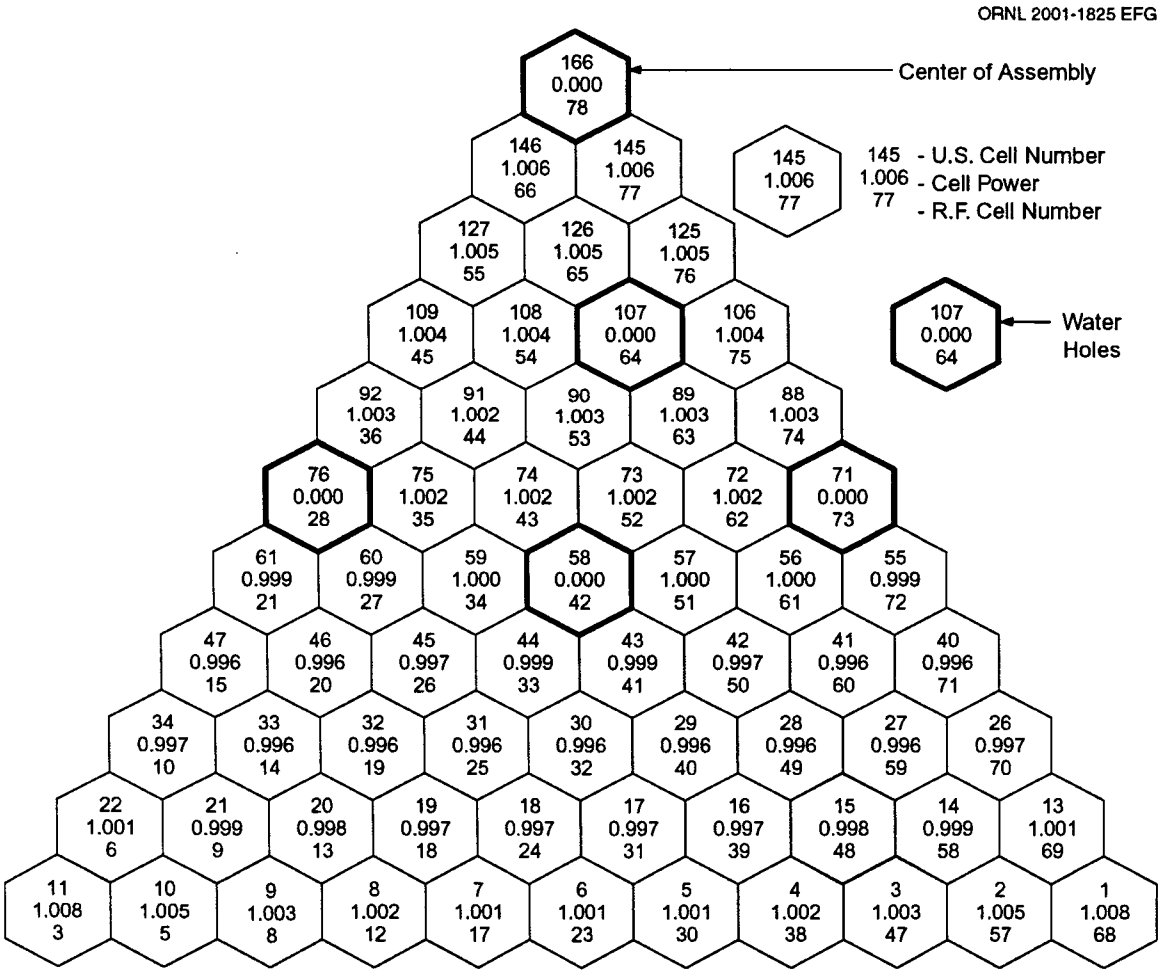


Fig. 4.62. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 11, State 5).

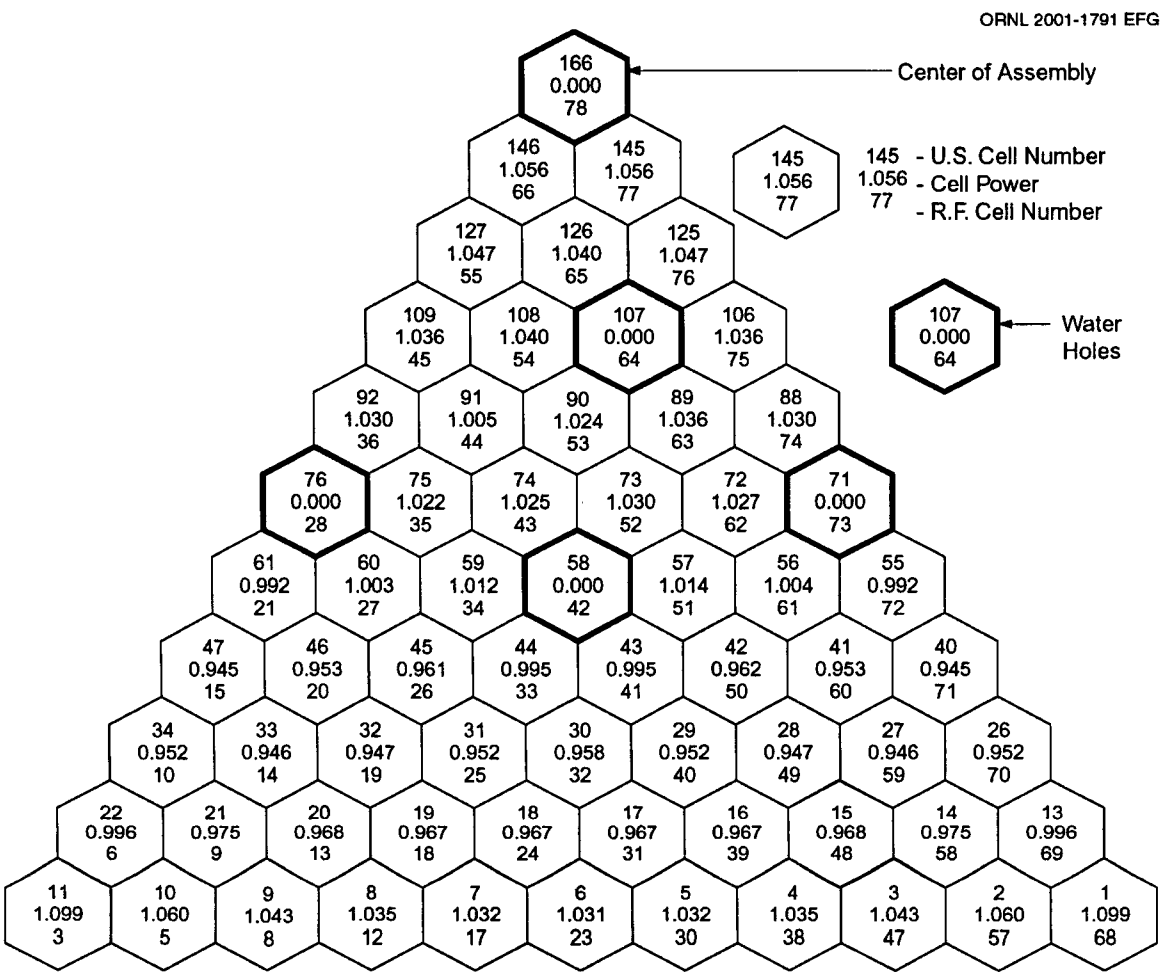


Fig. 4.63. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 11, State 6).

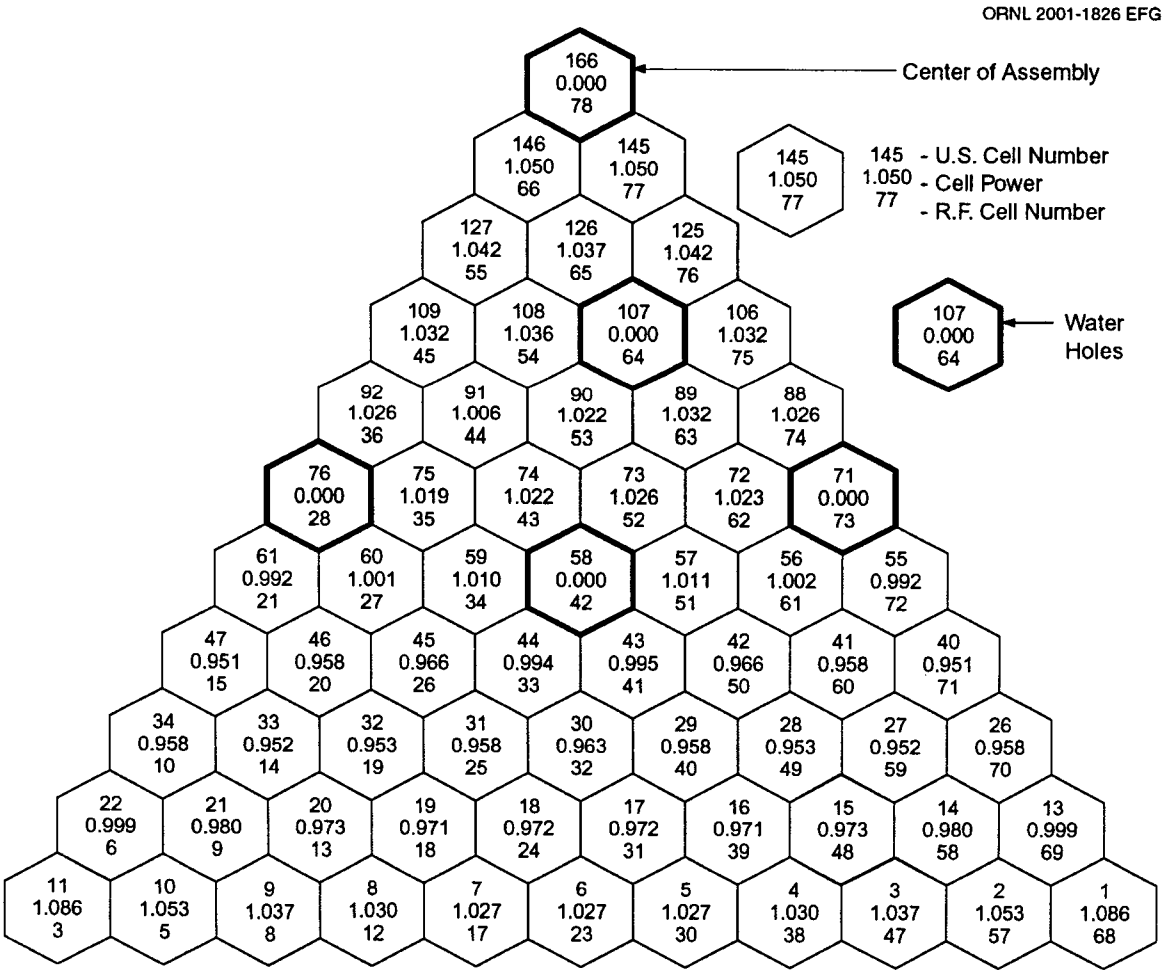


Fig. 4.64. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 11, State 6).

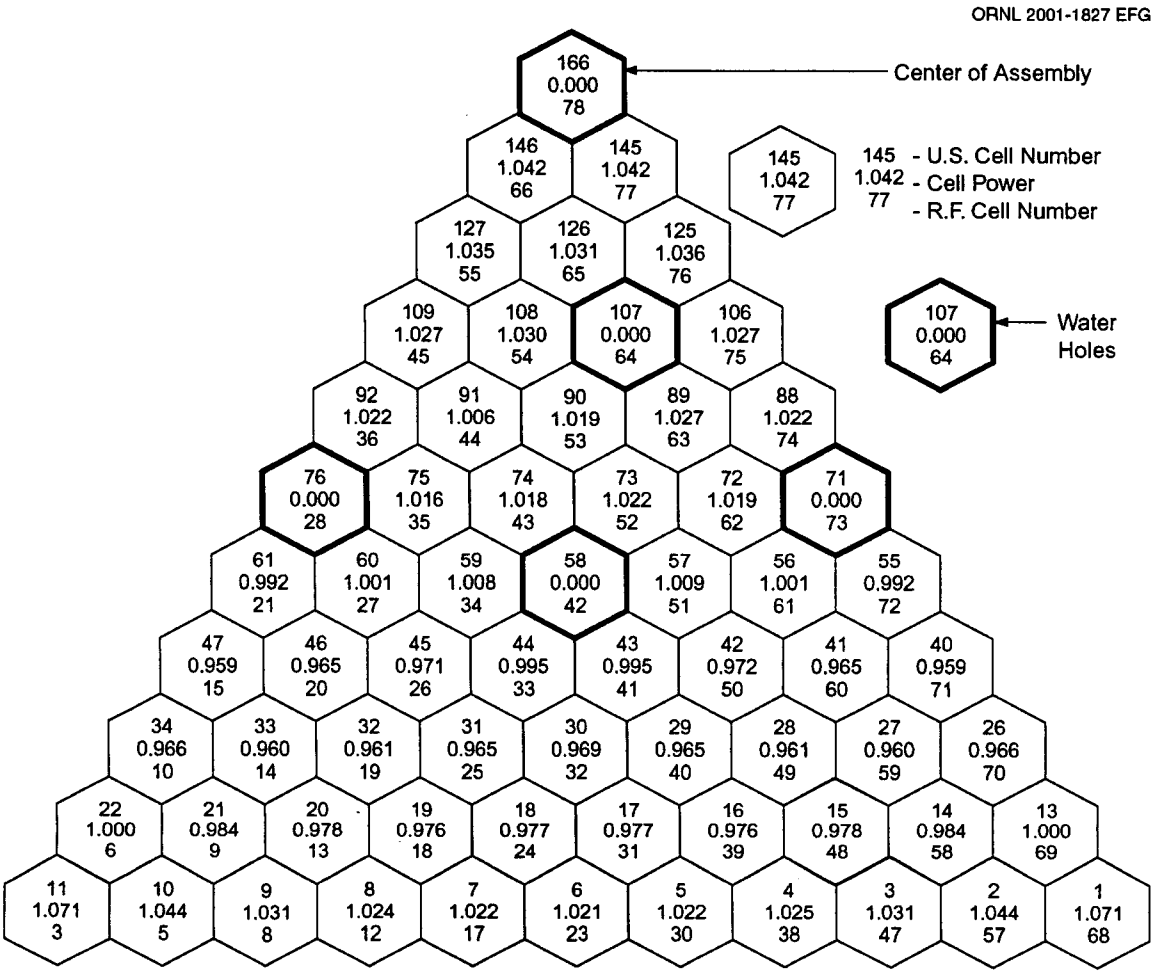


Fig. 4.65. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 11, State 6).

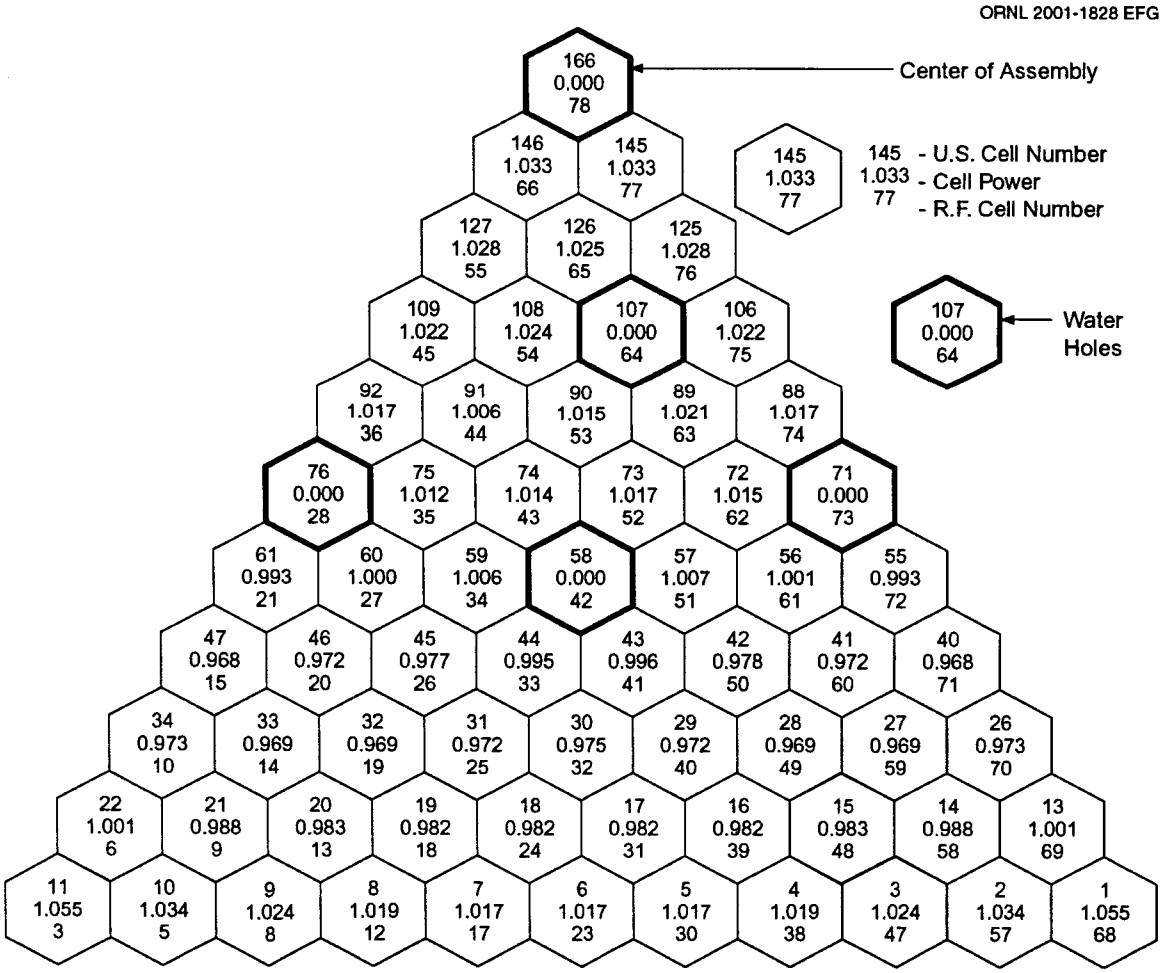


Fig. 4.66. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 11, State 6).

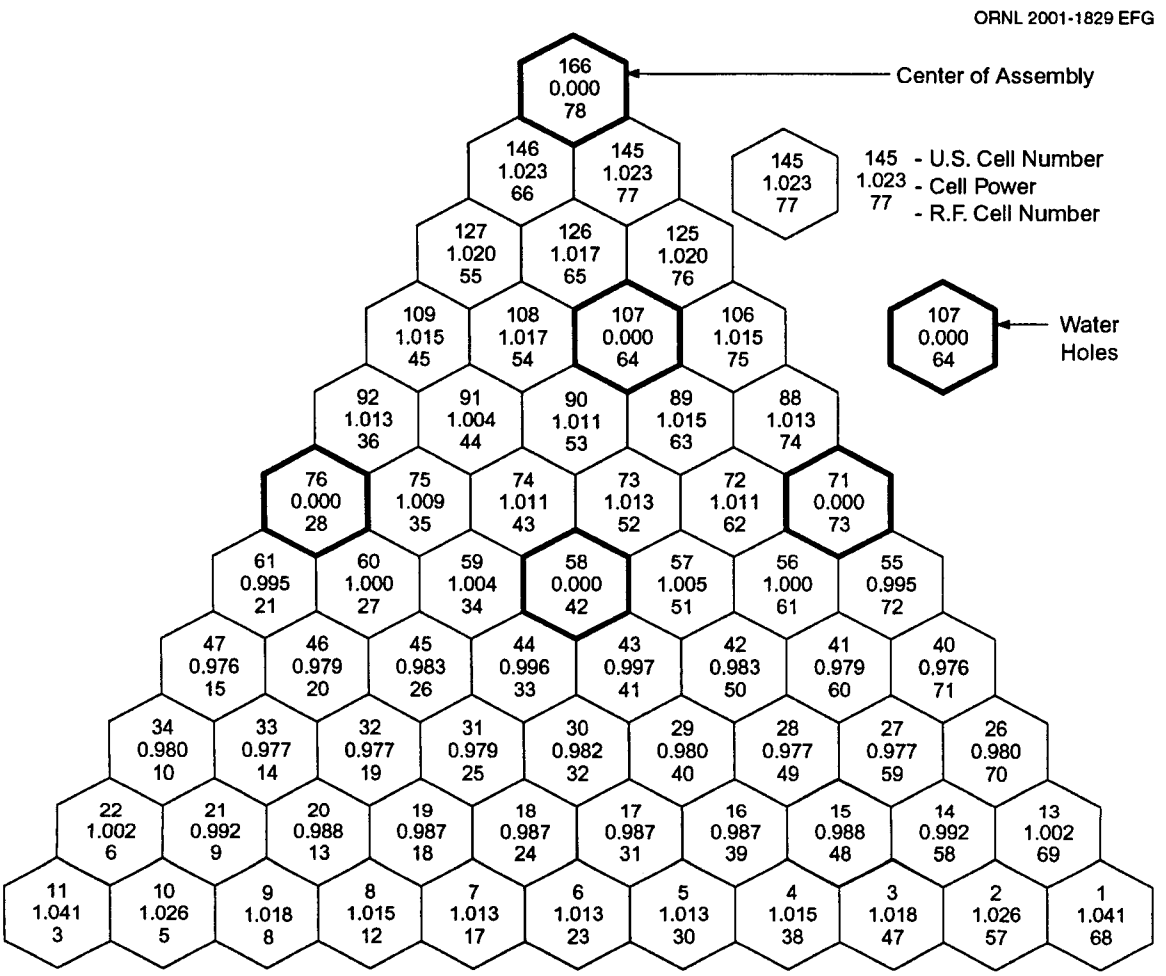


Fig. 4.67. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 11, State 6).

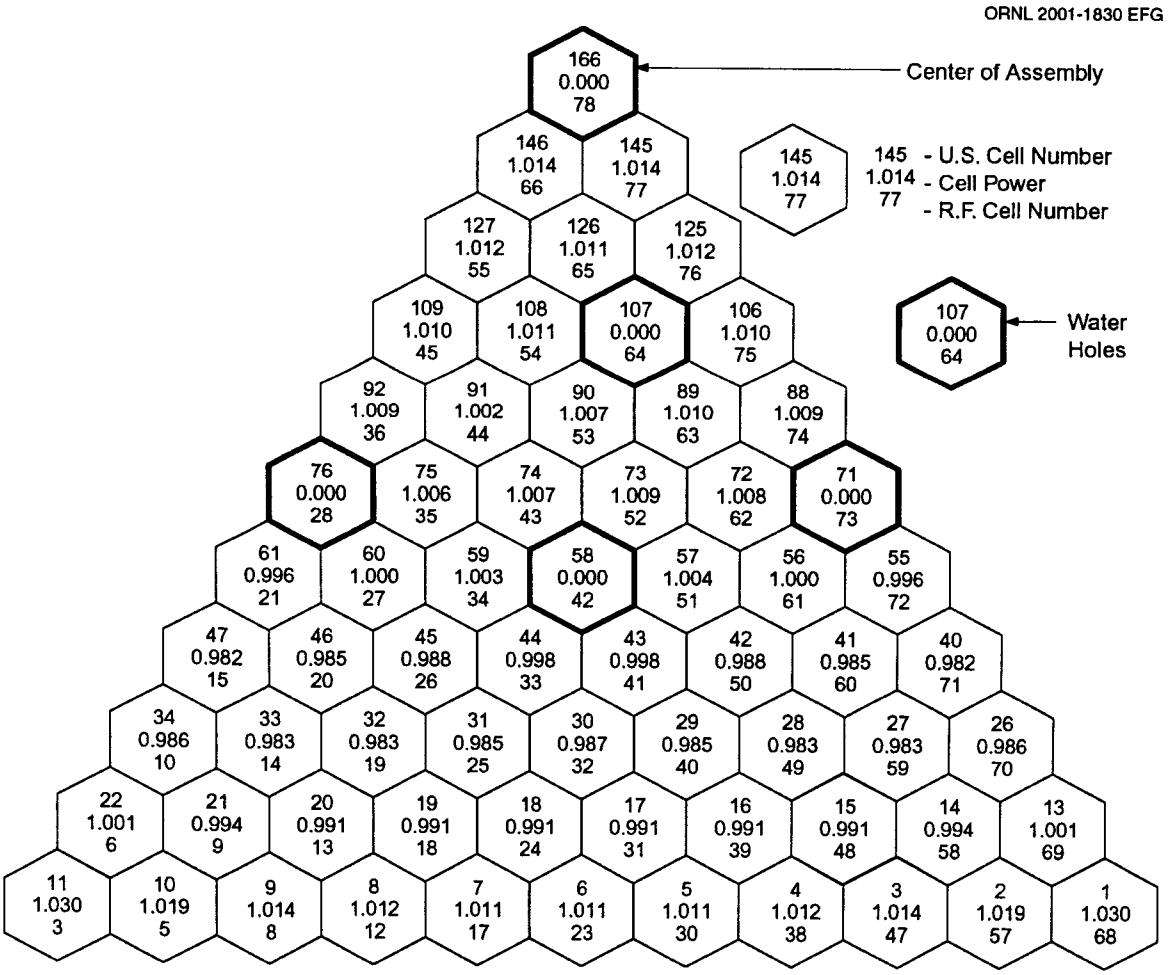


Fig. 4.68. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 11, State 6).

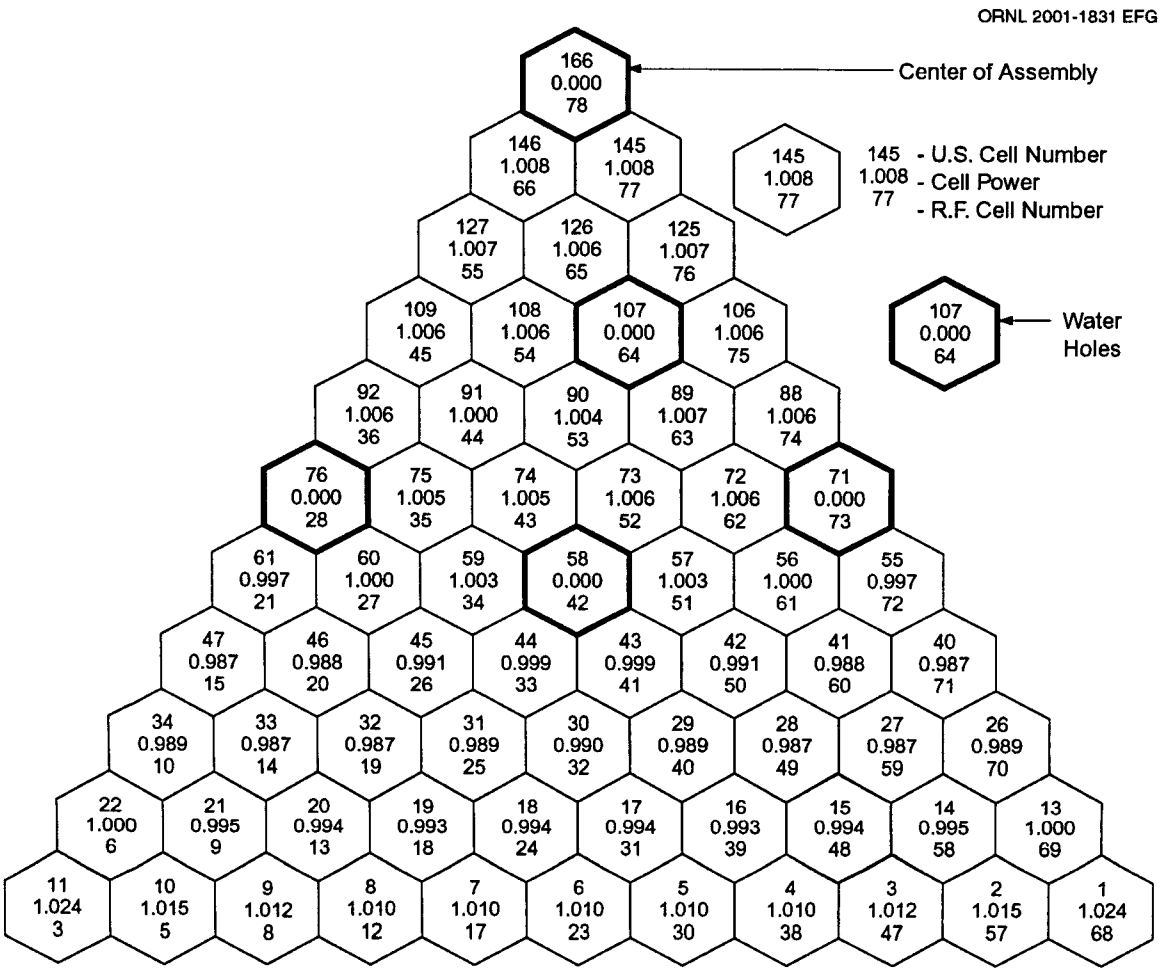


Fig. 4.69. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 11, State 6).

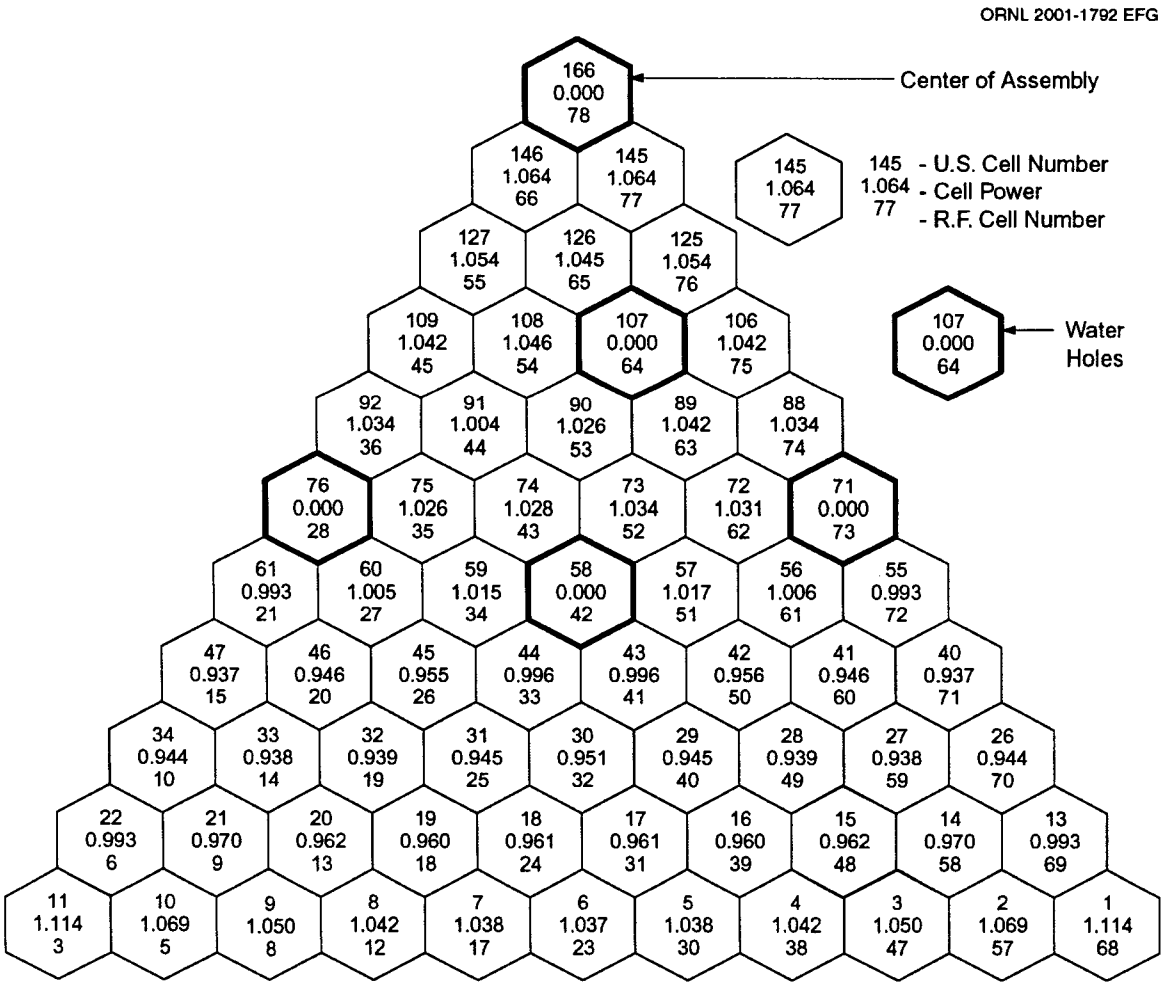


Fig. 4.70. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 12, State 1).

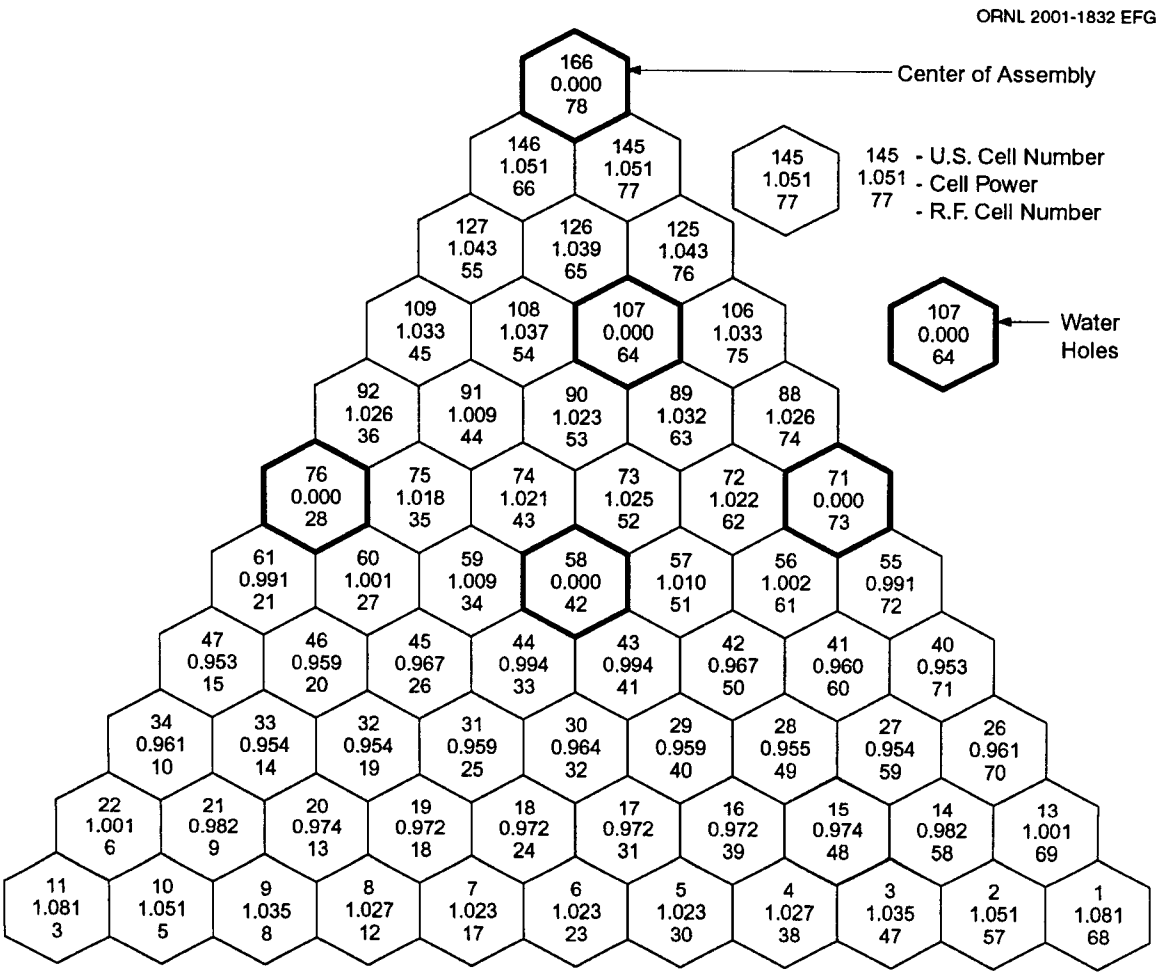


Fig. 4.71. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 12, State 1).

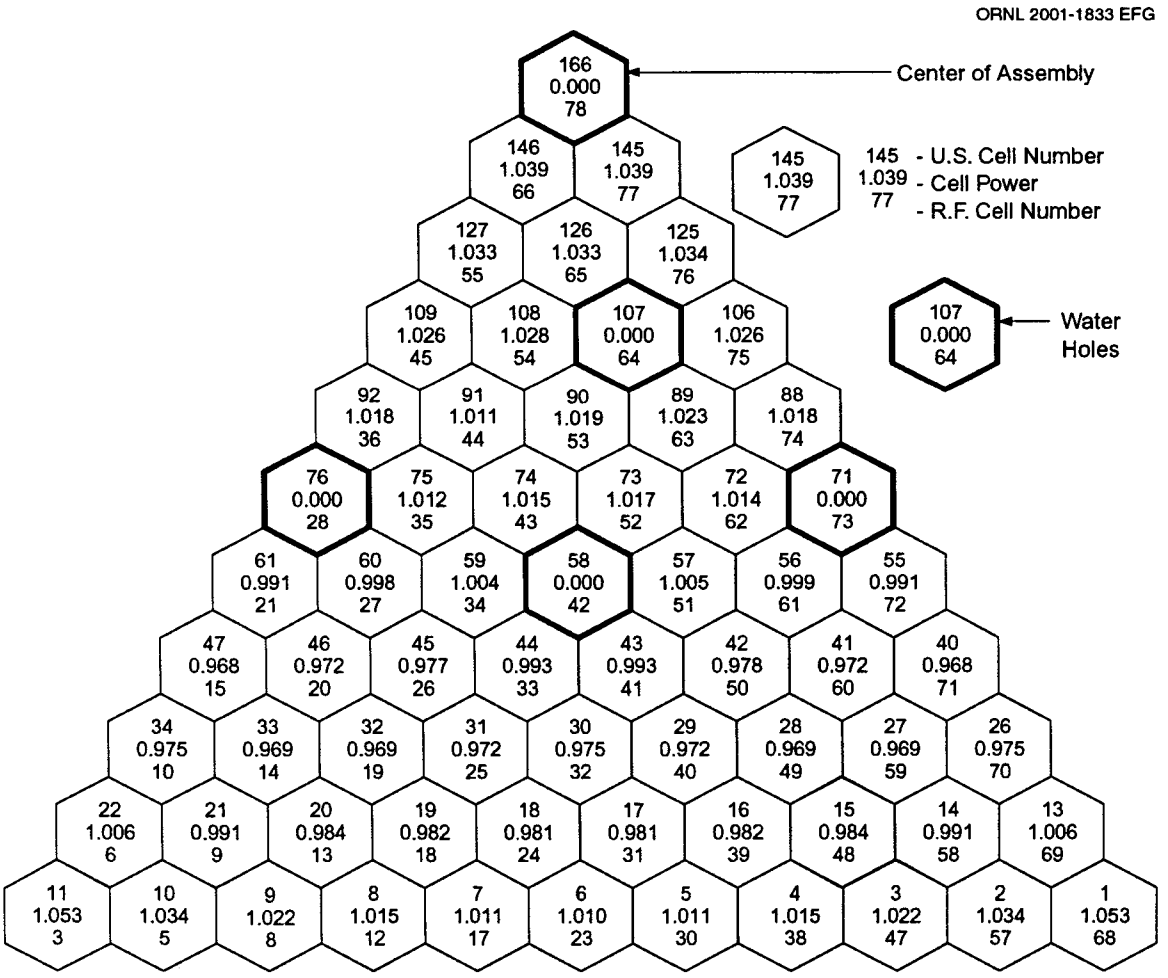


Fig. 4.72. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 12, State 1).

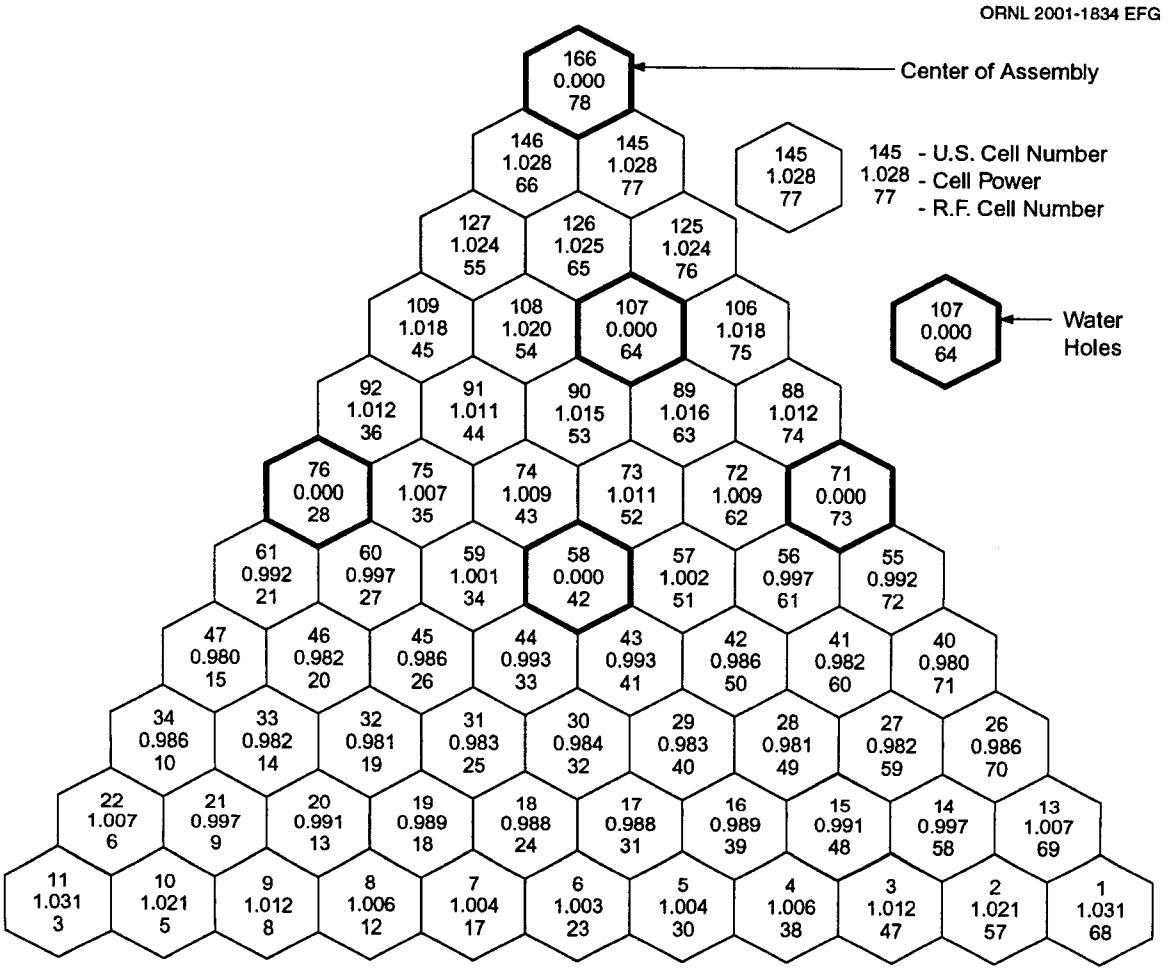


Fig. 4.73. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 12, State 1).

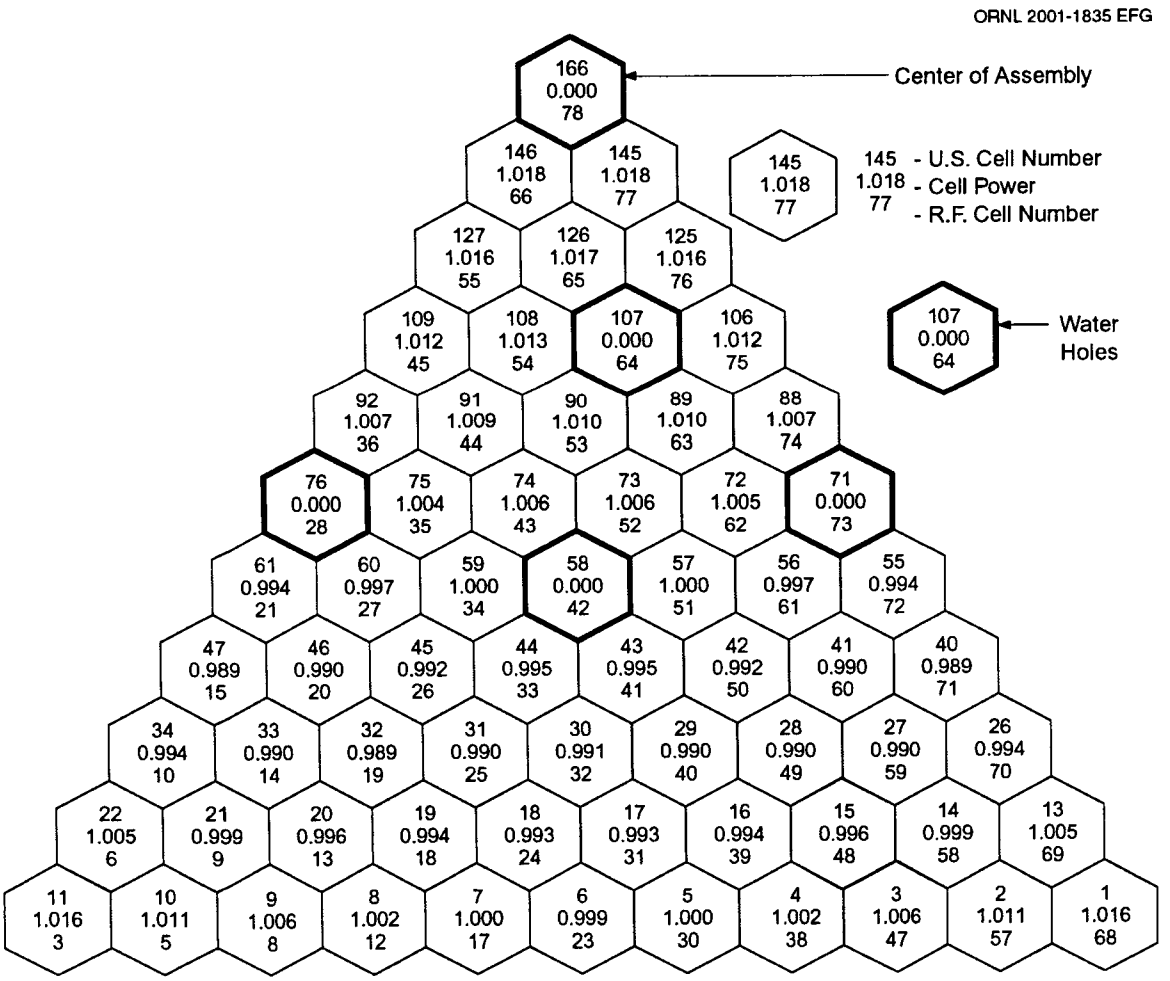


Fig. 4.74. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 12, State 1).

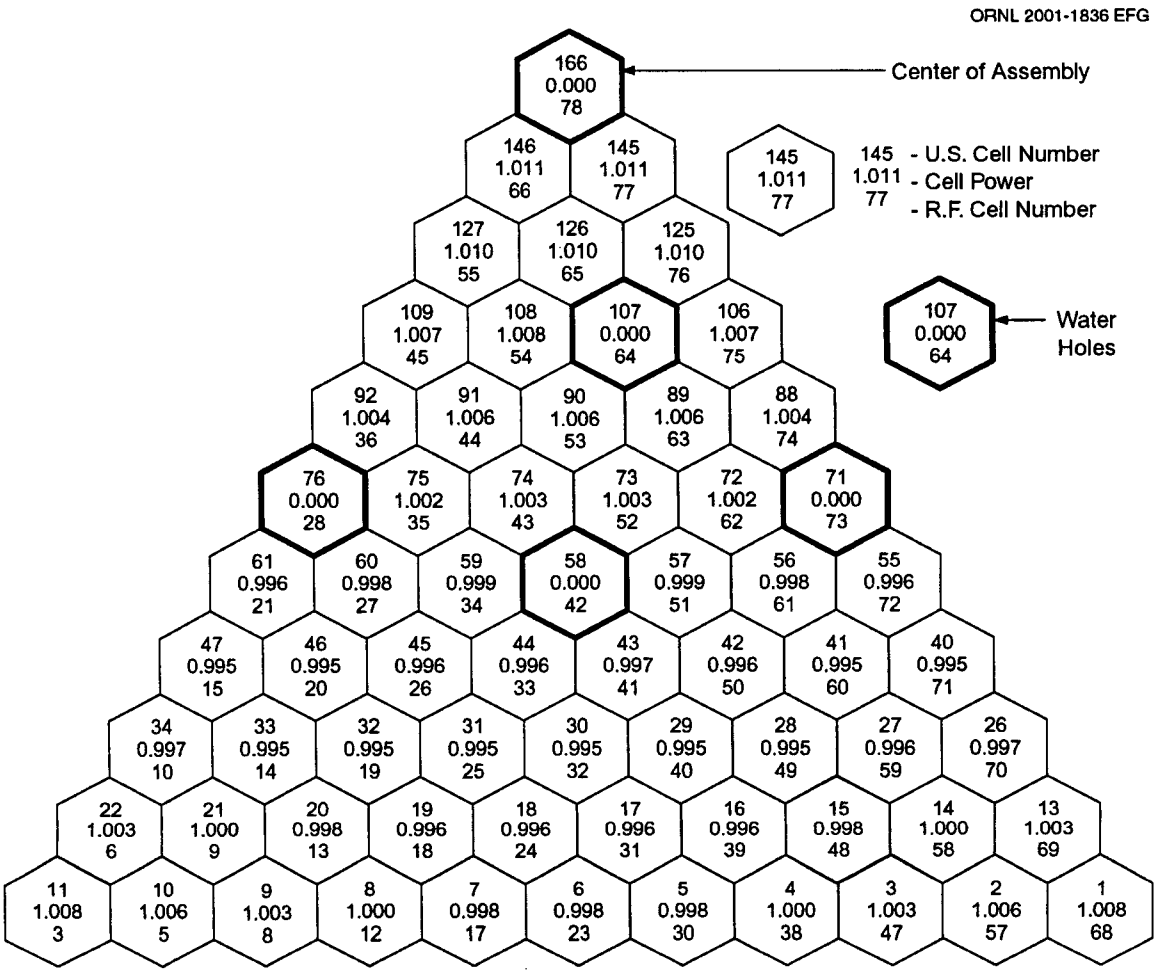


Fig. 4.75. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 12, State 1).

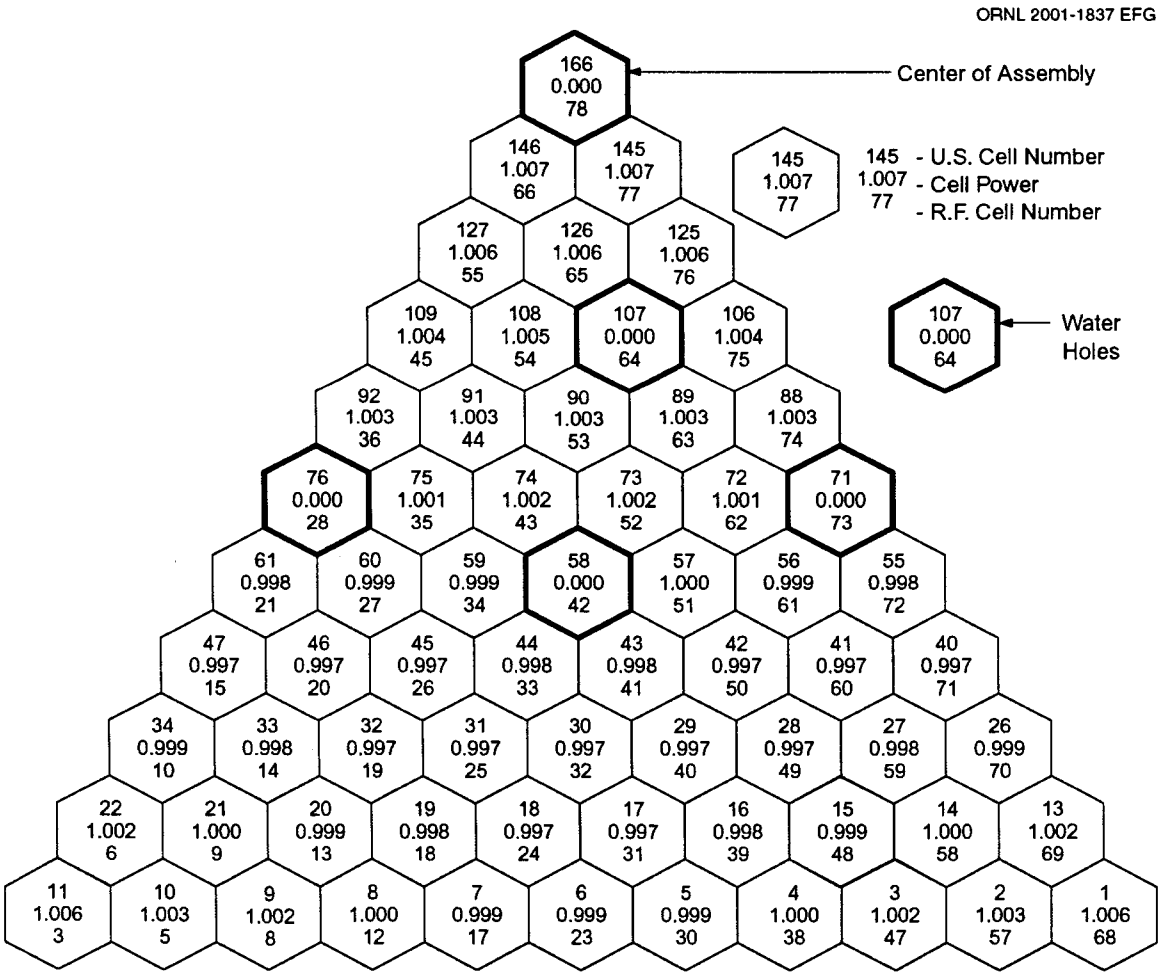


Fig. 4.76. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 12, State 1).

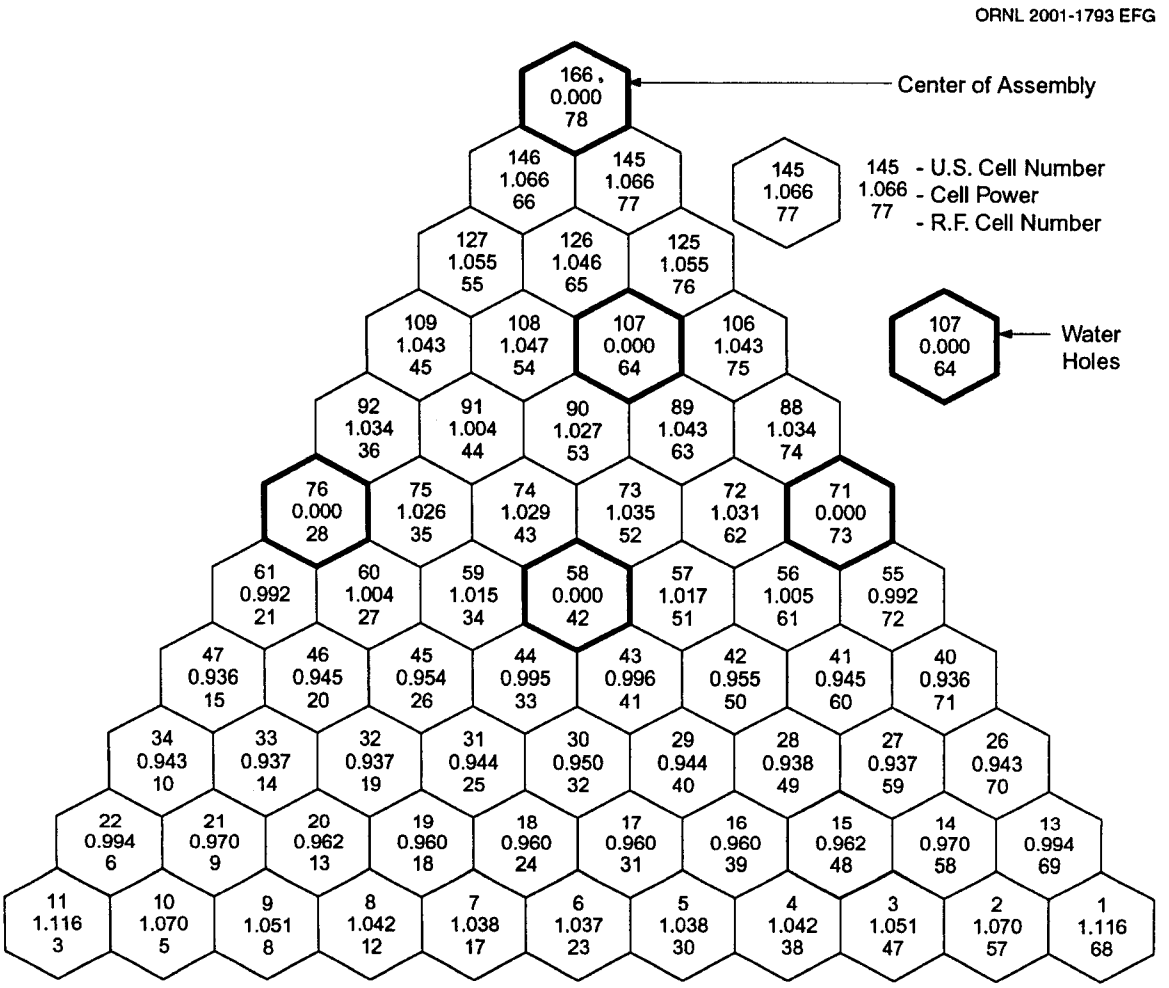


Fig. 4.77. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 12, State 3).

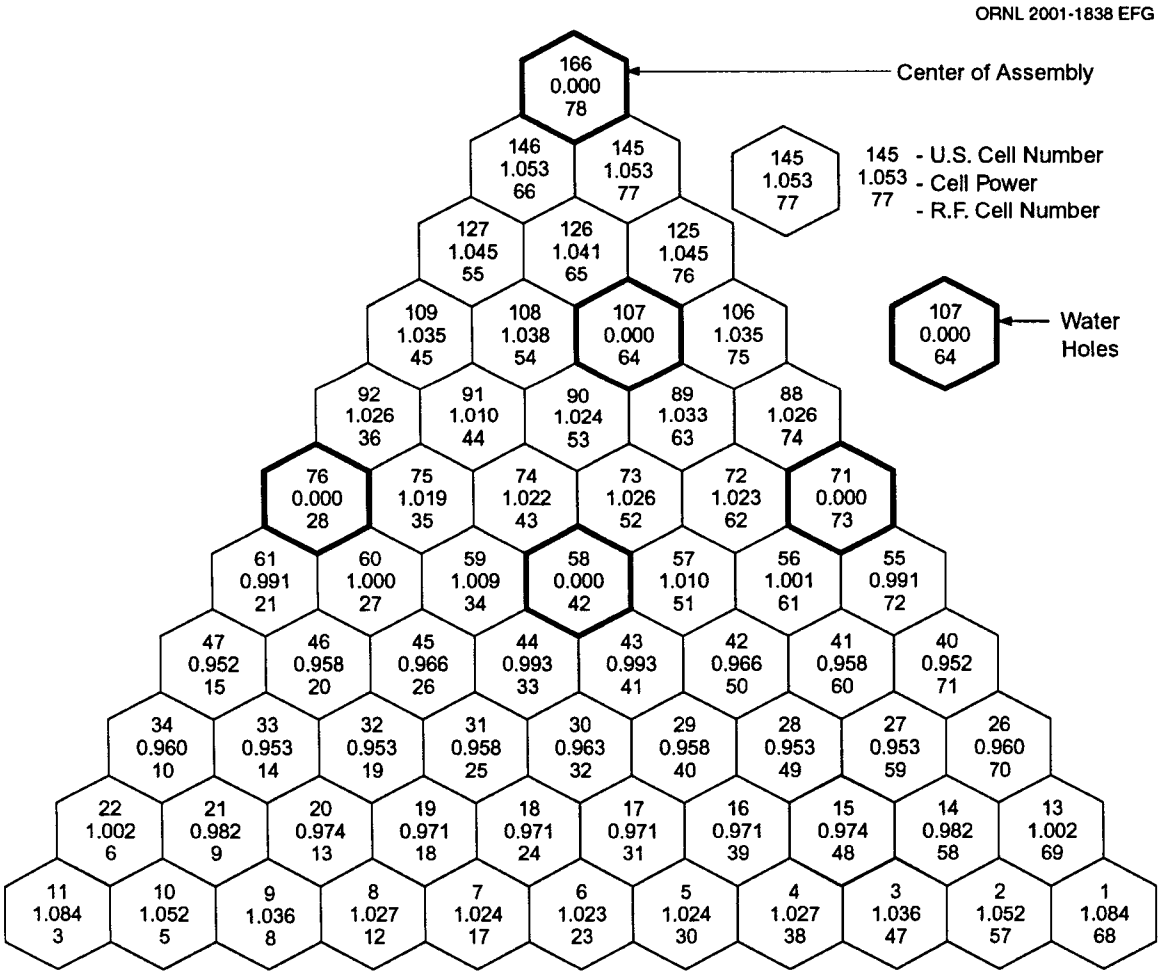


Fig. 4.78. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 12, State 3).

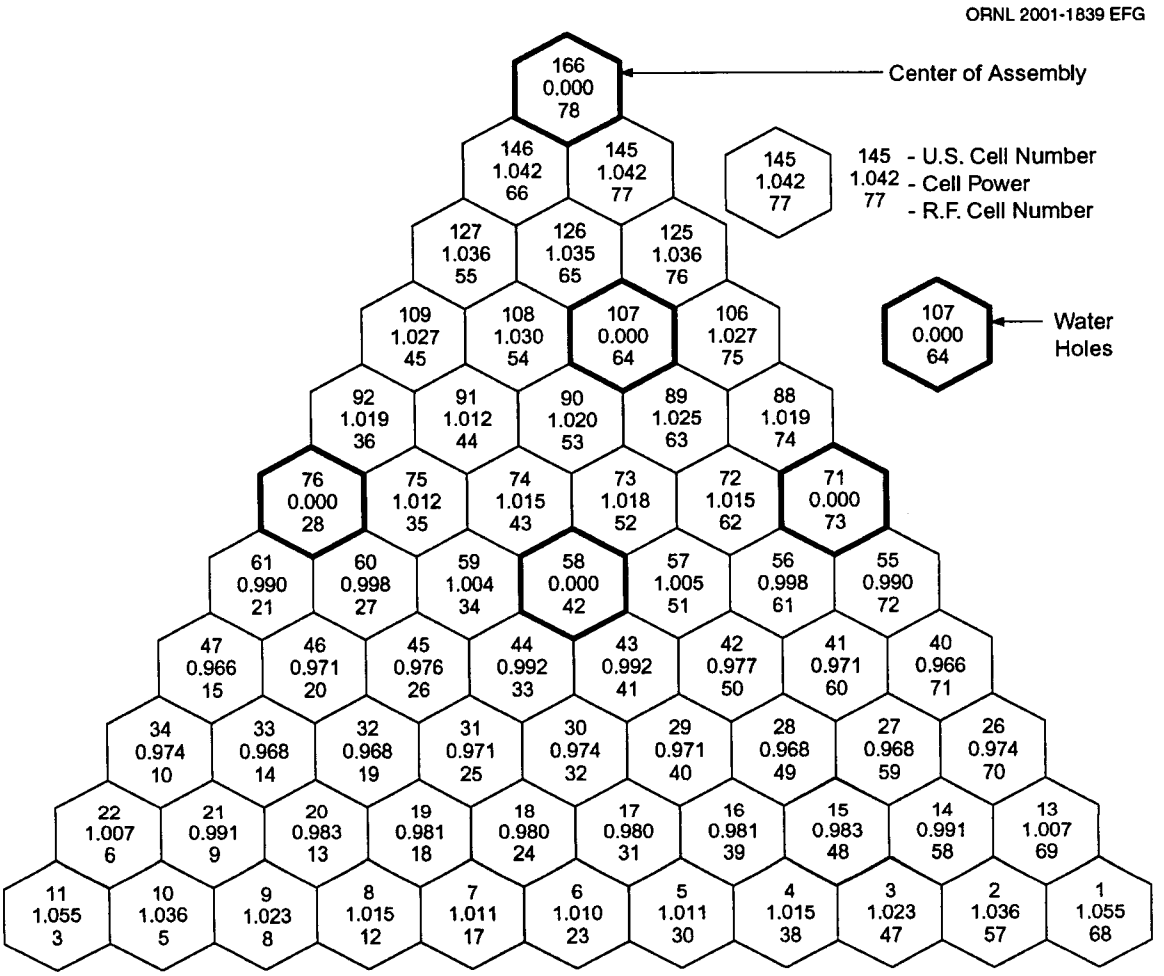


Fig. 4.79. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 12, State 3).

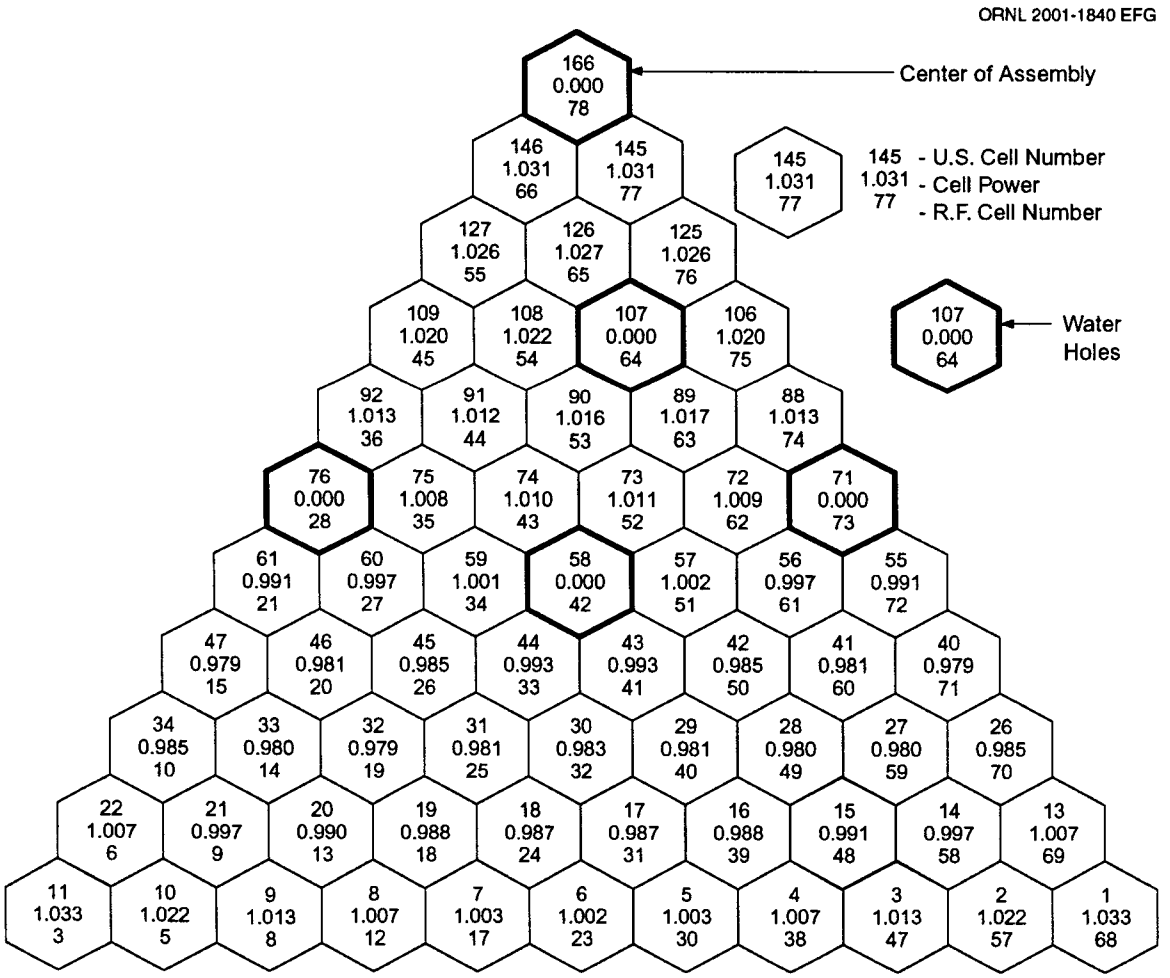


Fig. 4.80. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 12, State 3).

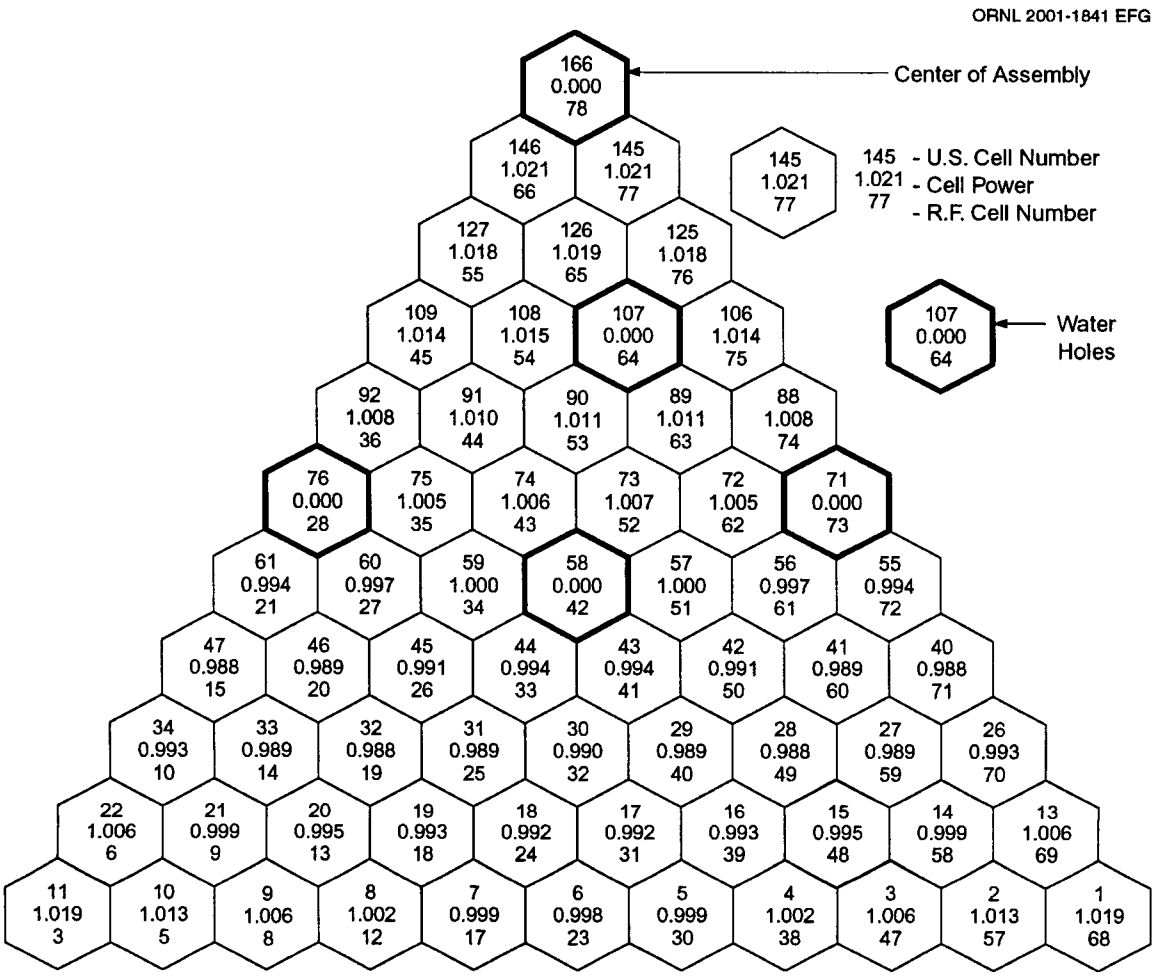


Fig. 4.81. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 12, State 3).

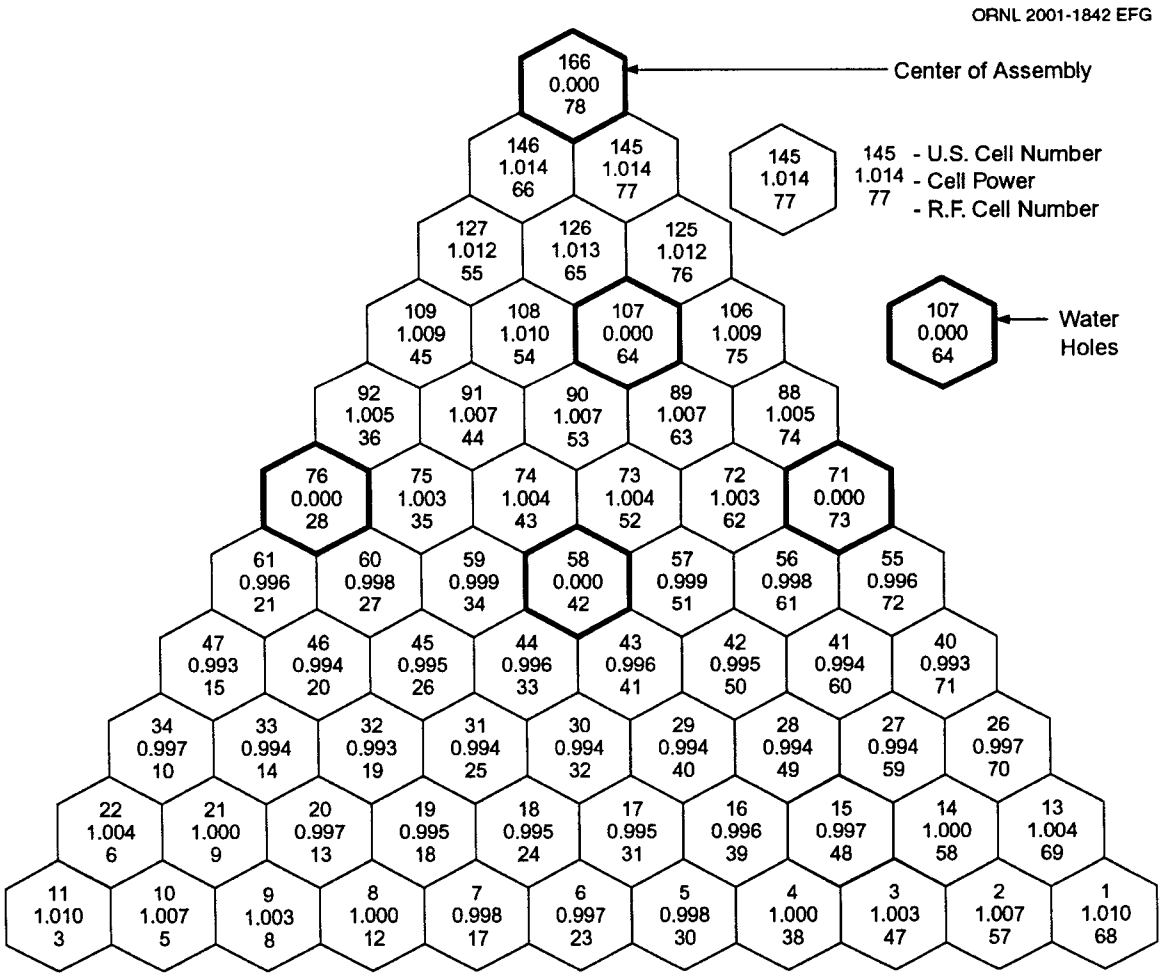


Fig. 4.82. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 12, State 3).

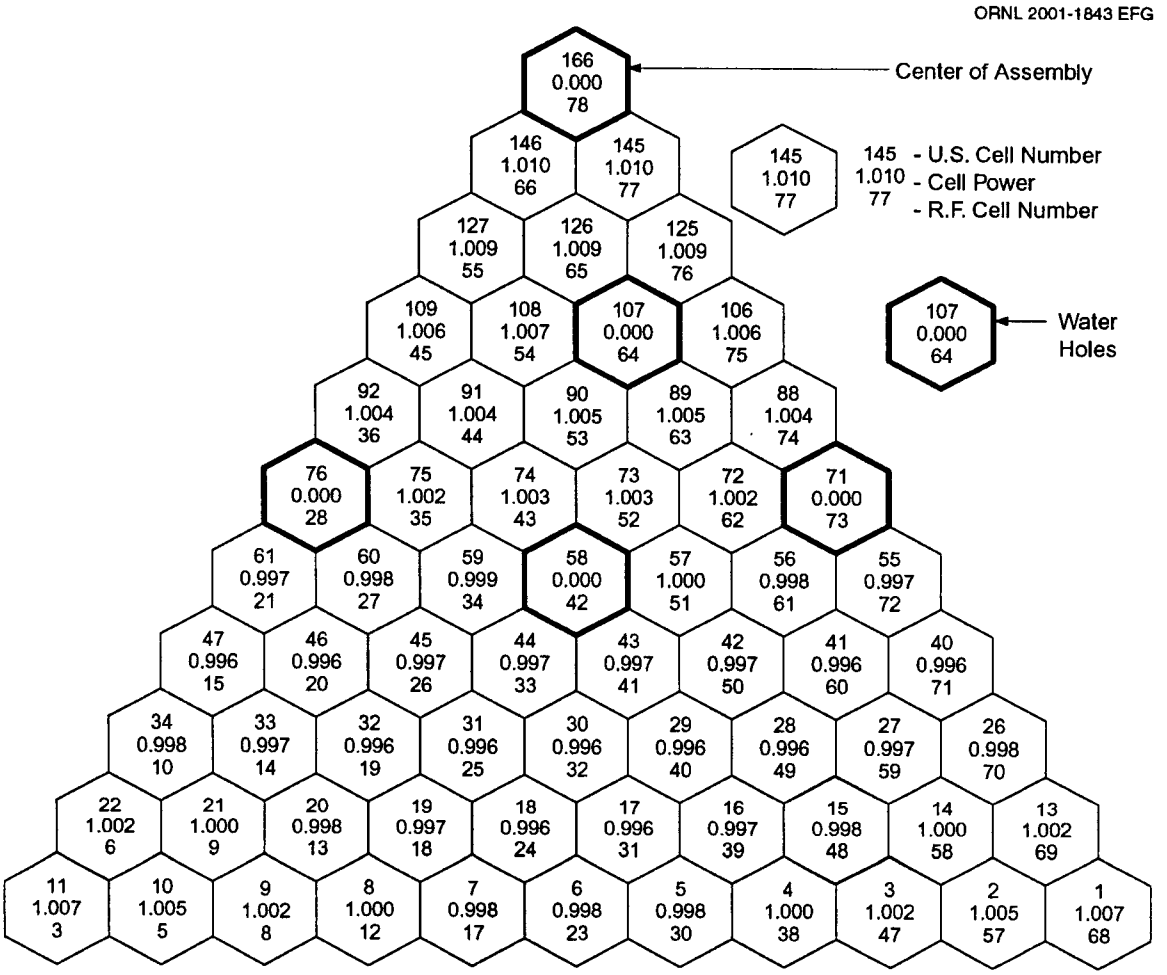


Fig. 4.83. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 12, State 3).

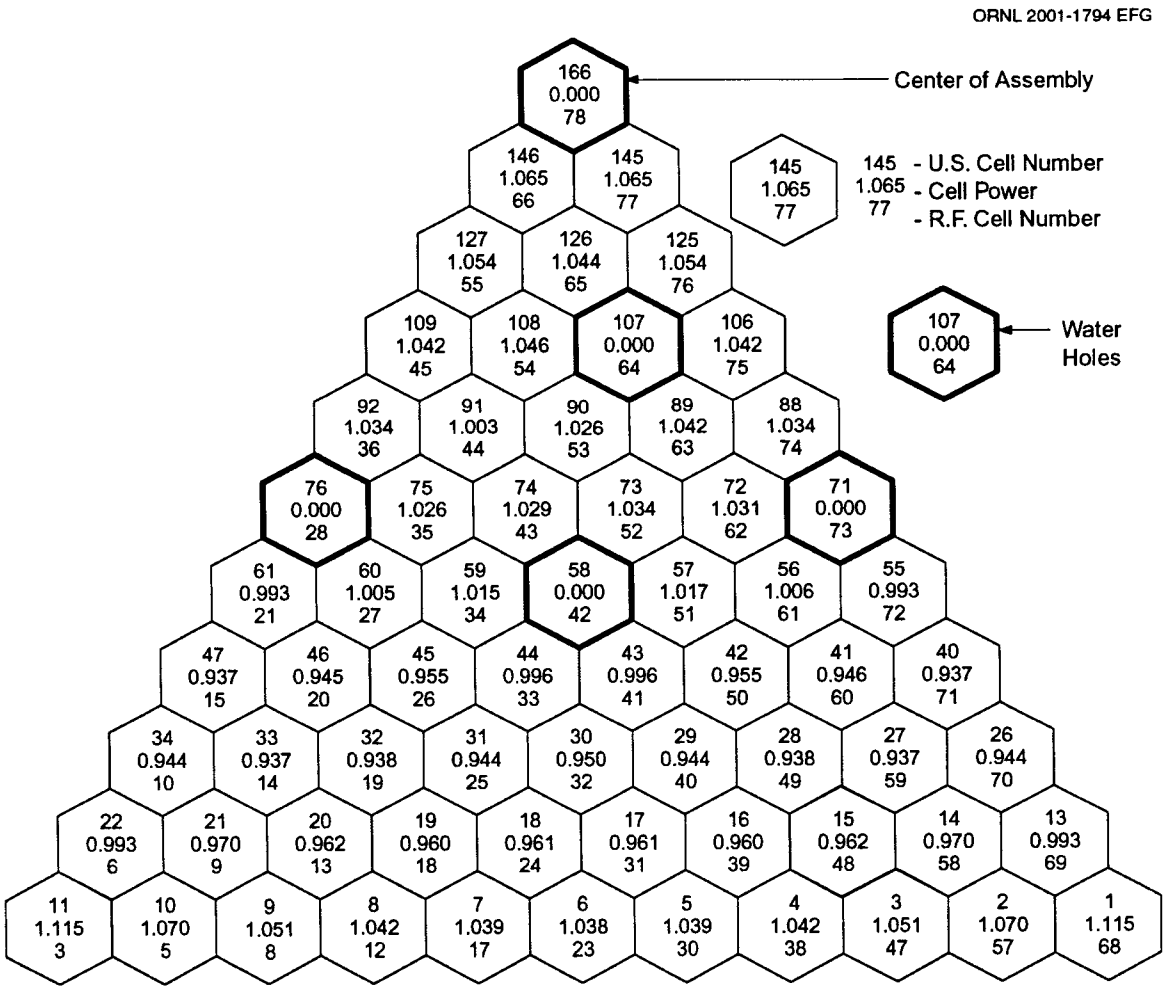


Fig. 4.84. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 12, State 4).

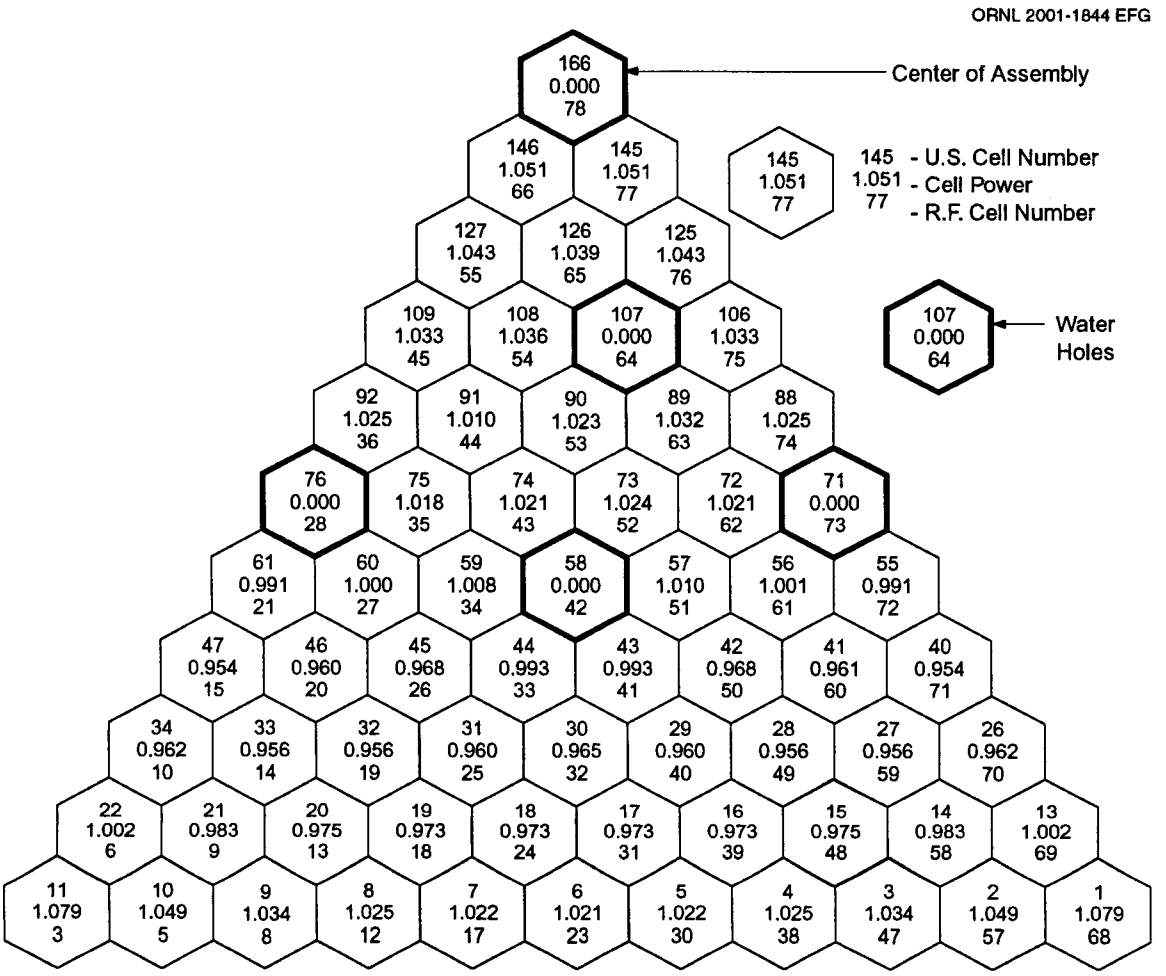


Fig. 4.85. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 12, State 4).

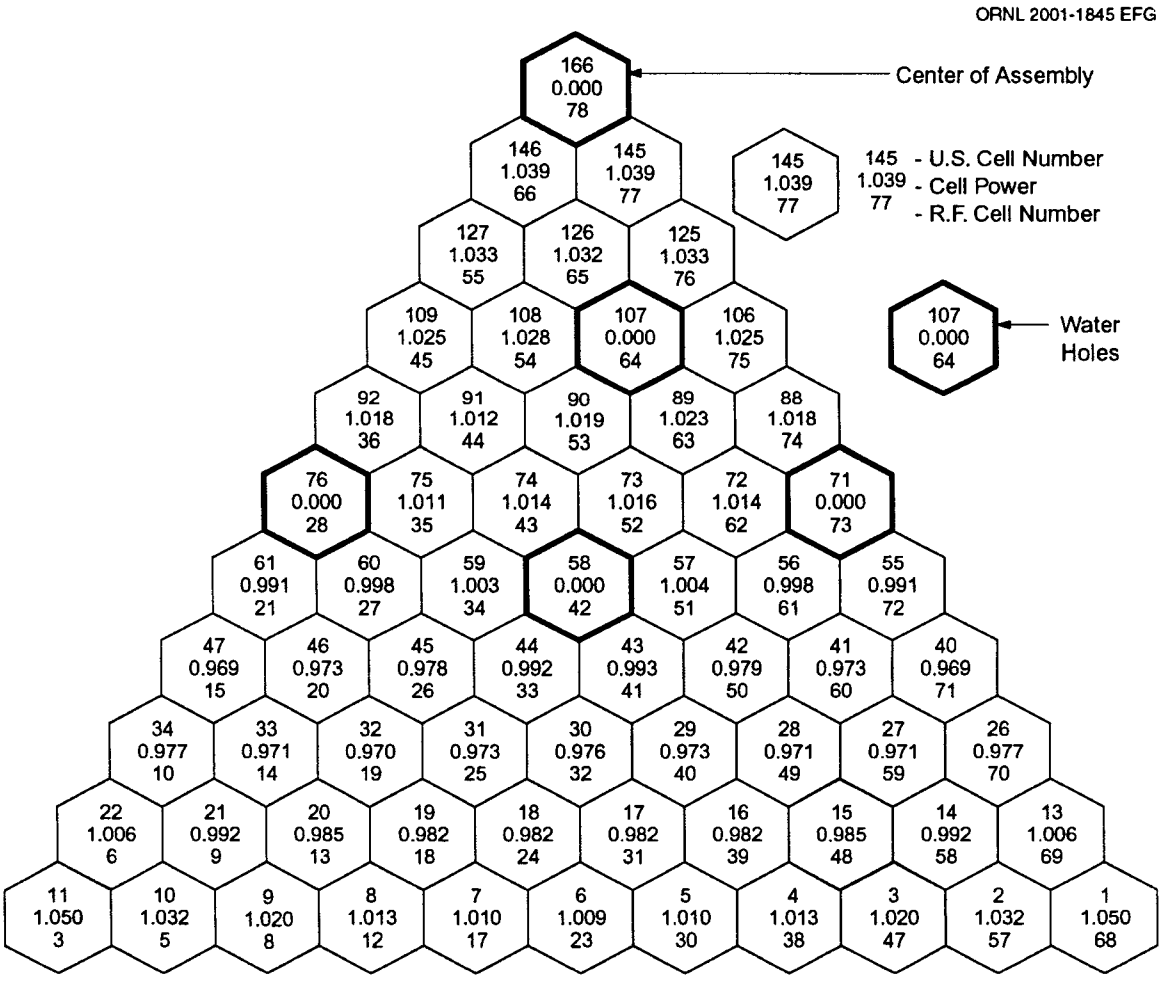


Fig. 4.86. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 12, State 4).

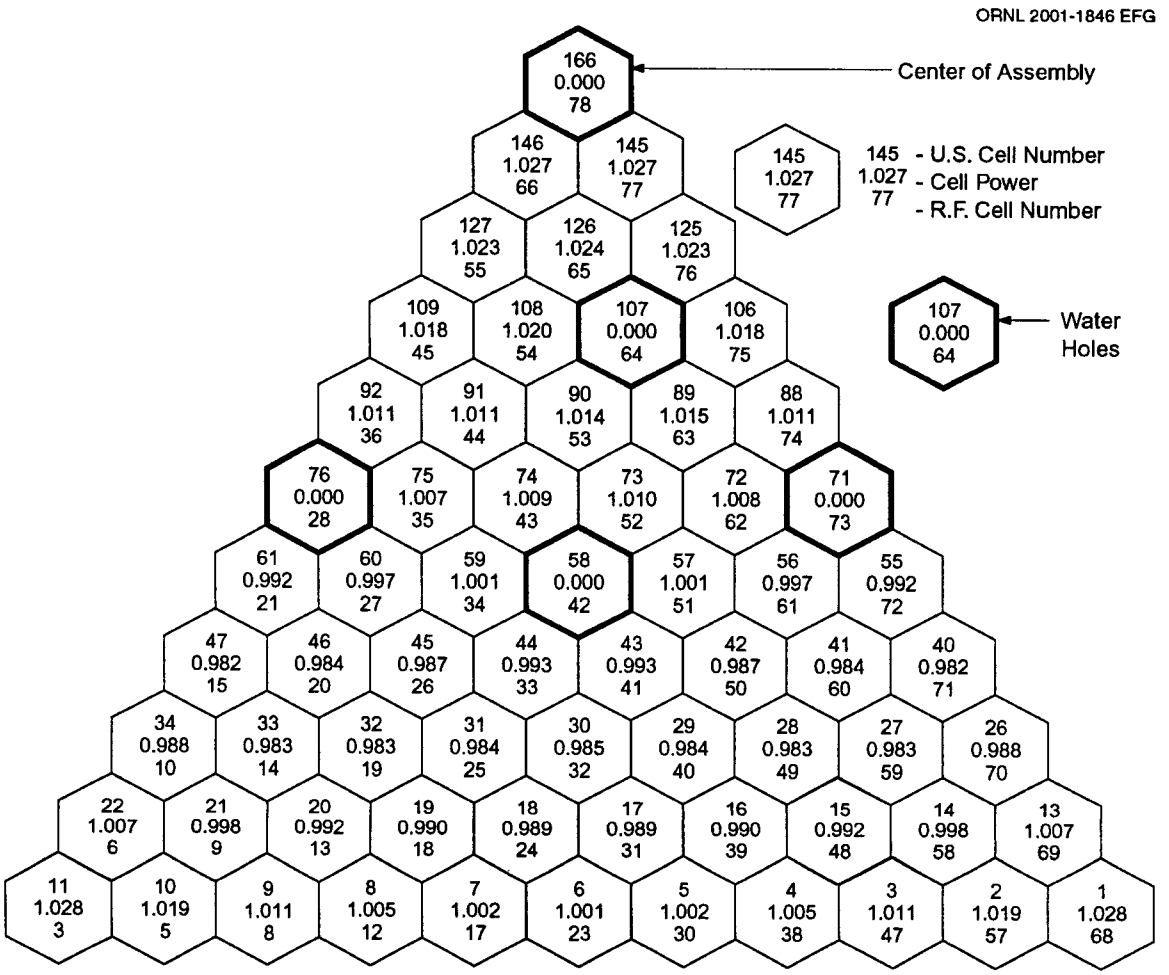


Fig. 4.87. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 12, State 4).

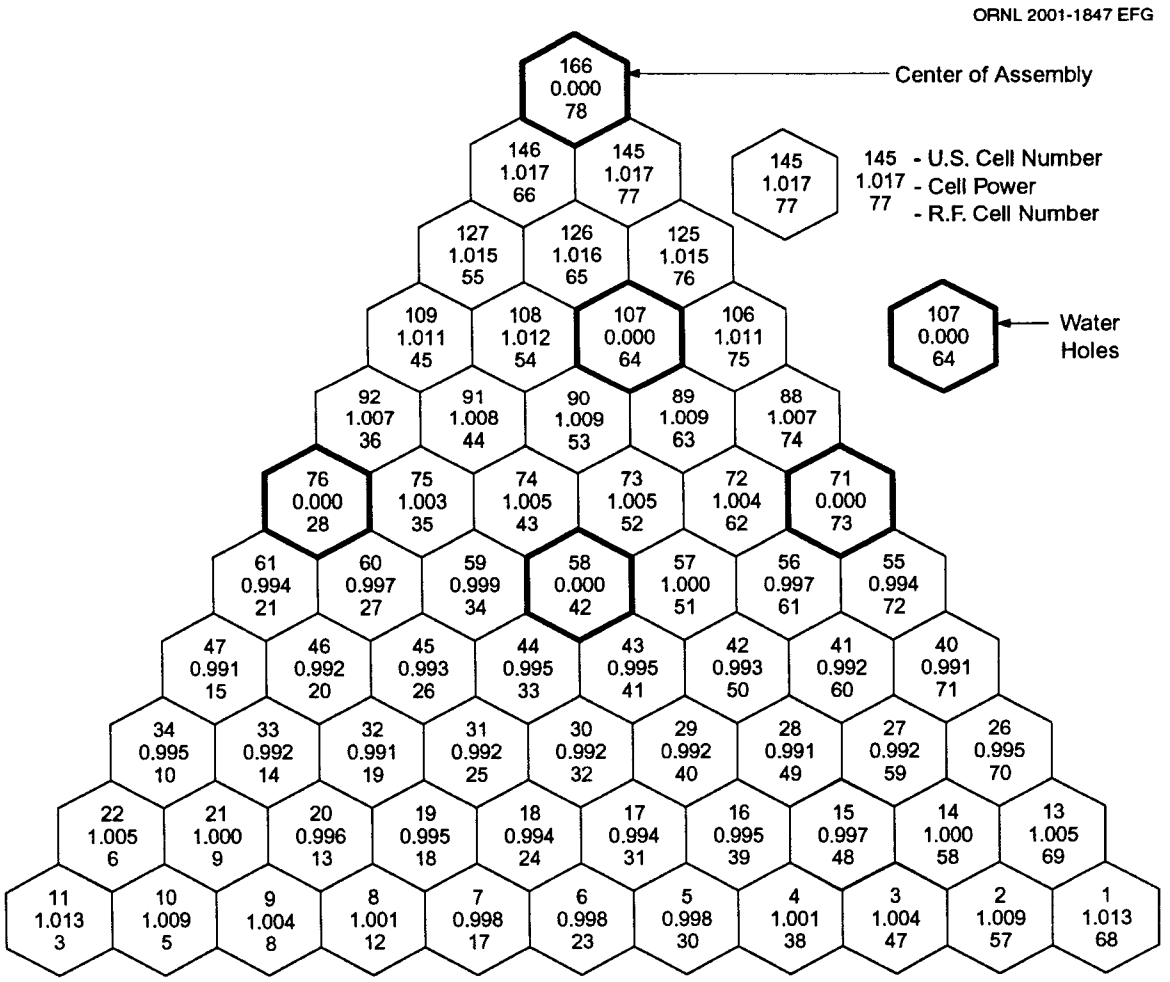


Fig. 4.88. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 12, State 4).

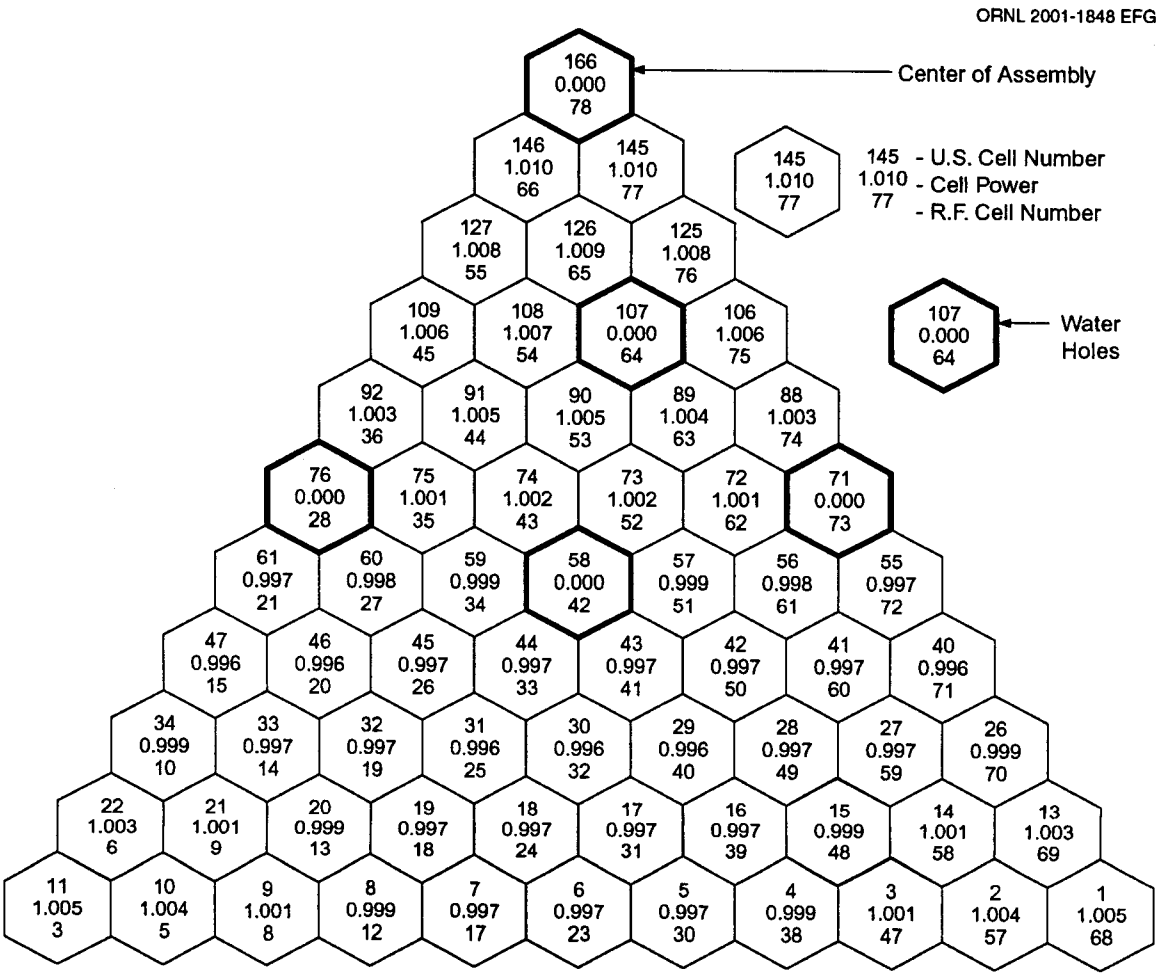


Fig. 4.89. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 12, State 4).

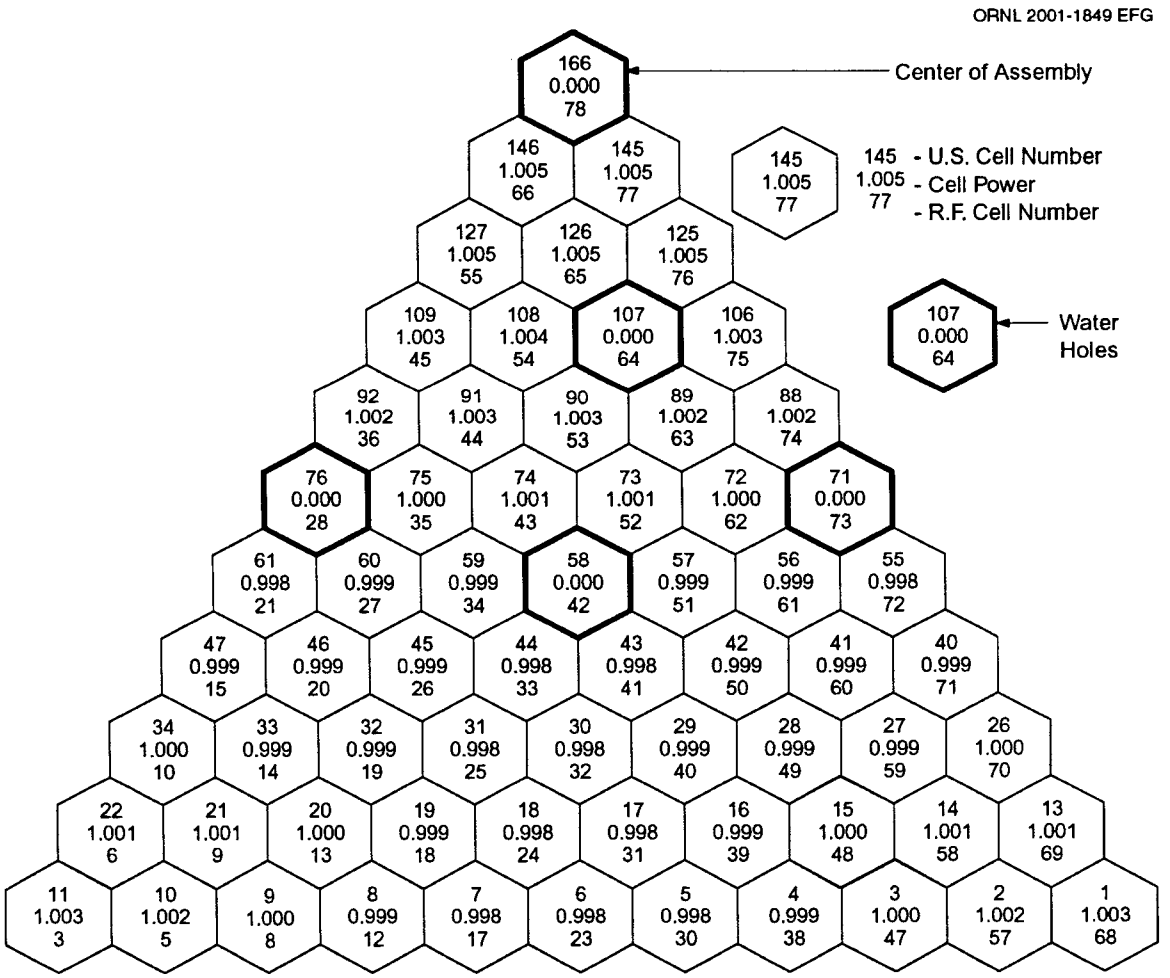


Fig. 4.90. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 12, State 4).

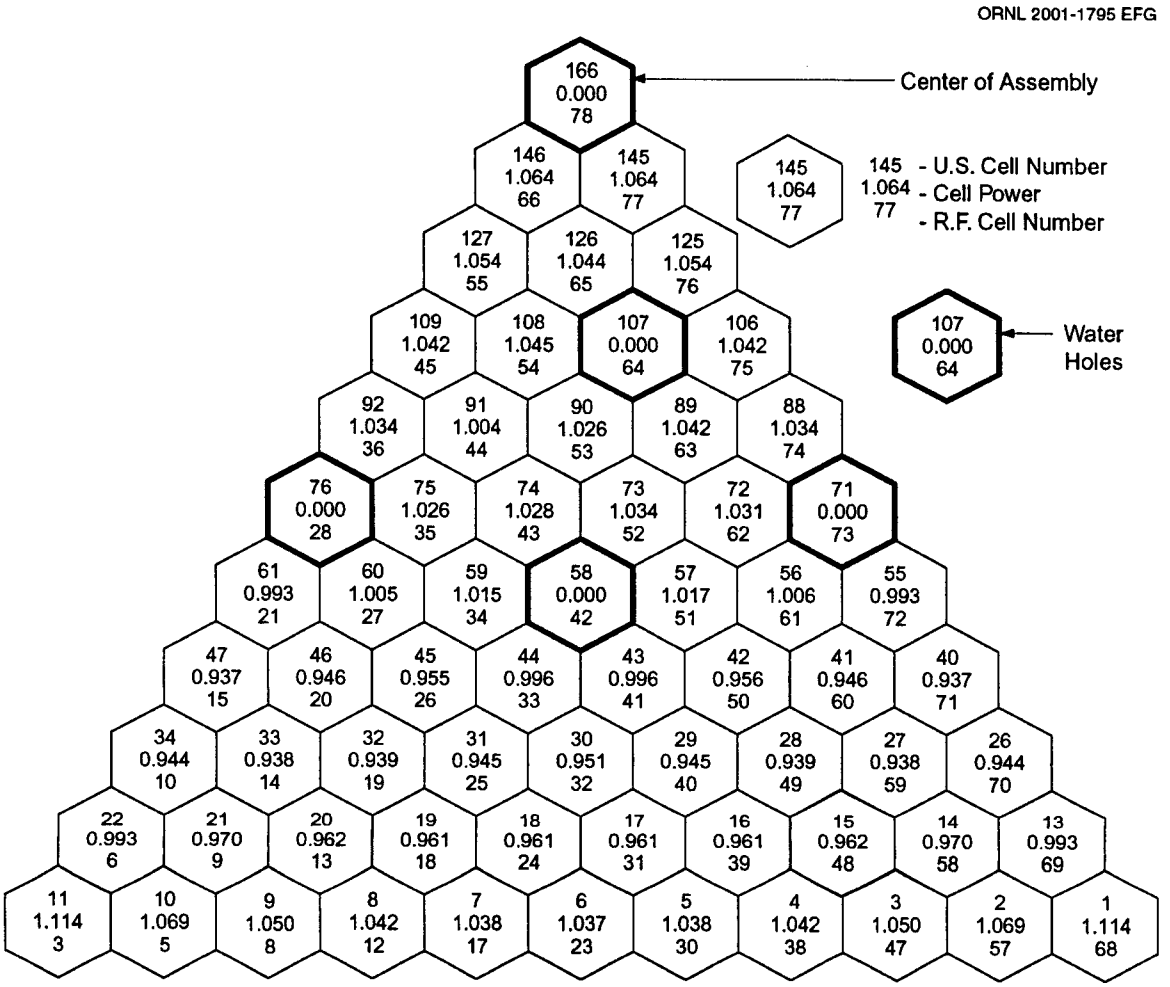


Fig. 4.91. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 12, State 5).

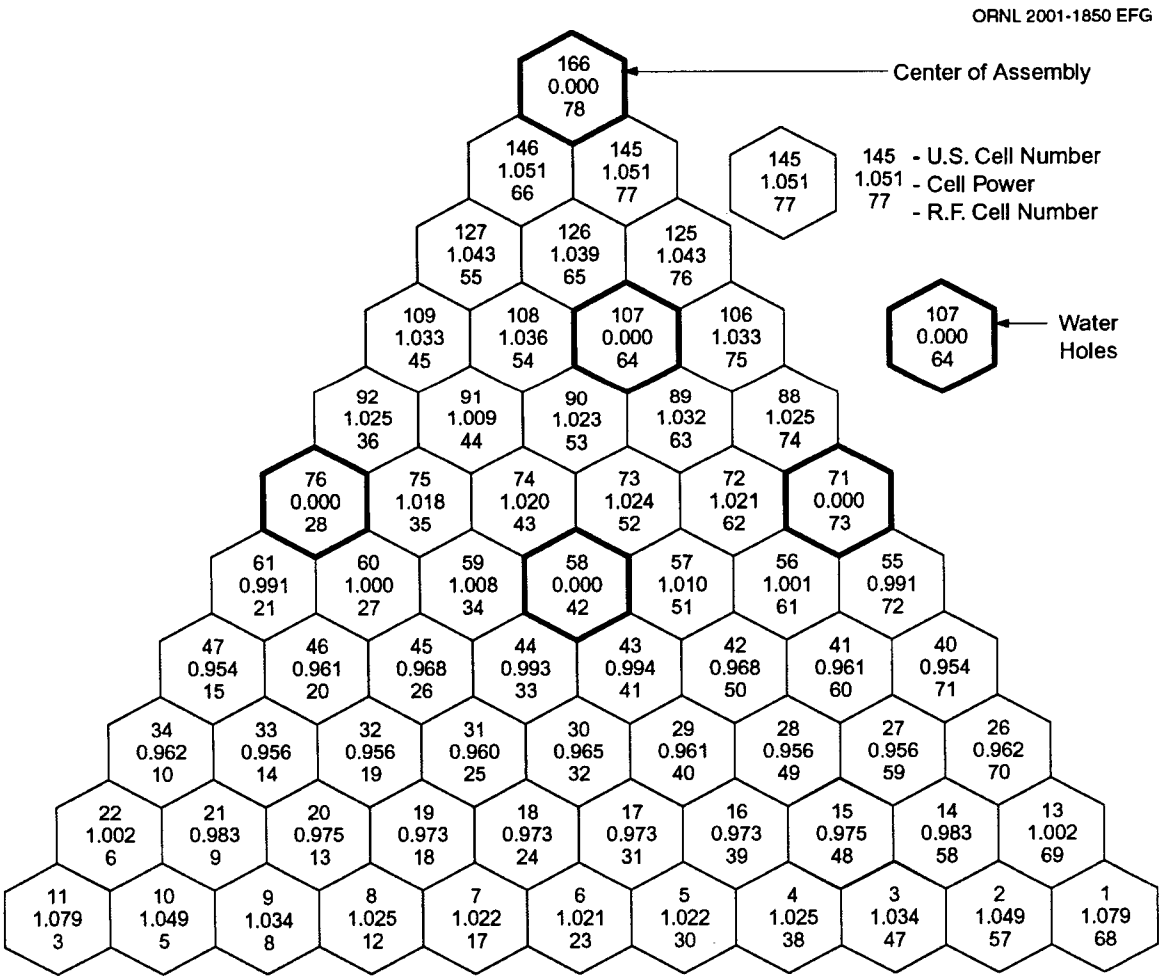


Fig. 4.92. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 12, State 5).

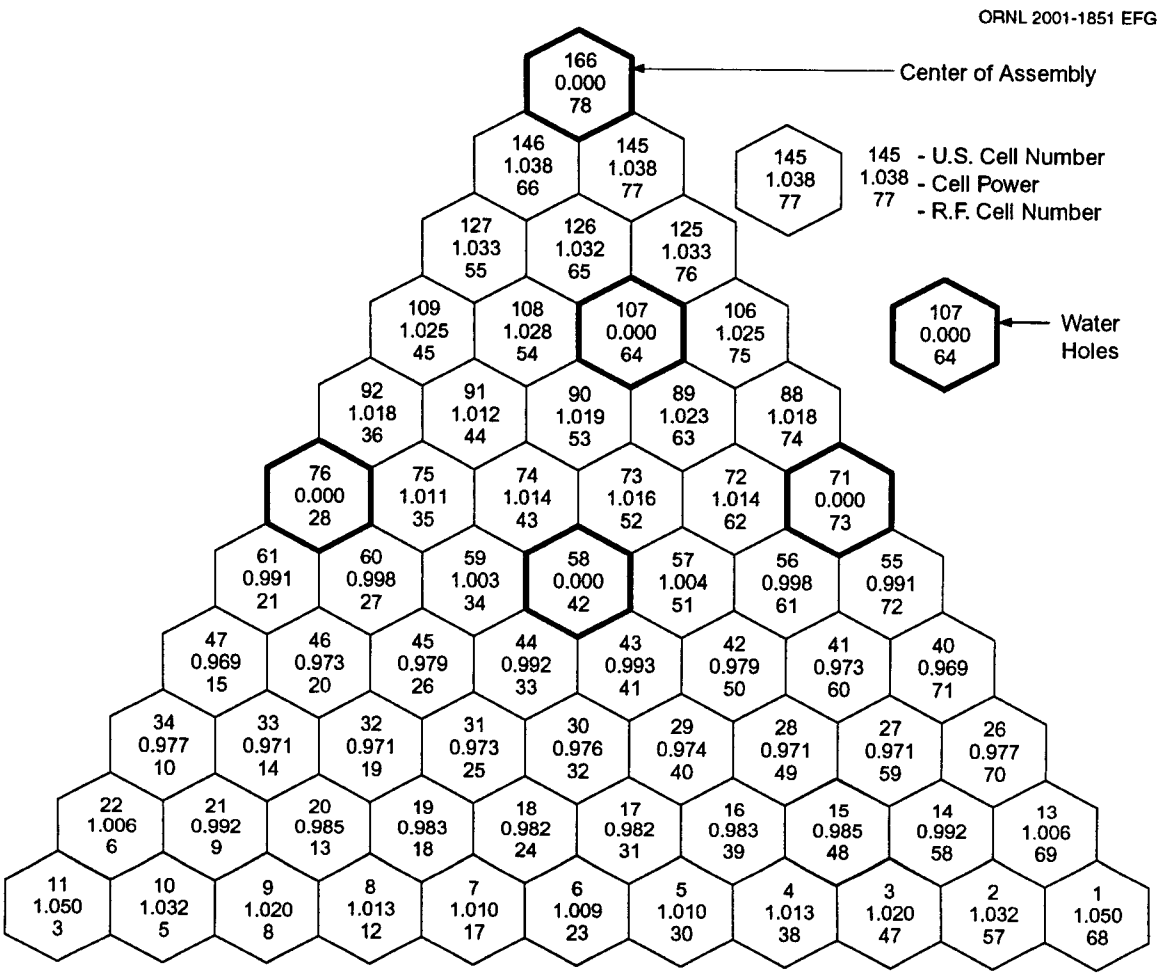


Fig. 4.93. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 12, State 5).

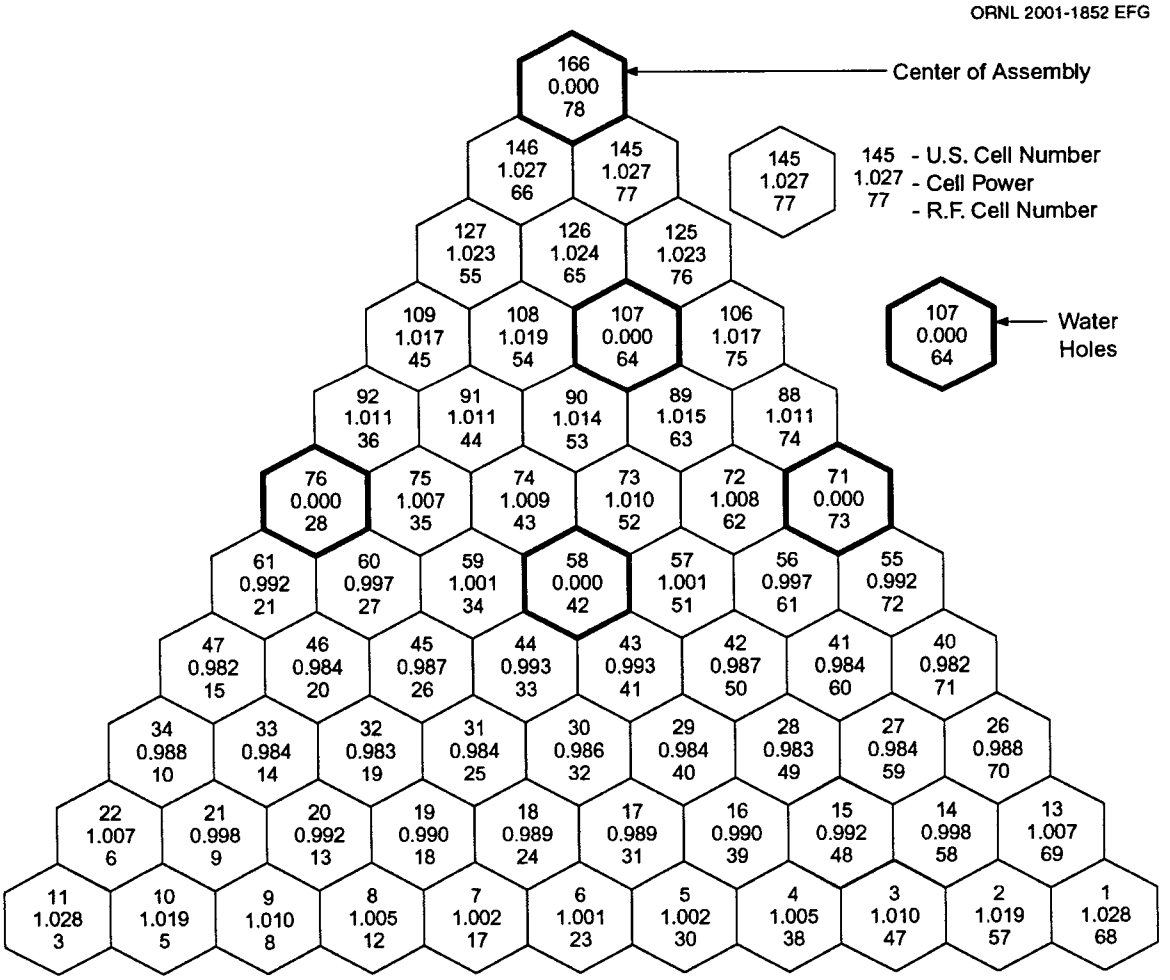


Fig. 4.94. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 12, State 5).

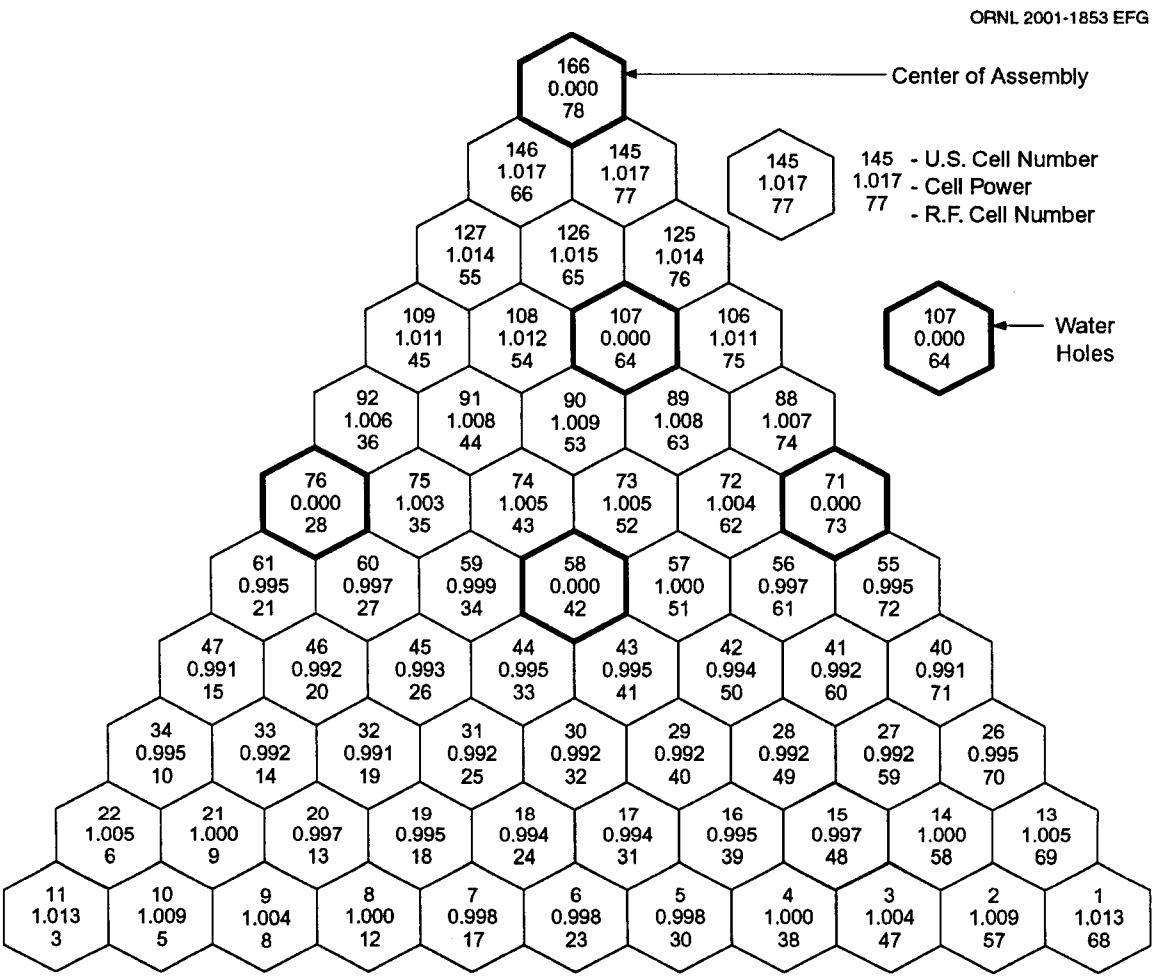


Fig. 4.95. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 12, State 5).

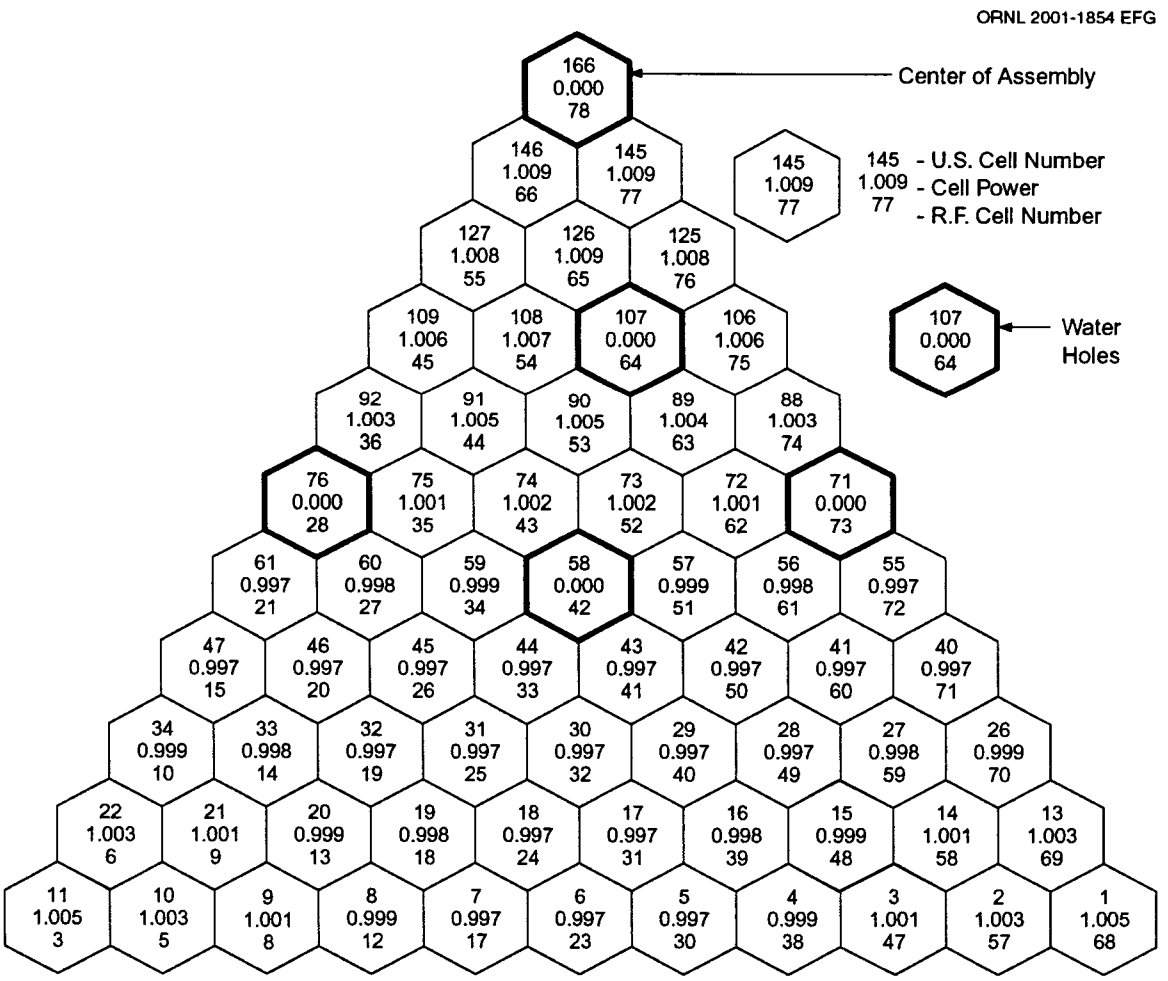


Fig. 4.96. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 12, State 5).

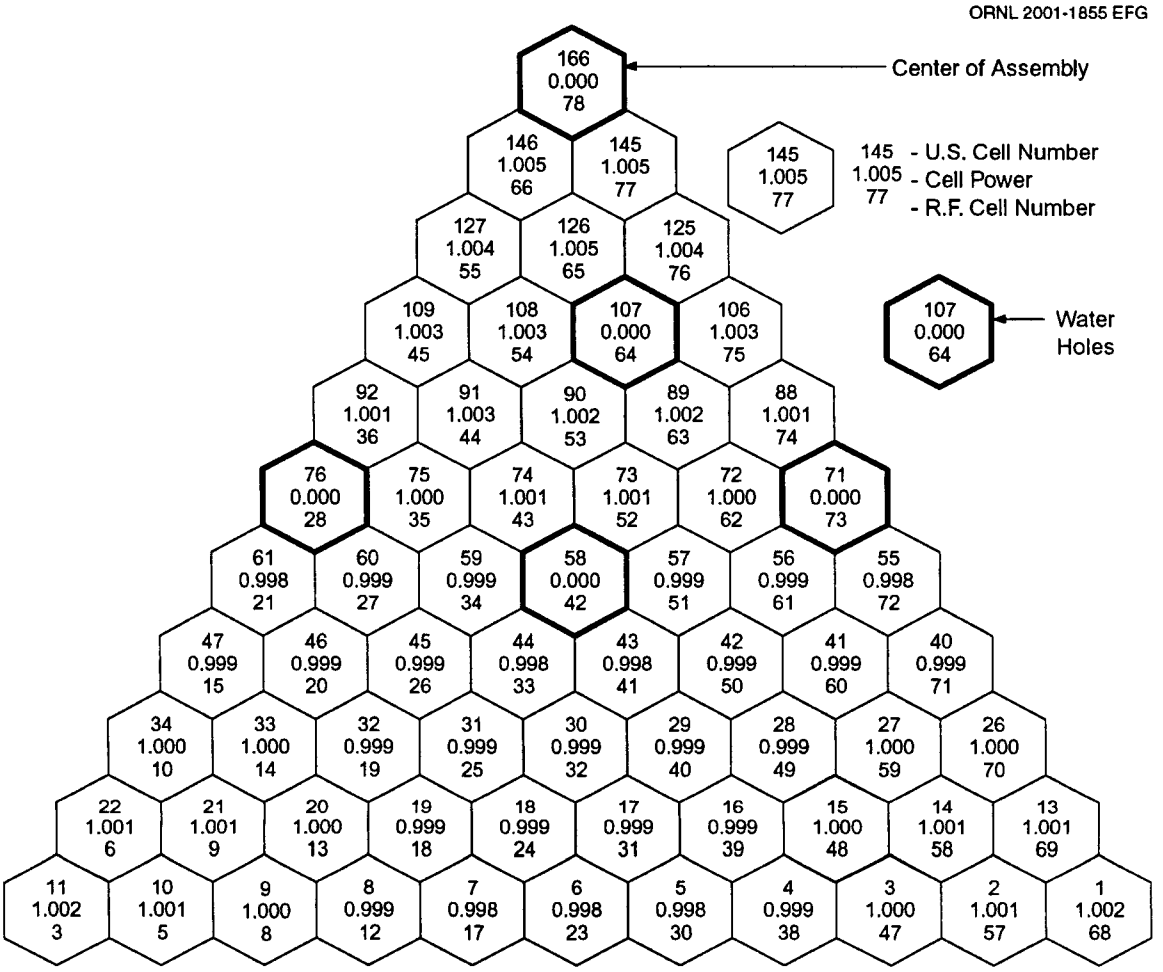


Fig. 4.97. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 12, State 5).

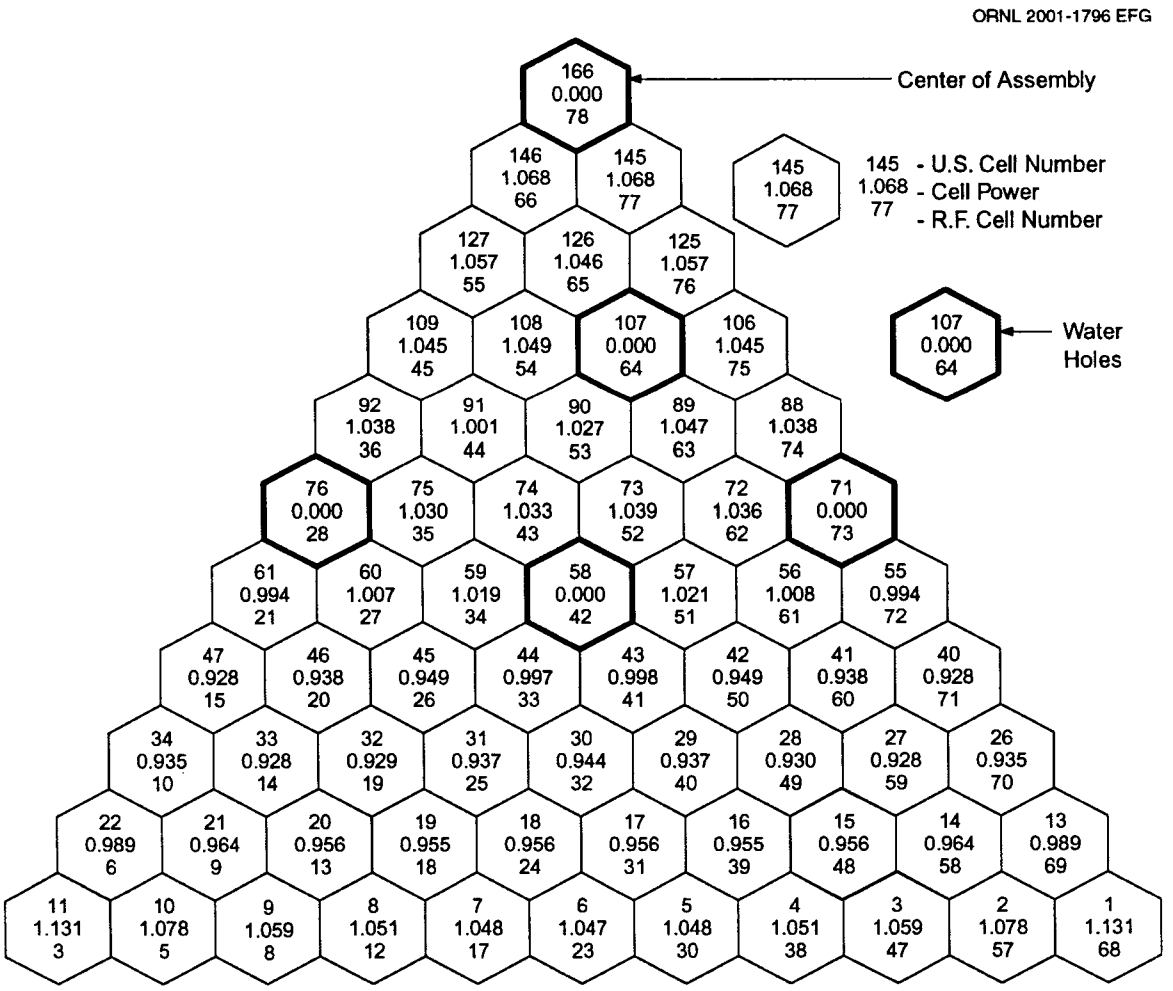


Fig. 4.98. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 0.0 MWd/MTU (Variant 12, State 6).

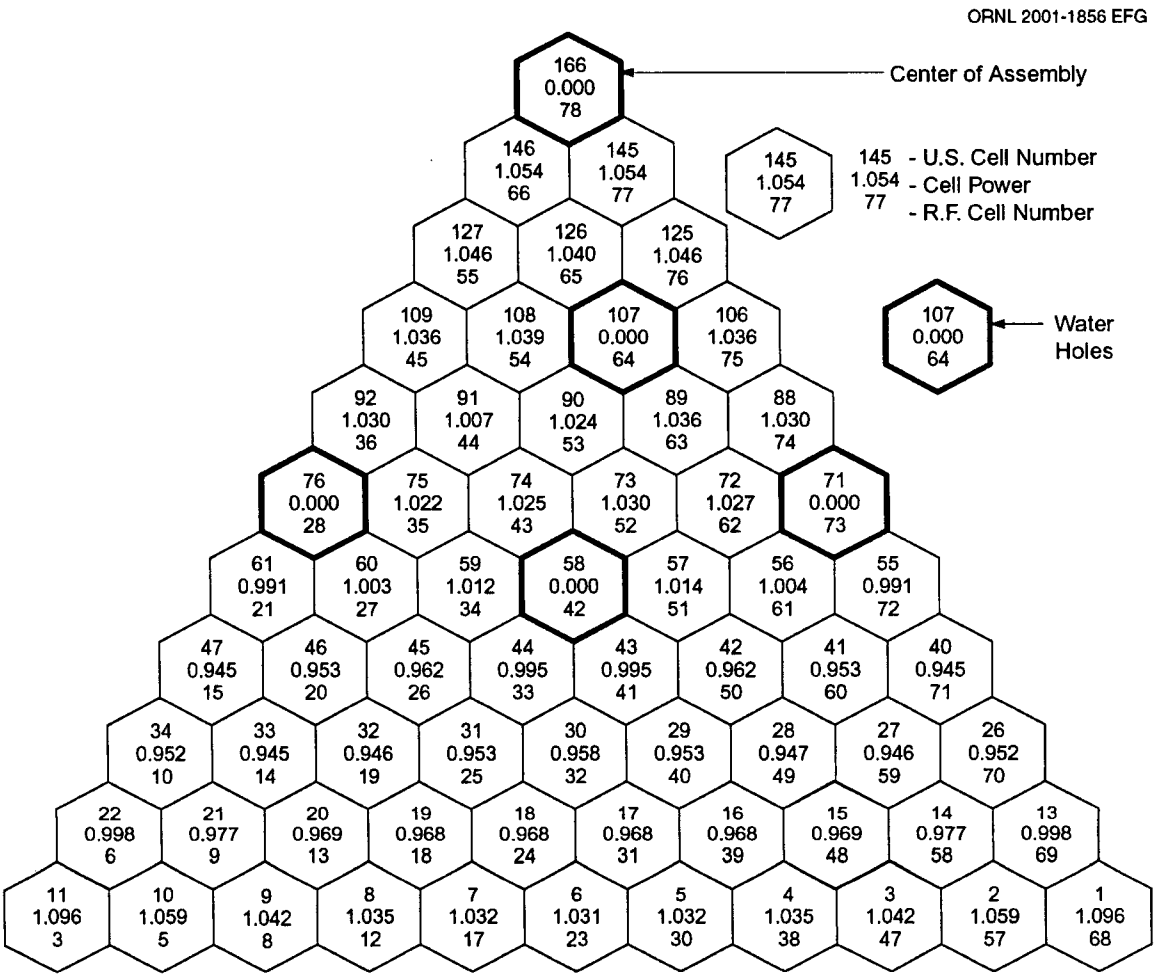


Fig. 4.99. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 10000.0 MWd/MTU (Variant 12, State 6).

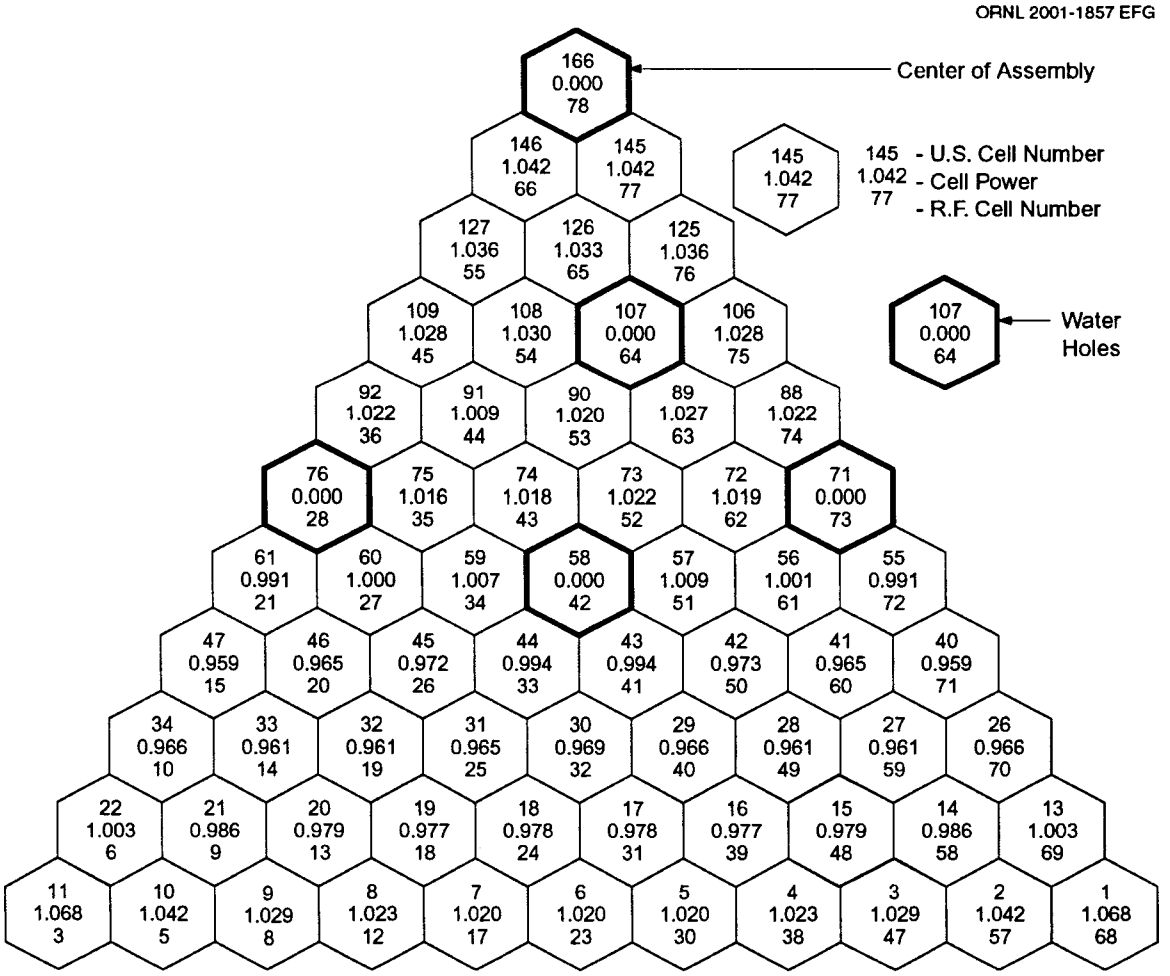


Fig. 4.100. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 20000.0 MWd/MTU (Variant 12, State 6).

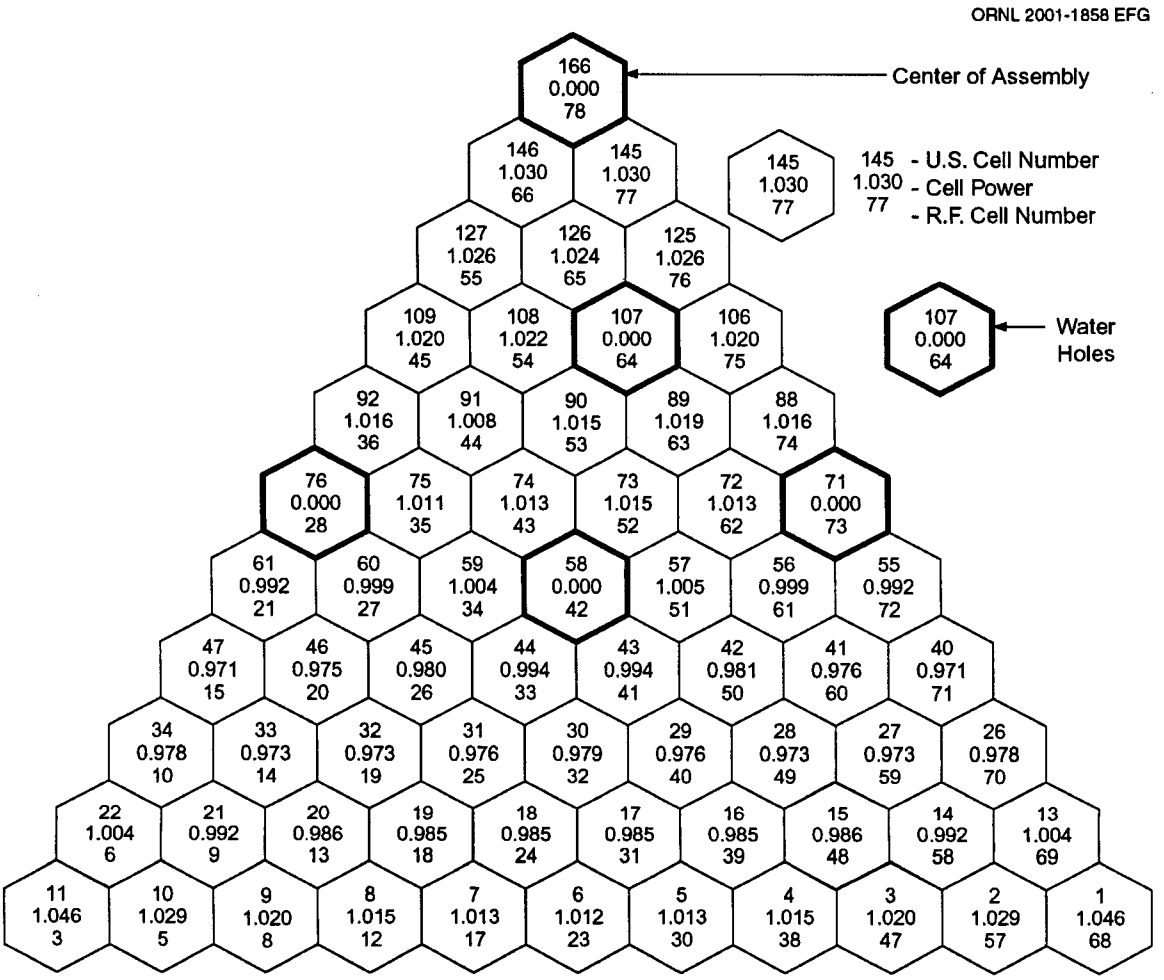


Fig. 4.101. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 30000.0 MWd/MTU (Variant 12, State 6).

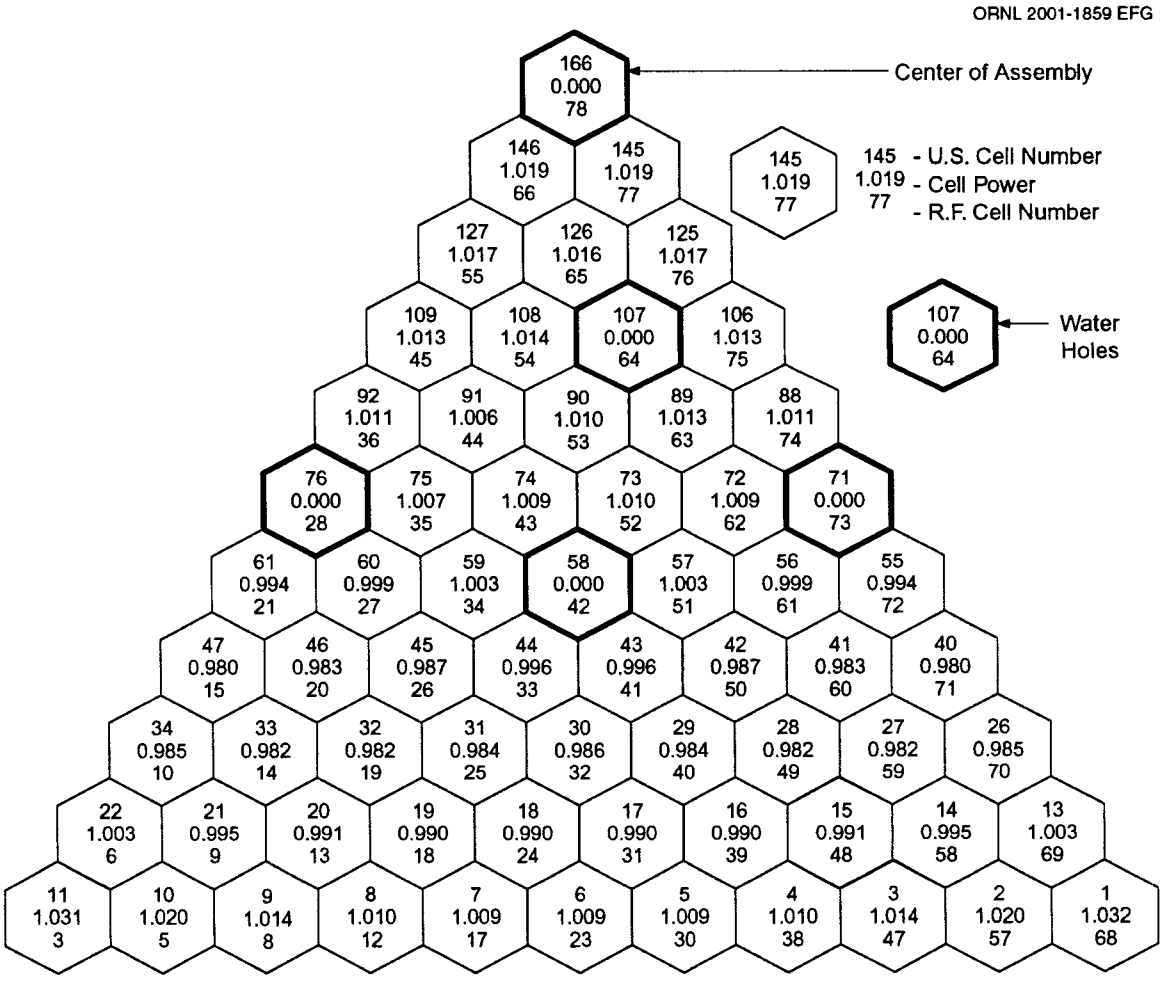


Fig. 4.102. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 40000.0 MWd/MTU (Variant 12, State 6).

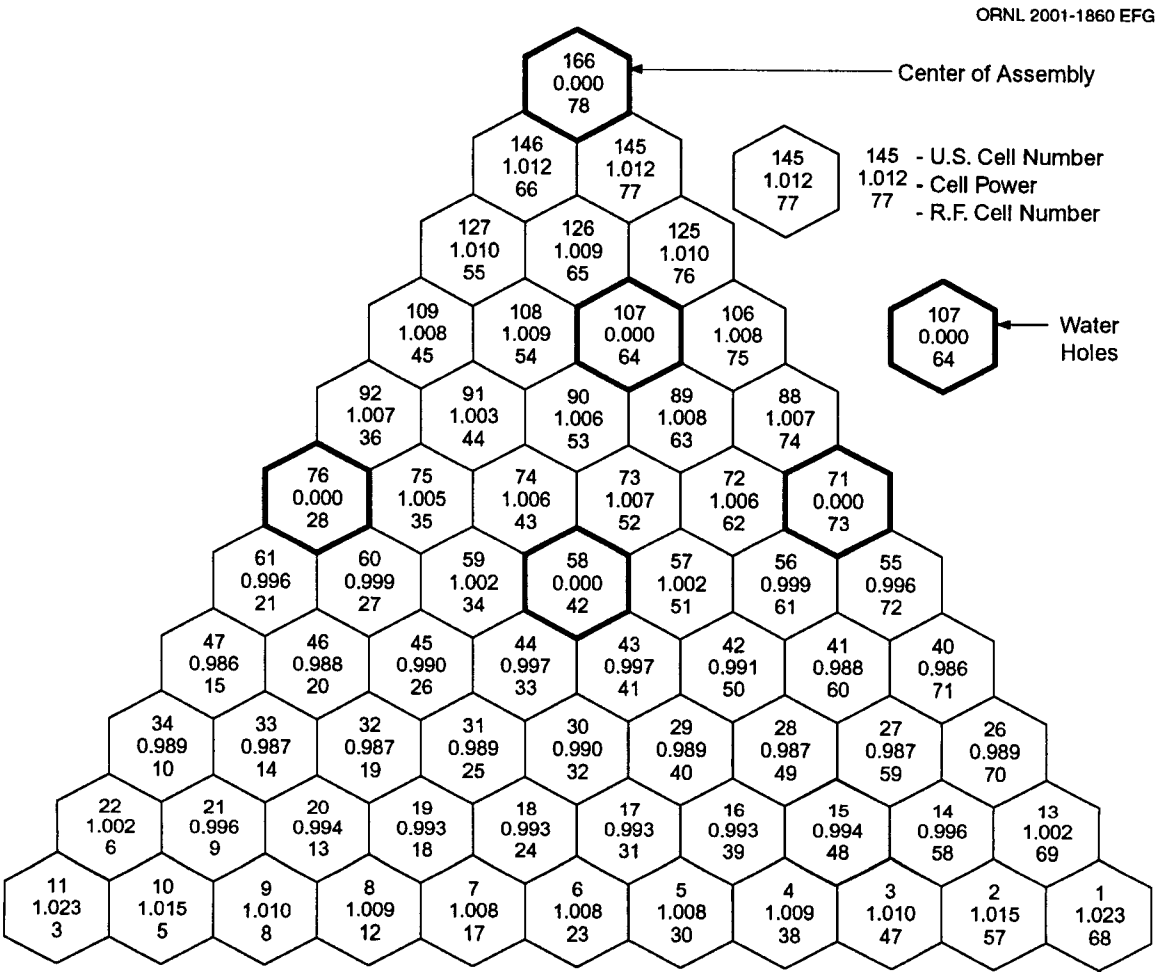


Fig. 4.103. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 50000.0 MWd/MTU (Variant 12, State 6).

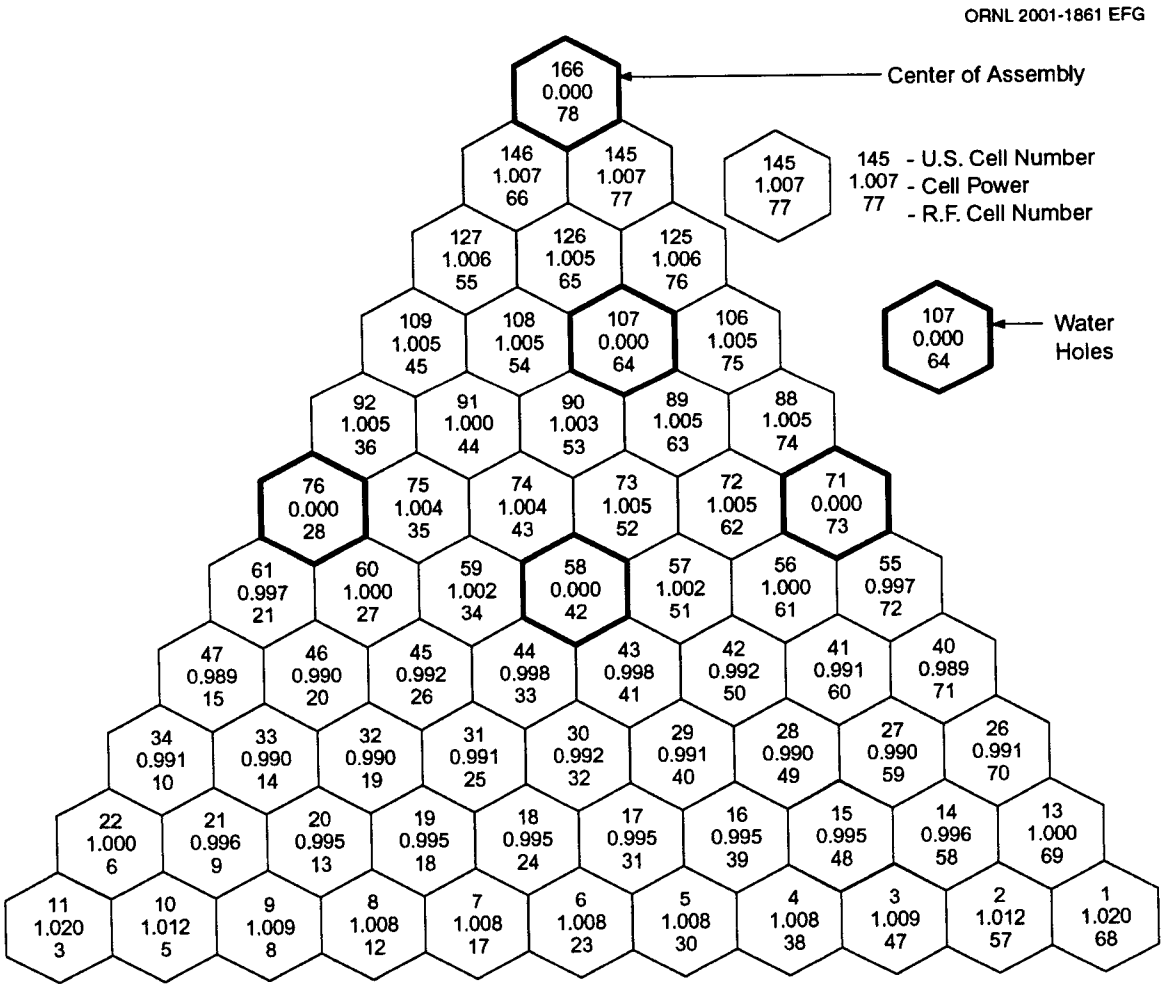


Fig. 4.104. Relative cell powers normalized to the average fuel cell power of 1.00, burnup 60000.0 MWd/MTU (Variant 12, State 6).

4.4.2.6 Analysis of Variant 13 with VENTURE code

The model used for the analysis of Variant 13 included a total of one MOX fuel element and three LEU fuel elements. The model allows for explicit representation of the central tube cells and guide tube cells, as well as the water gaps between the fuel elements. However, for Variant 13, fuel cells were used in the locations of central and guide tubes.

The k_{eff} and k_0 for different states of Variant 13 are listed in Table 4.94. Table 4.95 compares the k_{eff} calculated by the VENTURE and TVS-M computer codes. In general, the VENTURE multiplication factors are about 1% lower than the TVS-M values. Figures 4.105–4.111 are representations of the power distributions. For each (hexagonal) cell, the cell number is given at the top and relative power at the bottom. The cell powers are normalized to the average of 1.00. A minimal segment of Variant 13 geometry, which provides sufficient information, is shown. Cell numbers used are those provided in the definition of Variant 13 that is shown in Figs. 4.112–4.114.

Figure 4.111 shows the power distribution calculated for Variant 13, State 1 (V13S1), with reflective boundary conditions on all boundaries of the geometry model for Variant 13. For the calculations shown for V13S1 in Fig. 4.105 (as well as for other states of V13), the reflective boundary conditions were used on the left and top boundary, while periodic boundary conditions were used for the bottom and right boundary of the geometry model. As expected, due to the symmetry in the absence of the guide tube cells, the change in the boundary conditions did not affect the calculated k_{eff} and power distributions. The entry for State S6 is 3% higher than the KENO value in Table 4.81. The reason for the large difference is not known.

Table 4.94. k_{eff} and k_0 for the Variant 13

V13 State (comments)	k_{eff}	k_0
S1 (no Xe, Sm)	1.085568	1.29585
S3 (eq. Xe)	1.121200	1.34878
S4 (specification Xe and Sm concentration)	1.052278	1.25575
S5 (no Xe, Sm)	1.099098	1.31286
S6 (no Xe, Sm)	1.204025	1.35702
S1 (eq. Xe)	1.075901	1.29308
S3 (no Xe)	1.132030	1.35199

Table 4.95. Comparison of VENTURE and TVS-M k_{eff} for different states of Variant 13

V13 State (comments)	VENTURE k_{eff}	TVS-M k_{eff}	ΔK
S1 (no Xe, Sm)	1.085568	1.0957	–1013 pcm
S3 (eq. Xe)	1.12120		
S4 (specifically Xe and Sm concentration)	1.052278	1.0654	–1312 pcm
S5 (no Xe, Sm)	1.099098	1.1088	–970 pcm
S6 (no Xe, Sm)	1.204025	1.2138	–978 pcm
S1 (eq. Xe)	1.075901		
S3 (no Xe)	1.13203	1.1437	–1167 pcm

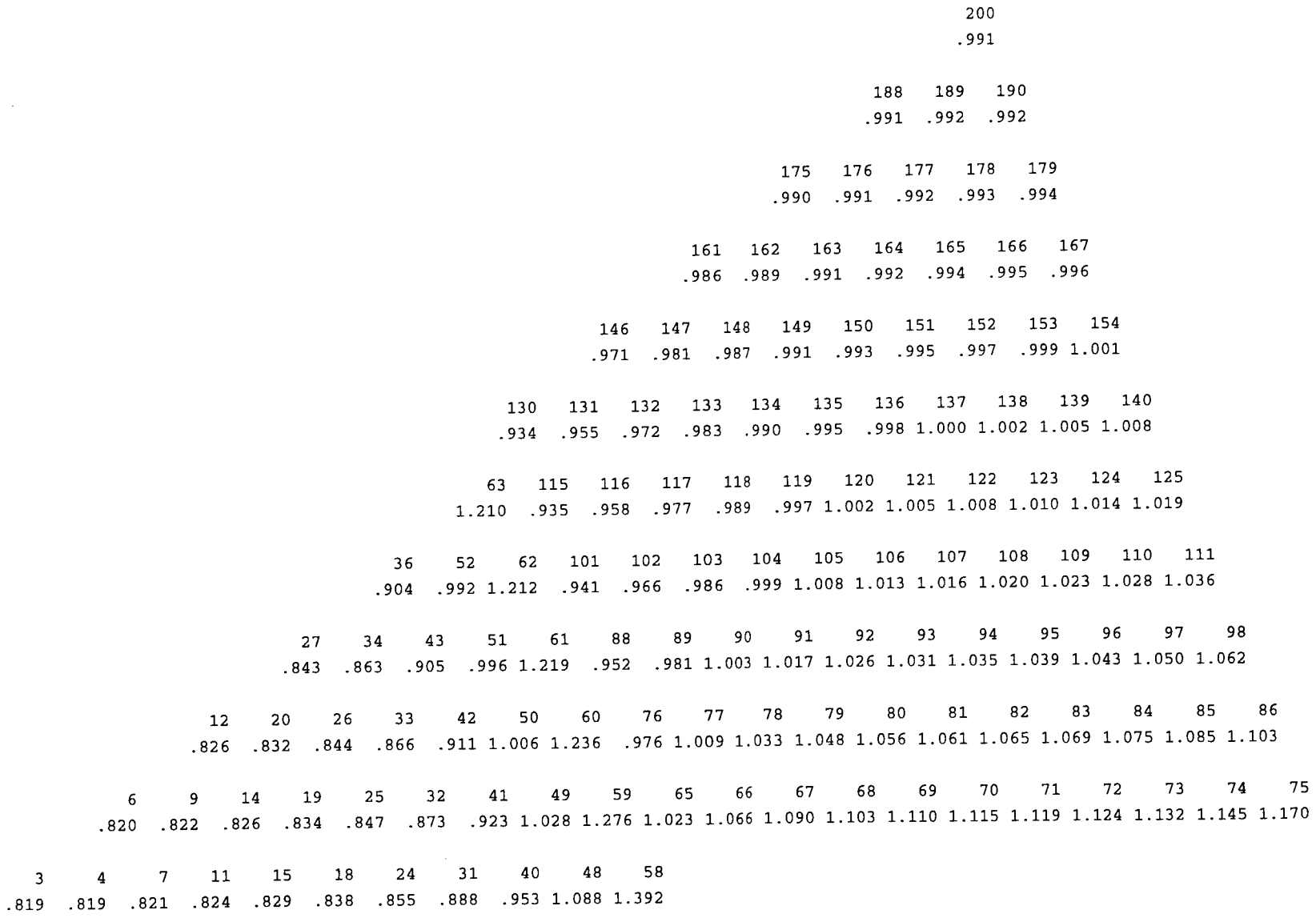


Fig. 4.105. Variant 13 State 1: relative cell powers normalized to the average power of 1.00.

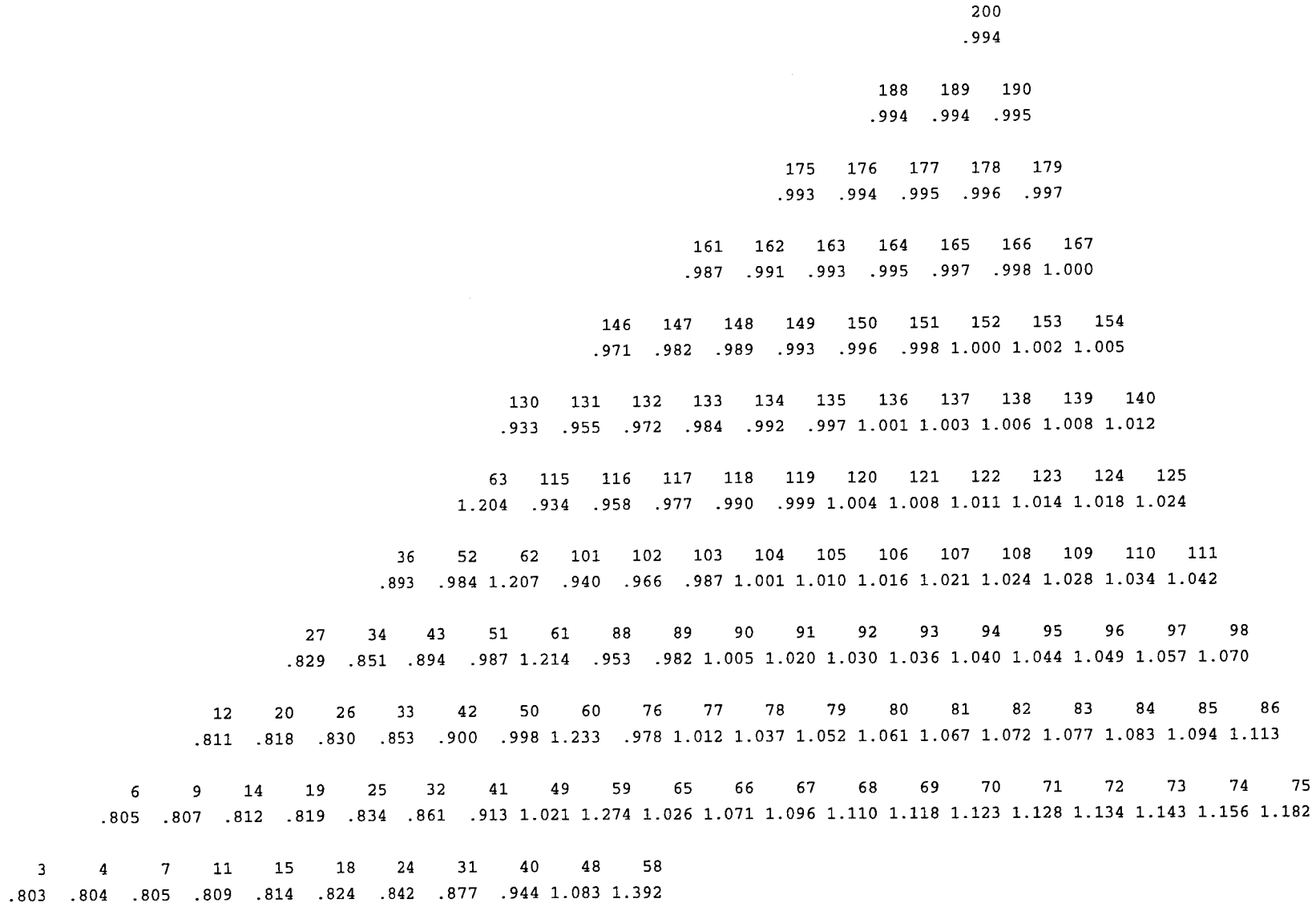


Fig. 4.106. Variant 13 State 3: relative cell powers normalized to the average power of 1.00.

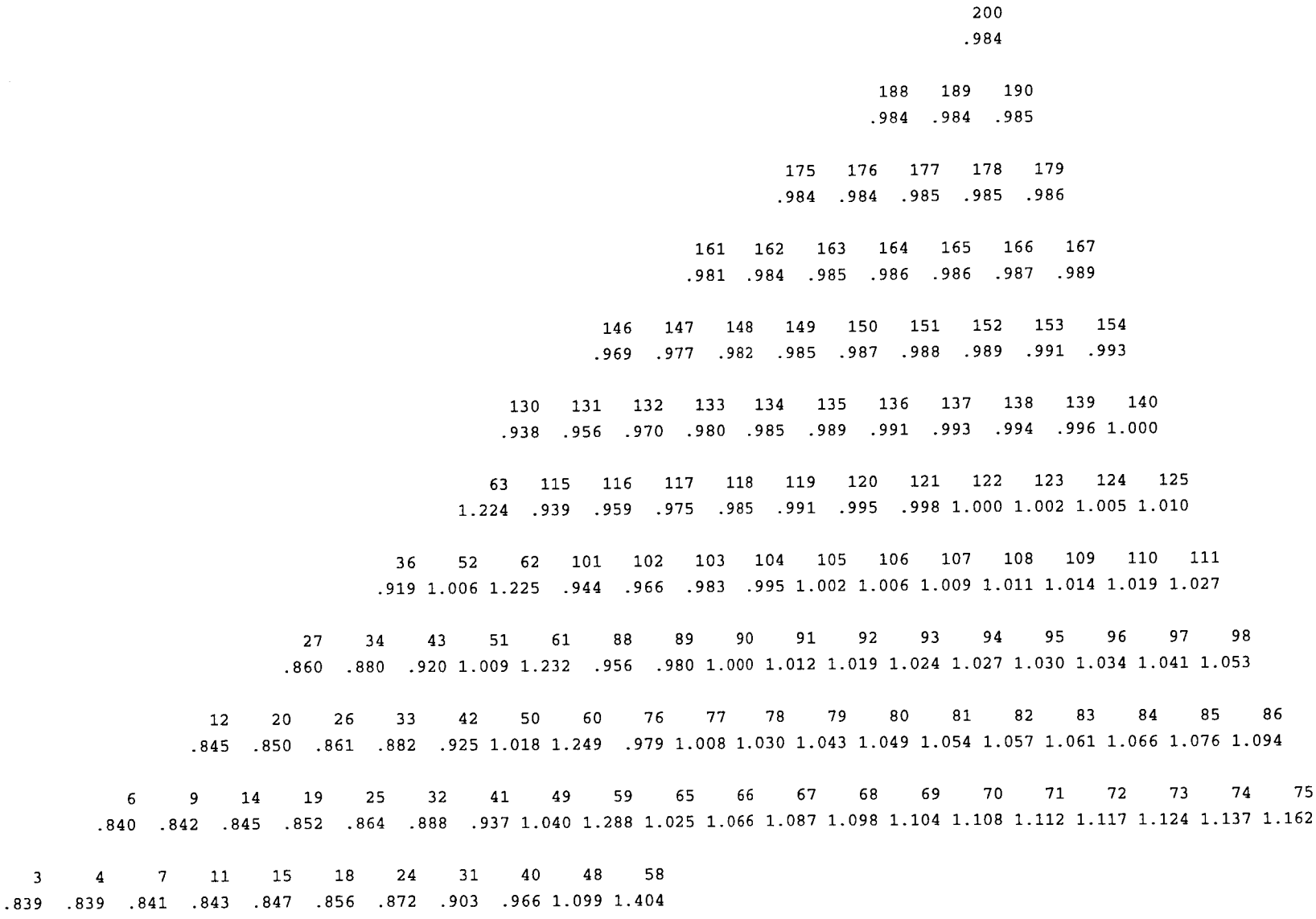


Fig. 4.107. Variant 13 State 4: relative cell powers normalized to the average power of 1.00.

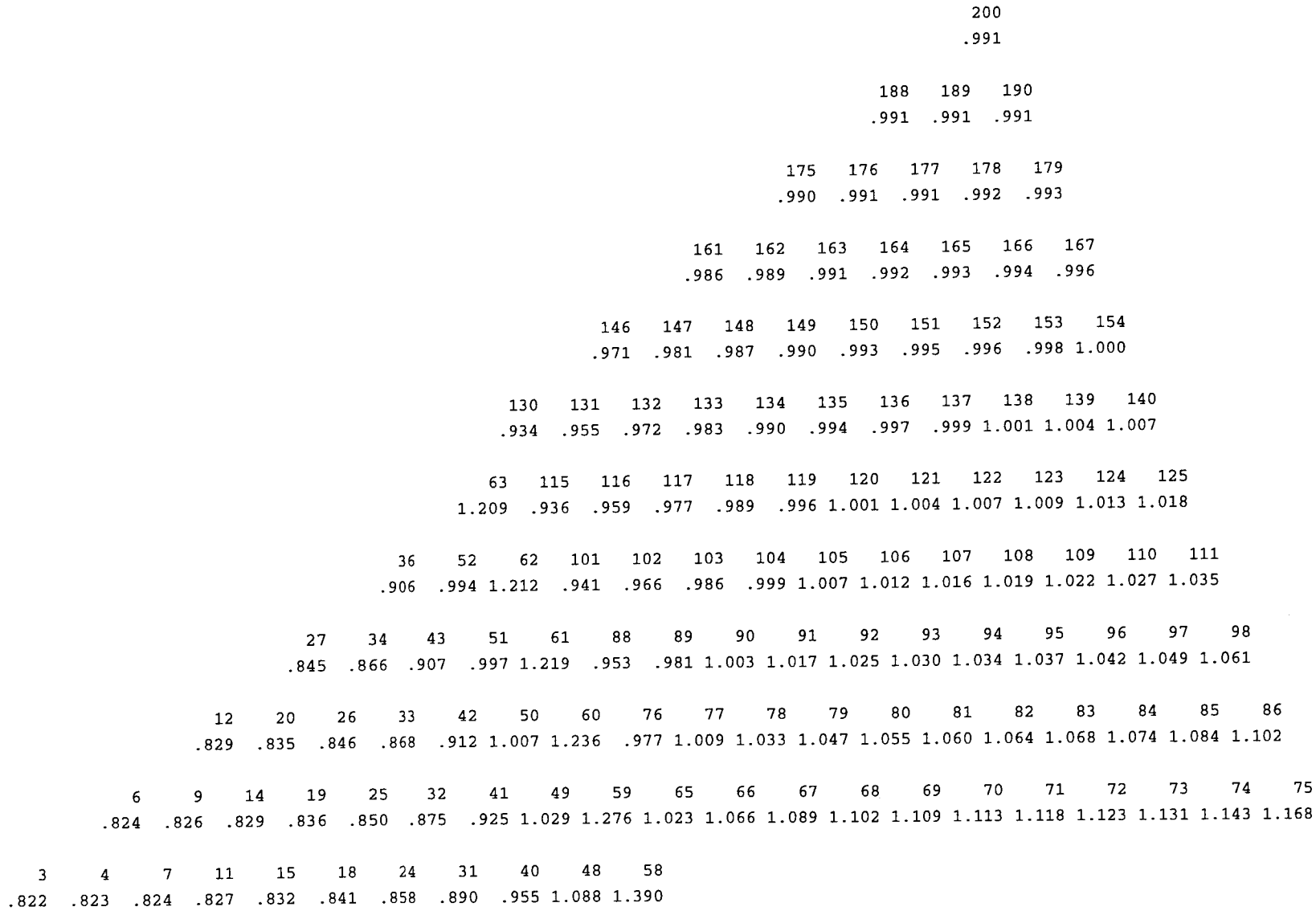


Fig. 4.108. Variant 13 State 5: relative cell powers normalized to the average power of 1.00.

200																			
.986																			
188	189	190																	
.986	.986	.986																	
175	176	177	178	179															
.986	.986	.986	.986	.987															
161	162	163	164	165	166	167													
.986	.986	.986	.986	.987	.987	.988													
146	147	148	149	150	151	152	153	154											
.985	.985	.986	.987	.987	.988	.988	.989	.990											
130	131	132	133	134	135	136	137	138	139	140									
1.000	.986	.986	.987	.988	.989	.990	.990	.991	.992	.995									
63	115	116	117	118	119	120	121	122	123	124	125								
1.156	1.001	.988	.989	.991	.992	.993	.994	.995	.997	.999	1.003								
36	52	62	101	102	103	104	105	106	107	108	109	110	111						
.895	.967	1.157	1.005	.994	.996	.999	1.001	1.002	1.004	1.005	1.007	1.010	1.017						
27	34	43	51	61	88	89	90	91	92	93	94	95	96	97	98				
.851	.865	.896	.969	1.161	1.015	1.007	1.011	1.016	1.018	1.020	1.022	1.023	1.026	1.032	1.045				
12	20	26	33	42	50	60	76	77	78	79	80	81	82	83	84	85	86		
.841	.845	.852	.867	.899	.975	1.173	1.037	1.037	1.046	1.051	1.054	1.056	1.058	1.060	1.065	1.074	1.097		
6	9	14	19	25	32	41	49	59	65	66	67	68	69	70	71	72	73	74	75
.839	.840	.842	.846	.854	.871	.907	.992	1.203	1.093	1.115	1.127	1.132	1.135	1.137	1.139	1.143	1.150	1.164	1.201
3	4	7	11	15	18	24	31	40	48	58									
.838	.838	.839	.840	.843	.848	.859	.881	.930	1.040	1.300									

Fig. 4.109. Variant 13 State 6: relative cell powers normalized to the average power of 1.00.

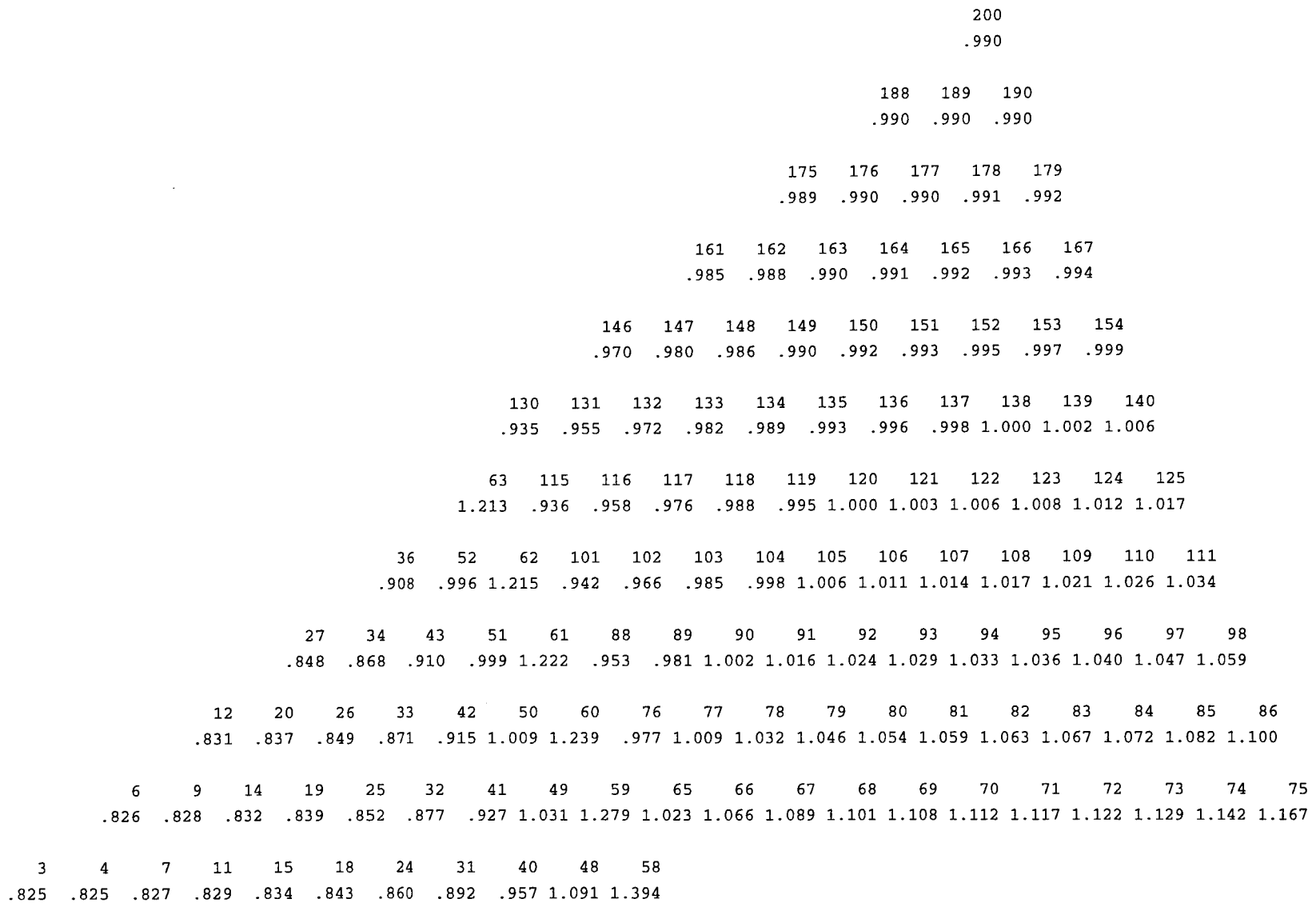


Fig. 4.110. Variant 13 State 1, with equilibrium xenon: relative cell powers normalized to the average power of 1.00.

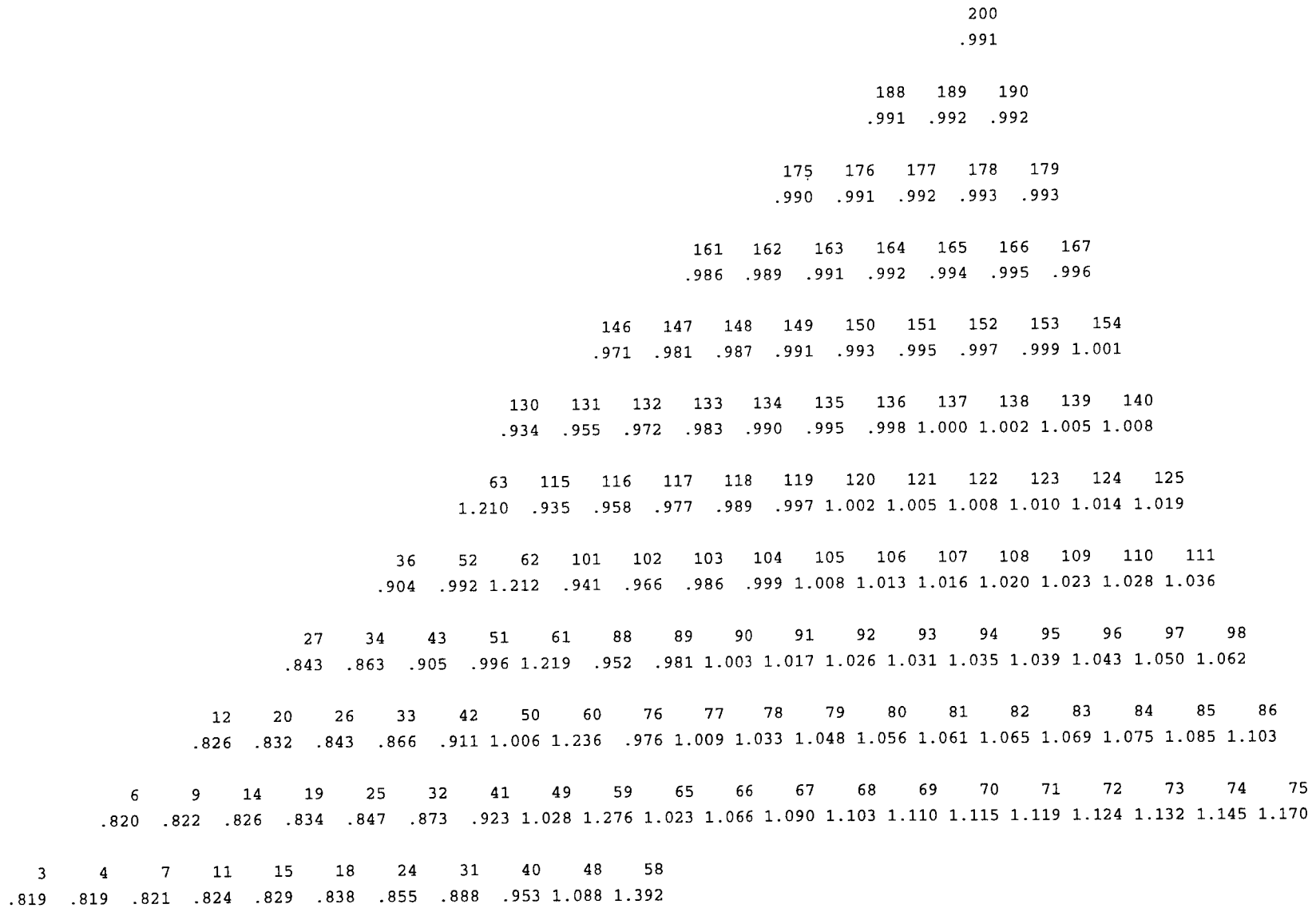


Fig. 4.111. Variant 13 State 1, reflective boundary conditions on all boundaries: relative cell powers normalized to the average power of 1.00.

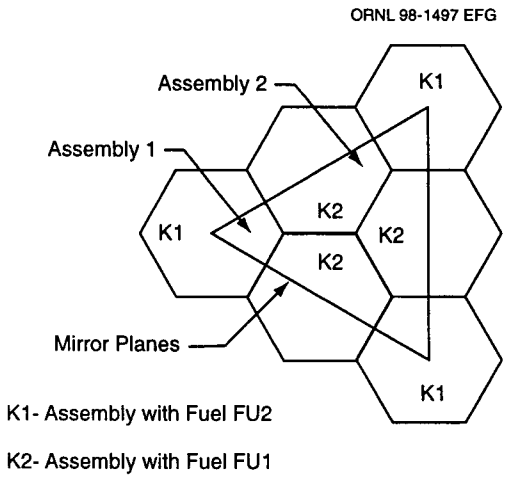


Fig. 4.112. Subelement of infinite array of MOX and LEU assemblies.

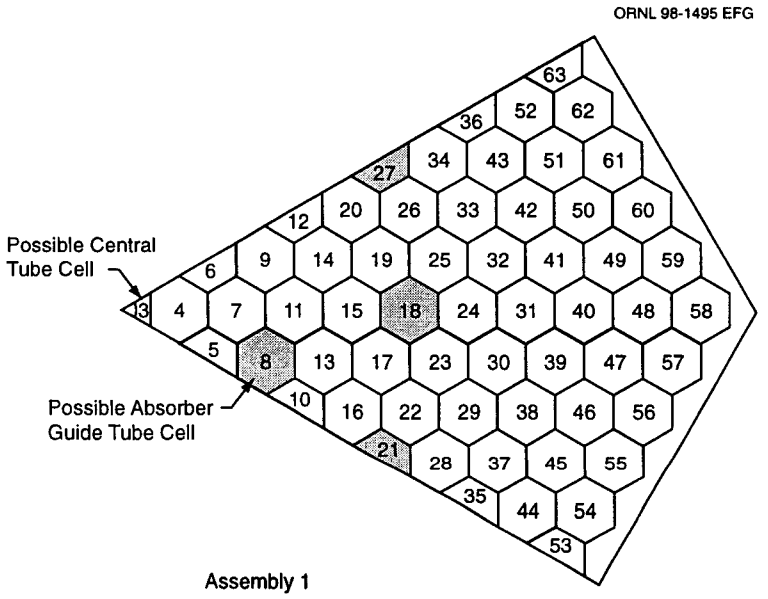


Fig. 4.113. Numbering scheme for assembly type K1 (see Fig. 4.112) for normalized pin powers.

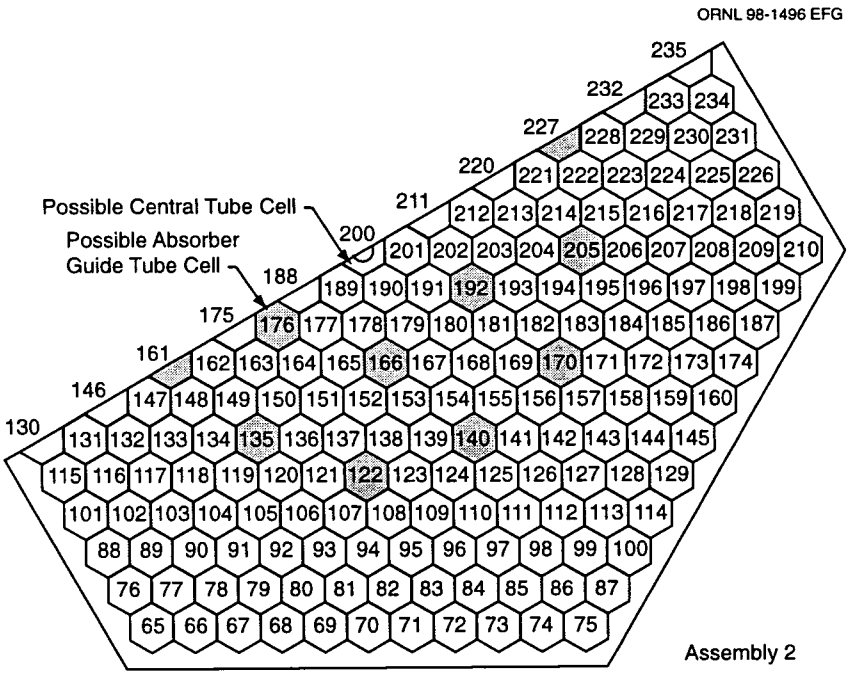


Fig. 4.114. Numbering scheme for assembly type K2 (see Fig. 4.112) for normalized pin powers.

4.4.3 Calculations Performed with the MCNP Monte Carlo Program (Georgeta Radulescu and Naeem Abdurrahman)

4.4.3.1 Introduction

The MCNP4A with the ENDF/B-VI multitemperature library were used for performing criticality calculations for the Variants 1, 2, 8, and 9, State1, BOL. The continuous ENDF/B-VI cross section libraries for 600 K, 900 K, and 1200 K have been made available by Brian Palmer from Framatome Cogema Fuels.

4.4.3.2 Calculational method

For State 1, the fuel and nonfuel zones temperatures are 1027 K and 579 K, respectively. Because the multitemperature library was processed for 600 K, 900 K, and 1200 K, the actual temperatures of the fuel rod and the moderator were simulated by considering two regions at different temperatures. The central region of the fuel had 1200 K, and the peripheral region of the fuel had 900 K. The region of the moderator next to the clad had 600 K, and the outer region of the moderator had 300 K. The volumes of the two regions were calculated so that the average temperature of the fuel is 1100 K and the average temperature of the moderator is 579 K. The $S(\alpha,\beta)$ treatment was invoked for the hydrogen atoms in water at 600 K and 300 K. All other materials had 600 K. The core height is 365 cm. Note that the benchmark specifications actually had $B^2 = 0.003$ which corresponds to a height of about 53 cm. So results here cannot be compared to any other results. Input data for the MCNP program are stored on the CD included with this report.

One-group, microscopic cross-sections, which were averaged on the fuel volume, were calculated using the formula:

$$\sigma = \frac{\int\int_{EV} \Phi(r,E)\sigma(E)dvdE}{\int\int_{EV} \Phi(r,E)dvdE} .$$

One-group, macroscopic cross-sections, which were averaged on the cell volume, were calculated using the formula:

$$\sum = \sum_R \frac{\sum_{i=1}^{n} N_i \int_E \int_{V_R} \Phi(r,E)\sigma_i(E)dvdE}{\int_E \int_{V_R} \Phi(r,E)dvdE},$$

where R represents fuel, clad, and moderator regions, and N_i is the atomic density of the *ith* nuclide in region R.

4.4.3.3 MCNP4A results for State 1

The cell flux and nuclide reaction rates are normalized per source neutron. The standard deviation for all tallies specified is about 1.5%. Results for each variant in State 1 are given in Tables 4.96–4.107.

Variant 1

$k_{inf} = 1.3222 \pm 0.0007$
$k_{eff} = 1.3157 \pm 0.0007$

Table 4.96. Flux and volume fractions for Variant 1, State 1

Cell flux	4.67597E+01
Fuel/cell	3.3244E-01
Clad/cell	1.34247E-01
Moderator/cell	5.33332E-01

Table 4.97. One-group, cell-averaged, macroscopic cross sections (cm^{-1})

Absorption	Fission	Nu*fission
6.36497E-02	3.44450E-02	8.45729E-02

Table 4.98. One-group, fuel-averaged, microscopic cross sections and reaction rates for selected nuclides

Isotope	Absorption		Nu*fission	
	Cross section (barns)	Reaction rate 1/(cm^3•s)	Cross section (barns)	Reaction rate 1/(cm^3•s)
^{235}U	4.58725E+01	6.23010E-01	9.08216E+01	1.23344E+00
^{236}U	8.87646E+00	0.00000E+00	7.97378E-01	0.00000E+00
^{238}U	1.00919E+00	2.94040E-01	2.78613E-01	8.11793E-02
^{238}Pu	2.96426E+01	0.00000E+00	6.66711E+00	0.00000E+00
^{239}Pu	1.57154E+02	0.00000E+00	2.86259E+02	0.00000E+00
^{240}Pu	2.33223E+02	0.00000E+00	1.86373E+00	0.00000E+00
^{241}Pu	1.33351E+02	0.00000E+00	2.90718E+02	0.00000E+00
^{242}Pu	3.46445E+01	0.00000E+00	1.36574E+00	0.00000E+00
^{135}Xe	1.59767E+05	0.00000E+00		
^{149}Sm	5.04030E+03	0.00000E+00		

Variant 2

$k_{inf} = 1.2314 \pm 0.0007$
$k_{eff} = 1.2371 \pm 0.0008$

Table 4.99. Flux and volume fractions for Variant 2, State 1

Cell flux	4.37758E+01
Fuel/cell	3.31861E-01
Clad/cell	1.36225E-01
Moderator/cell	5.31913E-01

Table 4.100. One-group, cell-averaged, macroscopic cross section (cm^{-1})

Absorption	Fission	Nu*fission
6.83645E-02	2.96882E-02	8.48229E-02

Table 4.101. One-group, fuel-averaged, microscopic cross sections and reaction rates for selected nuclides

Isotope	Absorption		Nu*fission	
	Cross section (barns)	Reaction rate 1/(cm^3•s)	Cross section (barns)	Reaction rate 1/(cm^3•s)
^{235}U	2.65100E+01	1.47861E-02	5.00564E+01	2.79192E-02
^{236}U	9.27563E+00	0.00000E+00	8.68224E-01	0.00000E+00
^{238}U	9.84288E-01	2.70499E-01	3.11856E-01	8.57033E-02
^{238}Pu	1.64437E+01	0.00000E+00	5.89191E+00	0.00000E+00
^{239}Pu	6.21352E+01	5.94633E-01	1.15221E+02	1.15288E+00
^{240}Pu	1.03414E+02	6.35843E-02	1.95378E+00	1.20130E-03
^{241}Pu	6.27977E+01	6.40850E-03	1.38476E+02	1.41314E-02
^{242}Pu	3.65921E+01	0.00000E+00	1.49516E+00	0.00000E+00

Variant 8

$k_{inf} = 1.1548 \pm 0.0007$
$k_{eff} = 1.1484 \pm 0.0007$

Table 4.102. Flux and volume fractions for Variant 8, State 1

Cell flux	4.70816E+01
Fuel/cell	3.32440E-01
Clad/cell	1.36116E-01
Moderator/cell	5.31444E-01

Table 4.103. One-group, cell-averaged, macroscopic cross section (cm^{-1})

Absorption	Fission	Nu*fission
6.22237E-02	3.06698E-02	7.54800E-02

Table 4.104. One-group, fuel-averaged, microscopic cross sections and reaction rates for selected nuclides

Isotope	Absorption		Nu*fission	
	Cross section (barns)	Reaction rate $1/(cm^3 \cdot s)$	Cross section (barns)	Reaction rate $1/(cm^3 \cdot s)$
^{235}U	4.91965E+01	5.36807E-01	9.76479E+01	1.06549E+00
^{236}U	9.01328E+00	0.00000E+00	7.96112E-01	0.00000E+00
^{238}U	1.02310E+00	3.02925E-01	2.75794E-01	8.16586E-02
^{238}Pu	3.23814E+01	0.00000E+00	6.86884E+00	0.00000E+00
^{239}Pu	1.64843E+02	0.00000E+00	3.01105E+02	0.00000E+00
^{240}Pu	1.09884E+02	1.56974E-02	1.77859E+00	3.42495E-02
^{241}Pu	1.42772E+02	0.00000E+00	3.11507E+02	0.00000E+00
^{242}Pu	3.51702E+01	0.00000E+00	1.35194E+00	0.00000E+00
^{135}Xe	1.78611E+05	0.00000E+00		
^{149}Sm	5.57709E+03	0.00000E+00		

Variant 9

$k_{inf} = 1.5699 \pm 0.001$
$k_{eff} = 1.5769 \pm 0.0009$

Table 4.105. Flux and volume fractions for Variant 9, State 1

Cell flux	4.36179E+01
Fuel/cell	3.32036E-01
Clad/cell	1.36196E-01
Moderator/cell	5.31768E-01

Table 4.106. One-group, cell-averaged, macroscopic cross section (cm^{-1})

Absorption	Fission	Nu*fission
6.82880E-02	3.70375E-02	1.08428E-02

Table 4.107. One-group, fuel-averaged, microscopic cross sections and reaction rates for selected nuclides

Isotope	Absorption		Nu*fission	
	Cross section (barns)	Reaction rate $1/(cm^3 \cdot s)$	Cross section (barns)	Reaction rate $1/(cm^3 \cdot s)$
^{235}U	2.84670E+01	1.58293E-02	5.42055E+01	3.01404E-02
^{236}U	8.37916E+00	0.00000E+00	8.22761E-01	0.00000E+00
^{238}U	9.75281E-01	2.67198E-01	2.98789E-01	8.18594E-02
^{238}Pu	1.71019E+01	0.00000E+00	5.85458E+00	0.00000E+00
^{239}Pu	8.42438E+01	0.00000E+00	1.53588E+02	0.00000E+00
^{240}Pu	2.38855E+02	0.00000E+00	1.97336E+00	0.00000E+00
^{241}Pu	6.88828E+01	9.20752E-01	1.51365E+02	1.45948E+00
^{242}Pu	3.37147E+01	0.00000E+00	1.44997E+00	0.00000E+00
^{135}Xe	7.29973E+04	0.00000E+00		
^{149}Sm	3.42320E+03	0.00000E+00		

4.4.3.4 MCNP4A results for State 6

The results presented in Tables 4.108 and 4.109 were obtained using the ENDF/B-VI library. The corresponding temperature of ENDB/B-VI library for all nuclides is 294 K except for ^{241}Am, where the temperature is 300 K. The S(α,β) treatment of water moderator for taking into account the molecular binding effects on neutron thermalization at 300 K was invoked in all calculations. Two core geometry types were considered: an infinite core (Table 4.108) and a core with a height of 365 cm (typical VVER core height, Table 4.109). The multigroup absorption and fission macroscopic cross sections are provided for State 6, Variant 1 (365-cm-high core). Note that the temperature and height are different from specifications. Therefore, these results cannot be compared to others.

Table 4.108 k_{inf} for State 6, Variants: V1, V2, V7–V13, and an infinite core

Variant	Fuel type	Geometry type	k_{inf}
V1	Fresh UO_2 fuel pin cell	C3	1.3730 ± 0.0008
V2	Fresh MOX pin cell	C3	1.3248 ± 0.0007
V7	MOX with ^{239}Pu only pin cell	C3	1.4114 ± 0.0008
V8	MOX with ^{240}Pu only pin cell	C3	1.2167 ± 0.0008
V9	MOX with ^{241}Pu only pin cell	C3	1.6430 ± 0.0010
V10	Fresh MOX (reactor plutonium) pin cell	C3	1.2083 ± 0.0007
V11	Fresh UO_2 fuel assembly	K331	1.3689 ± 0.0009
V12	Fresh MOX fuel assembly	K331	1.3356 ± 0.0008
V13	Multiassembly structure	MK2	1.3446 ± 0.0007

Table 4.109 k_{eff} for State 6, Variants: V1, V2, V7–V12, and a 365-cm-height core

Variant	Fuel type	Geometry type	k_∞
V1	Fresh UO_2 fuel pin cell	C3	1.3681 ± 0.0009
V2	Fresh MOX pin cell	C3	1.3218 ± 0.0008
V7	MOX with ^{239}Pu only pin cell	C3	1.4079 ± 0.0007
V8	MOX with ^{240}Pu only pin cell	C3	1.2121 ± 0.0007
V9	MOX with ^{241}Pu only pin cell	C3	1.6391 ± 0.001
V10	Fresh MOX (reactor plutonium) pin cell	C3	1.2046 ± 0.0007
V11	Fresh UO_2 fuel assembly	K331	1.3644 ± 0.0009
V12	Fresh MOX fuel assembly	K331	1.3315 ± 0.0008

4.4.4 WIMS-DIF3D Calculations (Helen J. Nasr and Marvin L. Adams)

4.4.4.1 Introduction

The results presented in the following sections were obtained using WIMS-D4M and DIF3D finite difference codes. The WIMS-D4M calculations are based on a 69-group, ENDF/B-V-derived nuclear data library. The ISOTXS-formatted cross sections generated by WIMS are input to the DIF3D code.

4.4.4.2 Problem description

All the problems were solved for an axial buckling $B^2 = 0.003$ cm^2 and zero current boundary conditions. All the variants with State 1 have been solved with the following ^{135}Xe and ^{149}Sm concentrations ($\times 10^{-24}$ cm^{-3}): ^{135}Xe = 9.4581E–9, ^{149}Sm = 7.3667E–8. Variant 13 has not been solved because DIF3D finite difference hexagonal geometry option cannot precisely model the gaps between VVER assemblies.

Because WIMS generates up to 20 broad-group, burnup-dependent, macroscopic or microscopic ISOTXS cross sections, 20 energy groups were used. The upper boundaries of the 20 energy groups were chosen from the WIMS library to be as close as possible to the ABBN library (see Table 4.110).

Table 4.110. The upper boundaries of 20 energy groups (eV)

1	1.0000+7	6	9.1180+3	11	1.4873+2	16	2.1000+0
2	2.2310+6	7	5.530+3	12	4.8052+1	17	0.996+0
3	0.5000+6	8	2.2395+3	13	2.7700+1	18	0.500+0
4	0.1110+6	9	9.0690+2	14	9.877+0	19	0.220+0
5	2.4780+4	10	3.6726+2	15	4.0000+0	20	5.000-3

For the pin-cell calculations (Variants 1–10), only WIMS was used. For the assembly cases (Variants 11–12), DIF3D was selected. In these cases, the DIF3D triangular geometry was used. It modeled triangular, rhombic geometry, with one-sixth core center (60° segment). Because there is a sixth core symmetry, it would be equivalent to the hexagonal assembly. The intra-assembly water gap surrounding the outer pin fuel cells was not modeled. Four different cells were modeled with WIMS, and the resulting cross section sets were assigned to fuel cell locations in the assembly as shown in Fig. 4.115.

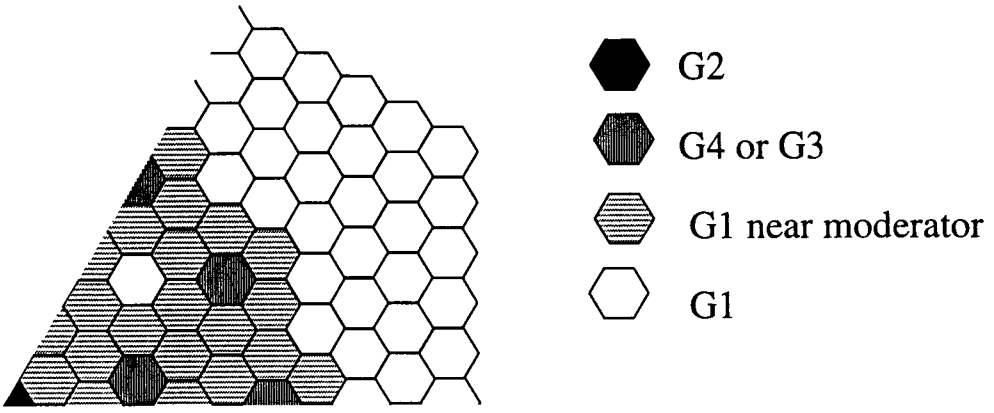


Fig. 4.115. Assembly K331, one-sixth assembly.

4.4.4.3 Results of calculations

For BOL, the k_{eff} and k_{inf} results are listed in Table 4.111. The burnup calculations are listed in the Tables 4.112 to 4.123. Input data for the WIMS program are stored on the CD included with this report.

Table 4.111. The k_{eff} and k_{inf} for 0 burnup

Case ID	k_{eff}	k_{inf}
V1S1	1.0584	1.2581
V1S3	1.1485	1.3674
V1S4	1.0985	1.3067
V1S5	1.1140	1.3255
V1S6	1.2206	1.3669
V2S1	1.0178	1.2006
V2S3	1.0604	1.2516
V2S4	1.0349	1.2210
V2S5	1.0527	1.2425
V2S6	1.1839	1.3205
V7S1	1.1032	1.3036
V7S3	1.1519	1.3621
V7S4	1.1227	1.3270
V7S5	1.1389	1.3466
V7S6	1.2642	1.4112
V8S1	0.9160	1.0869
V8S3	1.0071	1.1974
V8S4	0.9575	1.1372
V8S5	0.9742	1.1574
V8S6	1.0803	1.2088
V9S1	1.2954	1.5292
V9S3	1.3466	1.5906
V9S4	1.3151	1.5528
V9S5	1.3334	1.5748
V9S6	1.3483	1.5929

Table 4.111. (continued)

Case ID	k_{eff}	k_{inf}
V10S1	0.9317	1.0722
V10S3	0.9475	1.0907
V10S4	0.9366	1.0780
V10S5	0.9520	1.0961
V10S6	1.0638	1.1704
V11S1		1.2686
V11S2		1.3116
V11S3		1.3693
V11S4		1.3180
V11S5		1.3360
V11S6		1.3637
V12S1		1.2074
V12S2		1.2238
V12S3		1.2658
V12S4		1.2319
V12S5		1.2536
V12S6		1.3189

Table 4.112. Burnup calculations for Variant 1, States 3–6

Burnup step (MWd/kgU)	V1S3		V1S4		V1S5		V1S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.8913	1.0597	0.8558	1.0165	0.8679	1.0314	0.9635	1.0791
20	0.7617	0.9065	0.7346	0.8732	0.7388	0.8789	0.7857	0.8807
30	0.6817	0.8125	0.6600	0.7855	0.6579	0.7839	0.6639	0.7449
40	0.6397	0.7638	0.6212	0.7406	0.6157	0.7348	0.6089	0.6840
50	0.6170	0.7383	0.5996	0.7162	0.5934	0.7097	0.5853	0.6582

Table 4.113. Burnup calculations for Variant 2, States 3–6

Burnup step (MWd/kgU)	V2S3		V2S4		V2S5		V2S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.8937	1.0549	0.8720	1.0281	0.8828	1.0421	0.9635	1.0773
20	0.7897	0.9336	0.7693	0.9089	0.7729	0.9139	0.8045	0.8992
30	0.7177	0.8504	0.6998	0.8285	0.6974	0.8264	0.6912	0.7738
40	0.6722	0.7985	0.6546	0.7767	0.6493	0.7713	0.6301	0.7064
50	0.6427	0.7654	0.6258	0.7443	0.6188	0.7369	0.5986	0.6721

Table 4.114. Burnup calculations for Variant 7, States 3–6

Burnup step (MWd/kgU)	V7S3		V7S4		V7S5		V7S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.9311	1.1004	0.9068	1.0711	0.9195	1.0866	1.0023	1.1193
20	0.8005	0.9476	0.7784	0.9208	0.7827	0.9266	0.8086	0.9044
30	0.7170	0.8505	0.6969	0.8258	0.6937	0.8229	0.6832	0.7652
40	0.6672	0.7933	0.6492	0.7710	0.6436	0.7652	0.6248	0.7007
50	0.6377	0.7600	0.6206	0.7386	0.6132	0.7307	0.5958	0.6691

Table 4.115. Burnup calculations for Variant 8, States 3–6

Burnup step (MWd/kgU)	V8S3		V8S4		V8S5		V8S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.8168	0.9699	0.7827	0.9284	0.7927	0.9408	0.8797	0.9841
20	0.7171	0.8522	0.6913	0.8204	0.6932	0.8234	0.7273	0.8147
30	0.6612	0.7868	0.6405	0.7611	0.6373	0.7581	0.6398	0.7173
40	0.6315	0.7528	0.6133	0.7300	0.6081	0.7246	0.6031	0.6768
50	0.6147	0.7343	0.5973	0.7123	0.5915	0.7063	0.5841	0.6563

Table 4.116. Burnup calculations for Variant 9, States 3–6

Burnup step (MWd/kgU)	V9S3		V9S4		V9S5		V9S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.9327	1.1033	0.9040	1.0687	0.9163	1.0838	0.9265	1.0964
20	0.7624	0.9042	0.7380	0.8744	0.7391	0.8764	0.7400	0.8781
30	0.6911	0.8214	0.6692	0.7943	0.6661	0.7915	0.6618	0.7870
40	0.6516	0.7760	0.6328	0.7525	0.6265	0.7459	0.6212	0.7402
50	0.6282	0.7497	0.6106	0.7276	0.6036	0.7201	0.5977	0.7138

Table 4.117. Burnup calculations for Variant 10, States 3–6

Burnup step (MWd/kgU)	V10S3		V10S4		V10S5		V10S6	
	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}	k_{eff}	k_{inf}
10	0.8760	1.0090	0.8665	0.9979	0.8772	1.0107	0.9659	1.0633
20	0.8299	0.9572	0.8210	0.9467	0.8283	0.9556	0.9014	0.9933
30	0.7894	0.9119	0.7808	0.9017	0.7852	0.9074	0.8413	0.9282
40	0.7545	0.8732	0.7460	0.8631	0.7478	0.8658	0.7859	0.8684
50	0.7252	0.8411	0.7166	0.8309	0.7162	0.8312	0.7359	0.8145

Table 4.118. Burnup calculations for Variant 1, State 1

Burnup step (MWd/kgU)	V1S1	
	k_{eff}	k_{inf}
2	1.0060	1.1947
4	0.9568	1.1358
6	0.9161	1.0872
8	0.8801	1.0444
10	0.8469	1.0050
12	0.8171	0.9698
14	0.7902	0.9379
16	0.7649	0.9082
18	0.7423	0.8815
20	0.7217	0.8573
22	0.7033	0.8357
24	0.6866	0.8161
26	0.6719	0.7989
28	0.6596	0.7846
30	0.6486	0.7718

Table 4.119. Burnup calculations for Variant 2, State 1

Burnup step (MWd/kgU)	V2S1	
	k_{eff}	k_{inf}
2	0.9486	1.1186
4	0.9063	1.0687
6	0.8718	1.0281
8	0.8429	0.9943
10	0.8167	0.9636
12	0.7933	0.9362
14	0.7720	0.9114
16	0.7527	0.8891
18	0.7348	0.8683
20	0.7193	0.8504
22	0.7043	0.8330
24	0.6913	0.8180
26	0.6800	0.8050
28	0.6692	0.7927
30	0.6595	0.7816

Table 4.120. Burnup calculations for Variant 7, State 1

Burnup step (MWd/kgU)	V7S1	
	k_{eff}	k_{inf}
2	0.9766	1.1527
4	0.9196	1.0854
6	0.8778	1.0361
8	0.8438	0.9961
10	0.8149	0.9622
12	0.7892	0.9322
14	0.7662	0.9054
16	0.7455	0.8812
18	0.7272	0.8600
20	0.7114	0.8417
22	0.6968	0.8250
24	0.6839	0.8099
26	0.6721	0.7963
28	0.6623	0.7851
30	0.6536	0.7752

Table 4.121. Burnup calculations for Variant 8, State 1

Burnup step (MWd/kgU)	V8S1	
	k_{eff}	k_{inf}
2	0.9184	1.0888
4	0.8962	1.0620
6	0.8680	1.0285
8	0.8384	0.9934
10	0.8093	0.9590
12	0.7827	0.9276
14	0.7584	0.8990
16	0.7357	0.8722
18	0.7158	0.8488
20	0.6989	0.8289
22	0.6832	0.8106
24	0.6703	0.7951
26	0.6582	0.7814
28	0.6489	0.7705
30	0.6398	0.7600

Table 4.122. Burnup calculations for Variant 9, State 1

Burnup step (MWd/kgU)	V9S1	
	k_{eff}	K_{inf}
2	1.1576	1.3665
4	1.0541	1.2447
6	0.9654	1.1405
8	0.8869	1.0485
10	0.8204	0.9706
12	0.7669	0.9080
14	0.7250	0.8588
16	0.6956	0.8244
18	0.6745	0.7997
20	0.6604	0.7834
22	0.6495	0.7707
24	0.6425	0.7626
26	0.6366	0.7560
28	0.6317	0.7504
30	0.6273	0.7454

Table 4.123. Burnup calculations for Variant 10, State 1

Burnup step (MWd/kgU)	V10S1	
	k_{eff}	K_{inf}
2	0.9068	1.0435
4	0.8946	1.0297
6	0.8836	1.0171
8	0.8729	1.0051
10	0.8626	0.9934
12	0.8524	0.9820
14	0.8425	0.9708
16	0.8328	0.9598
18	0.8233	0.9491
20	0.8140	0.9387
22	0.8049	0.9286
24	0.7962	0.9188
26	0.7876	0.9092
28	0.7792	0.8998
30	0.7711	0.8908

4.5 COMMENTS ON THE VVER-1000 COMPUTATIONAL BENCHMARKS (J. C. Gehin)

As discussed in the introduction of Chapter 4, in late 1996 the technical staff of the Russian Research Center -- "Kurchatov Institute" (RRC-KI) prepared preliminary specifications for a series of computational benchmark problems based on VVER-1000 pin cells, assemblies and multi-assemblies. These specifications are essentially those presented in Section 4.3. What is not apparent, however, is that early-on in the benchmarking process many of the items in the specifications were unclear, particularly the use of the rather large buckling value of 0.003 cm^{-2} and the states that are to include equilibrium ^{135}Xe and ^{149}Sm. These issues were later resolved, but after many of the calculations that are discussed in Section 4.4 were completed. In addition, the set of variants discussed in this report were later expanded to include variants with states typical of accident conditions, variants with graded MOX assemblies more typical of a real design, and variants that require the calculation of kinetics parameters.[8] In addition, a VVER-1000 MOX assembly benchmark with gadolina absorbers was recently sponsored by the OECD/NEA.[9] Finally, it should be mentioned that these extensive computational benchmark calculations have been extended to mini-core and full core models that can be used to provide a more realistic verification of lattice-physics codes and core analysis codes.[10]

Since the time that these benchmark calculations were first performed, ORNL has obtained the HELIOS fuel assembly analysis code, which has added greatly to our capabilities for modeling VVER-1000 assemblies. As is apparent by the descriptions of the methods in Sections 4.4.1 (SCALE-KENO calculations) and 4.4.2, a large amount of effort was required to model these benchmarks using ORNL's best available methods at that time (1996). ORNL's final reference set of calculations provided to the Russians for use in their licensing process are documented in a subsequent report [11]. A comparison of these calculations to similar calculations performed at RRC-KI with TVS-M (a code similar in principle to HELIOS) and MCU (a Monte Carlo code), the results of which are documented in a companion report given in Ref. 12, was recently presented [13] and showed excellent agreement between the ORNL and RRC-KI calculations. However, these HELIOS calculations greatly benefited from experience gained during this earlier benchmarking. In addition to the HELIOS calculations, additional calculations have been performed with the SCALE SAS2H sequence.[14]

It is useful to compare the earlier calculations documented in this report with those performed more recently in the U.S. with HELIOS and SCALE/SAS2H. J. C. Gehin collected results, primarily k_{eff}, from the various sources (Section 4.4 of this report, Ref. 10 and Ref. 14). Calculations of the VVER-1000 computational benchmarks have been performed with SCALE/KENO, VENTURE, MCNP4A, WIMS-D4M/DIF3D, HELIOS and SCALE/SAS2H. Observations regarding some of the results are discussed below. These observations may have important implications upon the usability of the results for verification of the codes.

Variants 1 and 2 - UO_2 and WG MOX Pin Cell k_{eff} Values

- The SCALE/KENO results are in good agreement with the HELIOS results for S1 (the state for which burnup calculations are required).
- The SCALE/SAS2H calculations slightly over-predict k_{eff} in comparison to the KENO results. This is a bit surprising since both SCALE/KENO and SCALE/SAS2H used the same cross section libraries and essentially the same calculational sequence. The one-dimensional XSDRNPM calculations used in SAS2H should be sufficiently accurate to model these pin cells.
- The WIMS-D4M results at zero burnup agree with the SCALE/KENO and HELIOS results, but the values at higher burnups are grossly different for all states. There appears to be a calculational error. The results in Tables 4.112 - 4.123 should not be used without further confirmation.
- There appears to be modeling differences regarding the presence of ^{135}Xe and ^{149}Sm in several of the states. The SCALE/KENO results for states 4, 5, and 6 are low in comparison to HELIOS by an amount that could be attributable to that of ^{135}Xe and ^{149}Sm. The specifications on page 4-99 indicate that these states should not have ^{135}Xe and ^{149}Sm. However, it appears that these isotopes may be present in the SCALE/KENO calculations.
- The WIMS-D4M results are not provided for all of these states (state S1 at burnups > 0 MWd/kg, for example).

Variant 10 – Reactor Grade MOX Cell k_{eff} Values

- The results for this variant show larger discrepancies than for Variants 1 or 2.
- The SCALE/SAS2H results show the same previous trend of over-predicting k_{eff}.
- Unlike variants 2 and 3, the WIMS-D4M results show a sizable discrepancy for the values at 0 MWd/kg. The values at burnups > 0 MWd/kg still show the large discrepancies as indicated above.
- The discrepancies in states 4, 5, and 6 seen in Variants 1 and 2 between SCALE/KENO and HELIOS that appear to be related to the presence of ^{135}Xe and ^{149}Sm are not present in this variant.

Variants 11 and 12 - UO_2 and Weapons Grade MOX VVER-1000 Assembly k_{eff} Values

- Generally, the discrepancies for this assembly case are larger than for the previous pin-cell calculations.
- The VENTURE results are in reasonably good agreement with the SCALE/KENO results.
- States 4, 5, and 6 have large discrepancies between the SCALE/KENO and the HELIOS results, presumably due to the presence of ^{135}Xe and ^{149}Sm in the SCALE/KENO model.

In addition to the comments presented above, it should be noted that the MCNP4A k_{eff} results presented in the report cannot be compared to any of the other calculations because the calculations were performed with a core height of 365 cm, which is much larger than the ~57-cm-height representative of the 0.003 cm^{-2} buckling value.

The power distributions (fission densities) are provided in this report only for the VENTURE calculations. A quick comparison of the results for Variants 11 and 12 with those computed by HELIOS for state 1 show a good level of agreement, perhaps with a one to two percent maximum differences. It should be noted, however, that for this state there are not control rods present, so power distribution is relatively flat. A more interesting comparison would have been for state 2, which has control rods present. Unfortunately, the VENTURE results were not provided for this state, as required by the specifications. The VENTURE power distribution results were provided for states 3-6, which are not required by the benchmark specifications.

Overall, the level of agreement among the calculations performed at ORNL with SCALE/KENO, VENTURE, and HELIOS is good. There are a few exceptions and discrepancies related to difficulties interpreting the early benchmark specifications. In addition, the calculations performed with SCALE/KENO and VENTURE were very tedious due to the lack of automated sequences for cross section generation and burnup. In light of this fact the good agreement is even more impressive. However, the HELIOS calculations given in Ref. 4 provide the most accurate and complete set of calculations for verification.

4.6 REFERENCES

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5. EXPERIMENTAL BENCHMARKS

(J. J. Lichtenwalter)

5.1 INTRODUCTION

The goal of this work is to validate the SCALE-KENO Monte Carlo code system and its current nuclear database and other Monte Carlo codes (such as MCNP) as applied to VVERs or PWRs with MOX fuel. The calculations are also applicable to criticality safety of the out-of-reactor portion of the fuel cycle. Ten sets of critical configurations (more than 100 distinct critical experiments) were evaluated. These cases are representative of data needed to certify activities described in Chap. 2 of this report.

The experimental data for the calculations are documented in *the International Handbook of Evaluated Criticality Safety Benchmark Experiments.*[*] Thus, only very brief descriptions of the assemblies are given in 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 identifying the causes of the differences in the multiplication factors among different code/library combinations.

5.2 BARE SPHERE OF PLUTONIUM-239 METAL (CS-1)[**]

5.2.1 Overview of Experiment

In the early 1950s, the ^{239}Pu Jezebel critical assembly was fabricated and operated at the Los Alamos Scientific Laboratory.[1] Three Jezebel assemblies were actually built; one used plutonium with 4.5 at. % ^{240}Pu, referred to as the ^{239}Pu Jezebel; one used plutonium with 20 at. % ^{240}Pu, referred to as the ^{240}Pu Jezebel; and one used ^{233}U, referred to as the ^{233}U Jezebel. Only the ^{239}Pu Jezebel is described in this report. The ^{239}Pu Jezebel was an unreflected, or bare, delta-phase ^{239}Pu critical assembly, nearly spherical in shape. It is considered to be acceptable for use as a benchmark critical experiment.

The ^{239}Pu Jezebel was successfully operated for several years, and literally hundreds of experiments were performed, including a large number of reactivity worth measurements.[2] Subsequently, Jezebel was disassembled, structural parts destroyed, and the ^{239}Pu used for other purposes.

5.2.2 Description of Experimental Configuration

For criticality safety purposes, the nearly spherical mass was constructed in four major pieces, each of roughly the same mass, which were assembled to provide three-part subdivision for operational safety. Because of the toxicity of plutonium, all parts were nickel plated. The assembly was designed to be highly reproducible and to have minimum reflection, while retaining experimental flexibility. The following features ensured that these three design criteria were satisfied: (1) light, but rigid framework and supports; (2) self-aligning of the three subdivisions by means of guide wires that supported the central section and a ball and socket support for the upper section; (3) uniform mass adjustment buttons to supplement the single plutonium control rod bar; and (4) adjustable air cooling with a recording thermocouple to accommodate the 30 W of heating from the alpha decay of the plutonium. Provision was also made for the addition of "gross mass adjustment disks" of plutonium at the upper and lower poles of the assembly. Figure 5.1 shows the active portion of the original ^{239}Pu Jezebel. Cooling air was blown out of the locating arms that rode on taut piano-wire guides.

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[*] *International Handbook of Evaluated Criticality Safety Benchmark Experiments, Nuclear Energy Agency Nuclear Science Committee of the Organization for Economic Co-operation and Development, NEA/NSC/DOC(95)03, Paris (1999).*

[**] This section is a revision to the evaluation PU-MET-FAST-001 contained in NEA/NSC/DOC(95)03/1. Much of the text of Sect. 5.2 is from that document. The authors expressly acknowledge the original authors and reviewers of this text and in no way claim credit for their work.

Two different configurations of ^{239}Pu Jezebel were used as basic critical experiments. Configuration A contained 16.751 kg of plutonium-alloy at an average density of 15.61 g/cm^3. It had no polar gross mass-adjustment disks and was measured to be subcritical by 0.43 lower mass-adjustment plug (equivalent to 10 g alloy distributed over the exterior surface), with all mass adjustment plugs in place and the control rod fully inserted. With this configuration, the critical mass was determined to be 16.761 kg delta-phase plutonium alloy. Configuration B contained 16.909 kg alloy at an average density of 15.60 g/cm^3. It had two polar gross mass-adjustment disks and went critical with six lower mass-adjustment plugs removed and the control rod extracted 1.375 in. Based on experimental calibrations of the control rod and mass adjustment plugs, this configuration, with all mass-adjustment plugs installed and the control rod fully inserted, would have had a critical mass of 16.784 kg at an average density of 15.60 g/cm^3. Figure 5.2

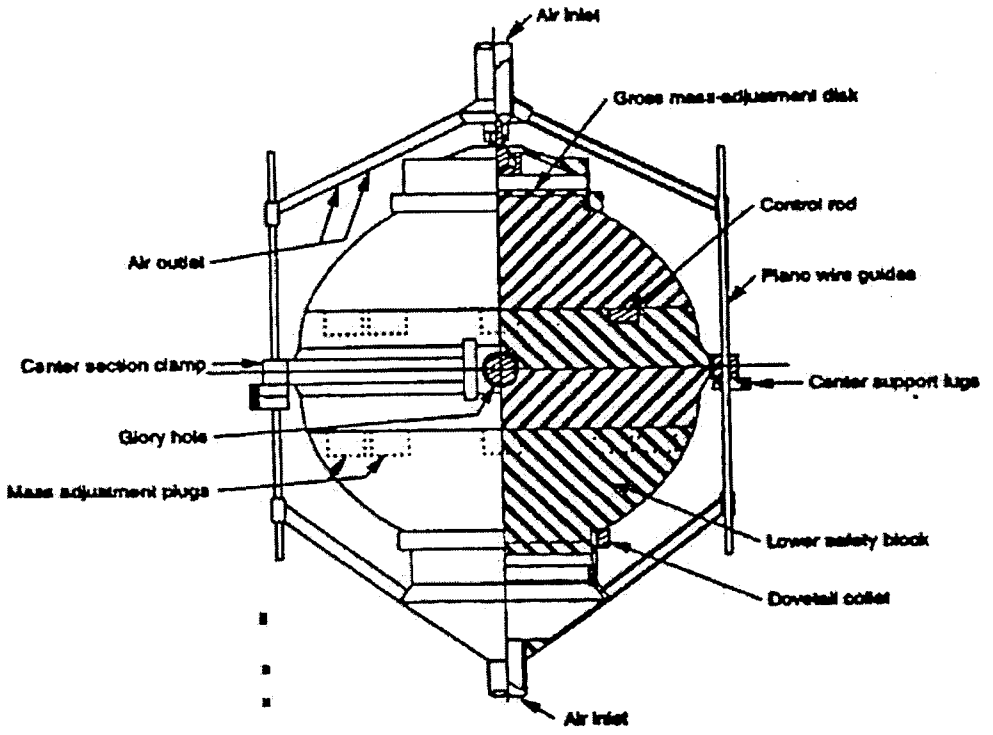


Fig. 5.1. The active portion of the original Jezebel assembly.

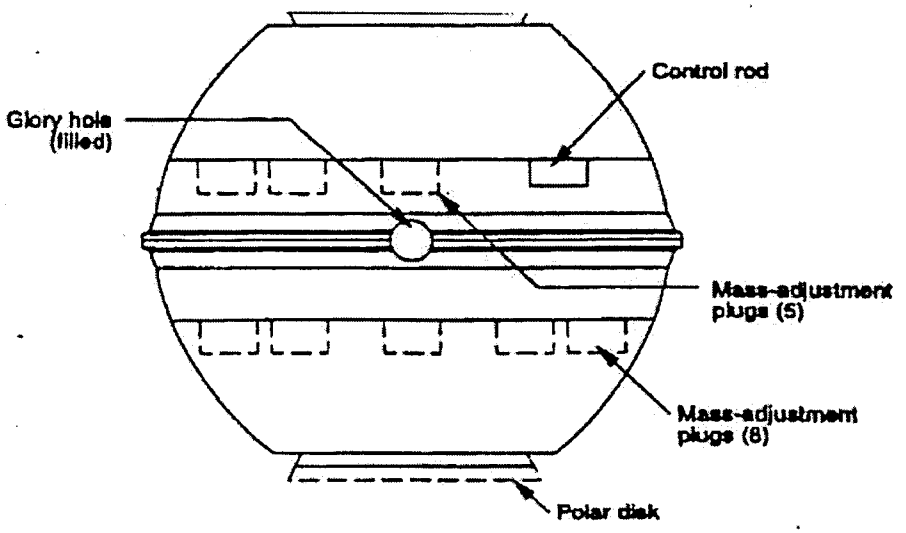


Fig. 5.2. Jezebel core, showing mass-adjustment locations.

shows the location of the control rod, polar disks, and mass adjustment plugs used in these two configurations.[3]

There has been no attempt to model the exact ^{239}Pu Jezebel assemblies for calculational purposes. However, through careful analyses and experimental measurements by the staff at Los Alamos, corrections were determined to convert the actual Jezebel configurations to idealized bare spheres of homogeneous delta-phase plutonium, which are amenable for the ^{239}Pu calculation.[3] A discussion of these corrections and the resulting idealized Jezebel benchmark model is provided in succeeding sections.

5.2.3 Description of Material Data

The average composition of the delta-phase plutonium alloy used in Jezebel was 98.98 wt % plutonium and 1.02 wt % gallium.[3] The isotopic composition of the plutonium is shown in Table 5.1.

Table 5.1. Composition of the plutonium in ^{239}Pu Jezebel

Isotope	Abundance (at. %)
^{239}Pu	95.2
^{240}Pu	4.5
^{241}Pu	0.3

Impurities in the alloy constituted about 600 parts per million (ppm) as follows: carbon (170 ppm, atom density = 1.3305×10^{-4}), oxygen (230 ppm atom density = 1.3514×10^{-4}), iron (115 ppm, atom density = 1.9357×10^{-5}), and others not specified.

5.2.4 Supplemental Experimental Measurements

A large number of experimental measurements were made using the ^{239}Pu Jezebel, including reactivity-worth measurements on a variety of materials,[2] leakage spectrum measurements,[4] neutron activation cross section measurements,[5] and neutron spectral measurements.[6] Because of the large number

and variety of these and other measurements, they are not presented in this report. Detailed information is provided in the references cited and in numerous other references to be found in the open literature of the late 1950s and the 1960s. This information is also summarized in a report issued by the Cross Section Evaluation Working Group (CSEWG) in 1974.[7]

5.2.5 Evaluation of Experimental Data

Although it would be difficult, if not impossible, to determine the exact specifications of all of the parts and pieces that comprised the original ^{239}Pu Jezebel reactor, the staff at Los Alamos determined an equivalent uniform, homogeneous spherical model that is well-defined and is entirely suitable and acceptable as a critical experiment benchmark. This work is described in Ref. 3 and is summarized in Sect. 5.2.6.

5.2.6 Benchmark Specifications

5.2.6.1 Description of model

More than 15 years after the original critical experiments were performed on the uranium Godiva and the three Jezebel nearly spherical bare metal assemblies, a re-evaluation of the critical specifications of these assemblies was made to precisely establish the critical dimensions and masses of uniform, homogeneous bare spheres of the fissile materials used in these assemblies.[3] Using experimental reactivity-worth measurements made on the original assemblies[2] together with measurements of the reactivity worth of the walls of the building (measured by performing critical experiments on Godiva, both inside the building and outside the building on a tower), it was possible to determine the critical masses of idealized uniform, homogeneous spheres as accurately as dimensional fabrication tolerances would permit.

For the two configurations of the ^{239}Pu Jezebel critical assemblies described previously, the following corrections were applied. All Jezebel parts were nominally coated with 0.005-in.-thick nickel to prevent contamination. Although the nickel plating weights were known, the distribution of the plating was uncertain. Consequently, uniform thickness was assumed in apportioning the nickel between external and internal surfaces of the plutonium pieces. Because planeness of mating surfaces could not be guaranteed, an average 0.001-in. gap between each of the three principal pairs of internal surfaces was assumed. Average densities were determined by adjusting measured material densities to allow for the nominal volume of internal nickel coating and voids. Voids remaining after correction for internal nickel were redistributed uniformly (with compensating surface-mass adjustment per Ref. 2) so that values of average density were maintained. [Note that a restatement of the inverse-square relationship between density and critical mass is that a given mass increment is three times as effective when distributed uniformly (by a change in density) as it is when added to the surface.] A tabulation of corrections in units of surface mass of plutonium alloy is given in Table 5.2.

Calculations using the ONEDANT code showed the external nickel to be equivalent to 63 g of plutonium alloy using Hansen-Roach cross sections. Using SCALE ENDF/B-V 27 group cross sections, the calculated worth of the nickel is 71 g of plutonium alloy. Both values are in reasonable agreement with the 74-g value in Table 5.2.

Based on the results for the two configurations shown in Table 5.2, the recommended benchmark critical experiment model is an isolated, bare sphere of delta-phase plutonium alloy with a critical mass = 17.02 ± 0.100 kg alloy at a density of 15.61 g/cm^3. The ± 0.100-kg uncertainty corresponds to the $\pm 0.6\%$ uncertainty estimated by the experimenters in Ref. 3.

5.2.6.2 Dimensions

A 17,020-g sphere of plutonium alloy with a density of 15.61 g/cm^3 has a radius of 6.3849 cm.

Table 5.2. The ^{239}Pu Jezebel corrections to obtain idealized spheres

	Plutonium-alloy mass (kg)	
	Configuration A	**Configuration B**
Critical mass of experimental configuration	16.761	16.784
(density, g/cm^3)	(15.61)	(16.50)
Corrections:		
Asphericity	–0.033	–0.047
Internal nickel and homogenization	0.047	0.033
Equatorial band	0.045	0.045
Polar supports	0.117	0.117
External nickel	0.074	0.074
Framework	0.002	0.002
Building-wall reflection	0.010	0.010
Air reflection	0.004	0.004
Trace impurities	–0.001	–0.001
Elevated temperatures	–0.007	–0.007
Critical mass of homogenization sphere	17.019	17.014
(density, g/cm^3)	(15.61)	(15.61)

5.2.6.3 Material data

For plutonium metal alloyed with 1.02 wt % gallium at a mixed-alloy density of 15.61 g/cm^3, the plutonium comprises 98.98 wt % of the alloy. For the isotopic composition of the plutonium shown in Table 5.1, the atom densities given in Table 5.3 are obtained.

Calculations using the ONEDANT code with Hansen-Roach 16-group and ENDF/B-V 30-group cross sections show that including the trace impurities increases k_{eff} by 0.0006. This corresponds to a 35-g surface mass of plutonium alloy, an effect considerably larger than the 1 g shown in Table 5.2. Nevertheless, the calculated effect of the impurities is still well below the 100-g overall uncertainty in the critical mass reported by the experimenters. Thus, the impurities are omitted from the calculational benchmark material specifications shown in Table 5.3.

Similar calculations using the ONEDANT code with Hansen-Roach 16-group and ENDF/B-V 30-group cross sections show that simply omitting the gallium from the material specifications produces a k_{eff} that is about 0.0035 higher than the value obtained with the gallium present. This Δk is too large to warrant omitting the gallium from the material specifications.

Table 5.3. Atom densities for the ^{239}Pu Jezebel benchmark

Nuclide	Atom density (atoms/barn-cm)
Ga	1.3752×10^{-3}
^{239}Pu	3.7047×10^{-2}
^{240}Pu	1.7512×10^{-3}
^{241}Pu	1.1674×10^{-4}

5.2.6.4 Temperature

Corrections were made to the specifications to adjust the actual Jezebel material to nominal room temperature as shown in Table 5.2. Therefore, the temperature of the benchmark plutonium alloy is nominal room temperature.

5.2.7 Experimental and Benchmark-Model k_{eff}

As described previously, specifications of the mass were adjusted to the critical mass with all mass-adjustment plugs installed and the control rod fully inserted. Thus, the "experimental" value of k_{eff} is 1.000 ± 0.0002. The uncertainty in k_{eff}, as calculated with ONEDANT using both Hansen-Roach 16-group and SCALE ENDF/B-V 27-group cross sections, results from the 100-g uncertainty in the critical mass.

5.2.8 Results of Calculations

Calculational results are shown in Tables 5.4 and 5.5 [Table 5.5 was generated by the staff of the Amarillo National Resource Center for Plutonium (ANRCP).]

Table 5.4. Calculational results

KENO (44-group ENDF/B-V)	KENO (238-group ENDF/B-V)
0.9962 ± 0.0014	0.9943 ± 0.0013

Table 5.5. ANRCP calculation result

MCNP result with ENDF/B-VI
0.99806 ± 0.00165

Reaction rates, R(x), based on 238-group cross sections, for the plutonium isotopes and gallium of the sphere averaged at all energy and volumes of the assembly are shown in Table 5.6, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.6 also lists the leakage from the sphere surface per source neutron and the energy of the average lethargy causing fission (EALCF) and associated deviation.

A sample code input listing is provided on the CD-ROM enclosed with this report. The KENO V.a calculation(s) were run with 300 generations of 400 histories per generation and the first five generations skipped for a total of 118,000 active histories.

Table 5.6. Jezebel reaction rates (s^{-1})

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
^{239}Pu	$3.1670e^{-1}$	$3.0664e^{-1}$	$9.6154e^{-1}$
^{240}Pu	$1.0864e^{-2}$	$9.9906e^{-3}$	$3.1509e^{-2}$
^{241}Pu	$9.5510e^{-4}$	$8.8779e^{-4}$	$2.7979e^{-3}$
Ga	$1.3257e^{-4}$	—	—
EALCF		$1.2369e^{+6} \pm 2.32e^{+3}$	
Leakage		$6.7240e^{-1} \pm 4.34e^{-4}$	

5.3 WATER-REFLECTED 9-, 10-, 11-, AND 12-in.-DIAMETER CYLINDERS OF PLUTONIUM NITRATE SOLUTIONS (CS-2)*

5.3.1 Detailed Description

5.3.1.1 Overview of experiment

Thirty-five critical experiments with cylindrical reactors that were performed in the P-11 area of the Hanford Reservation in the early 1950s are evaluated in this report. These experiments are commonly referred to as the P-11 experiments.[8] The P-11 series of experiments were directed toward determining the effect of geometry, concentration, foreign atoms, plutonium isotopic content, neutron reflection, and temperature on the critical mass of light-water-moderated and -reflected homogeneous plutonium solutions. The series of experiments used a number of spherical and cylindrical containers. (Drawings and references were found for hemispherical containers, but experiments with these shapes apparently were never made—probably because of an accidental excursion, followed by a fire during cleanup that permanently shut down the facility.)

Only the 35 plutonium nitrate solution experiments in cylinders with water reflectors are evaluated in this report. The plutonium nitrate solutions were contained in a series of cylinders with inside diameters of 8, 9, 10, 11, and 12 in. The cylindrical reactors were inside a large cylindrical water-filled tank that provided at least 12 in. of water reflection around the cylinders in all directions. Each cylinder was fitted with a movable water-filled piston "tamper" (top reflector) that was 12 in. thick. The only experiment with an 8-in. cylinder was described as subcritical by an unknown amount and is not acceptable for a benchmark analysis. All of the descriptions of the 10-in. cylinder experiments reported acid molarities and nitrate contents that were estimated from log book entries rather than measured and are not considered acceptable for benchmarks. This left 14 of the 35 experiments for benchmark evaluation. All 14 were concluded to be acceptable for benchmarks.

*This section is a revision to evaluation PU-SOL-THERM-010 contained in NEA/NSC/DOC(95)03/1. Much of the text of Sect. 5.3 is from that document. The authors expressly acknowledge the original authors and reviewers of this text and in no way claim credit for their work.

5.3.1.2 Description of experiment configuration

The cylindrical reactor units and the 12-in.-deep, water-filled piston tamper (top reflector) were fabricated from a 0.062-in. stainless steel sheet in the Bremerton, Washington, naval shipyard.[8] The reactor volume was determined by the position of the 12-in. water-filled piston tamper.

The piston was adjustable over a maximum range of 19 in. either by manual or remote operation to a precision of ± 0.010 in. The air gap between the cylinder wall and the piston did not exceed 0.050 in. Reference 8 refers to "four cylindrical reactors (that) ranged from 8.0 to 12.0 inches inside diameter;" however, Ref. 8 also shows results for five cylinders with criticality achieved for four of the cylinders, namely those with 9-, 10-, 11-, and 12-in. diameters. The single experiment reported for the 8-in.-diameter cylinder was subcritical. The solution depth in the cylinders was detected by two electrodes that were recessed into the piston tamper. These electrodes were insulated from the water in the piston by a 1-in.-diam polyethylene body that was recessed into the piston tamper. These electrodes served as fluid contactors. The reentrant tube and source rod were inserted into the reactor through a 3/4 in. Schedule 40 pipe, open on the bottom and centered in the piston tamper. A 1/4-in. spiral vent tube passed displaced air through the tamper piston. Grease seals and air bellows prevented the escape of contamination where adjustable mechanisms passed though the top of the cylinders. The temperature within the tamper was maintained at 80°F.

The cylinder volume was measured when the solution level was detected by the contactors. The details of the contactor geometry were discussed with one of the experimenters.* It was his recollection that the contactors were slightly recessed into the piston to ensure that there was no air gap between the liquid level and the bottom of the piston. This recess was minimal to allow solution height determination even with the bottom of the tamper and to avoid having solution in the air gap between the piston and the cylinder wall.

The reactivity for the cylinders was controlled by "a 36 square in. cadmium sheet passed horizontally 7/8 in. below the bottom of the cylindrical reactors affording the necessary control".[8] The test unit assembly drawing, Drawing H-7-626 in Ref. 9, shows that the cadmium control sheet traveled some 25 in. from completely under the cylinder to completely out from under it. The control sheet was completely withdrawn during the critical determinations.

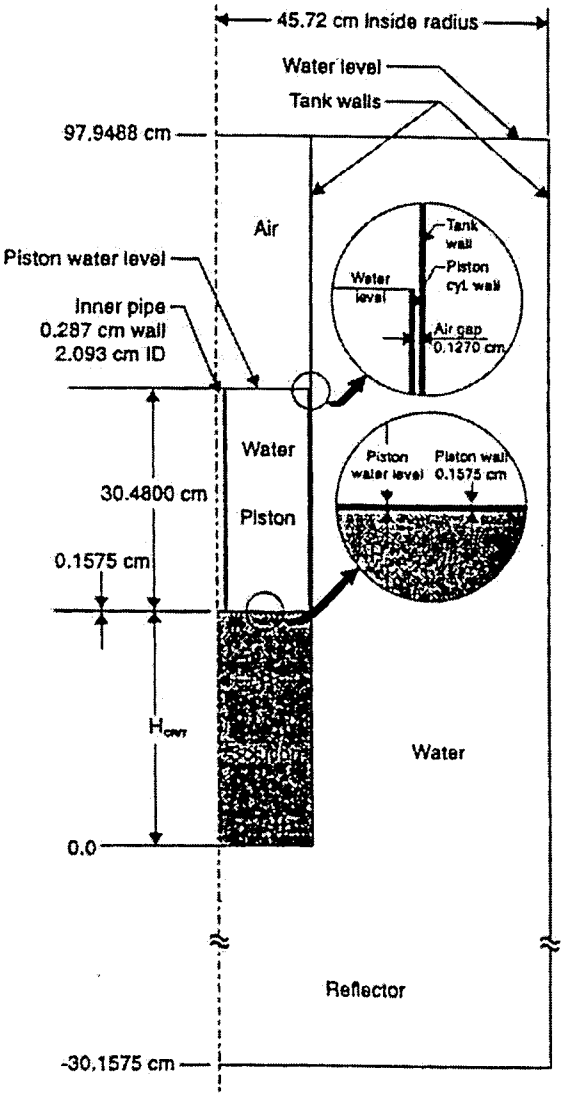
The safety control for the cylindrical reactors was a cylindrical cadmium sheath external to and coaxial with the reactor. This sheath was 12 in. in height and of such a diameter as to clear the reactor wall by 1/4 in. on a diameter. The safety control traveled 2 ft, 4 in. and was completely withdrawn during the determination of the critical height.

The PoBe neutron source was remotely positioned within the experiment container or withdrawn from it as required. This source was isolated from the plutonium solution by a 5/16-in.-ID stainless steel reentrant tube centered in the tamper piston. This tube was either manually or remotely positioned over its 20 in. of travel. The drawing of the experimental setup[9] shows the reentrant tube completely withdrawn.

The water reflector was contained in a "300 gallon cylindrical tank"[8] described as "the main body of which was three feet in diameter and four feet high." This volume determination may be somewhat high, because it is noted that a 300-gal cylinder with a 3-ft diameter (91.4 cm) would be about 5-1/2 ft deep. Benchmark 3, in Ref. 10, shows the tamper tank as having an outside diameter of 92 cm and a height of 122 cm, with no wall thickness given. Reference 9 shows the water level to be 50-1/16 in. (127 cm) above the floor level. Reference 9 also shows that the bottom of the tank is several inches below the floor level with sizeable parallelepipedal extensions below the tank bottom, with dump valves attached. The bottom of this cylindrical tank was also dished (apparently conically, Ref. 8, p. 15) to improve circulation within the tank. These discrepancies and tank details are not considered significant because even the 3-by-4 ft tank dimensions provide at least 1 ft of water reflection in all directions around all of the cylinders. The 1 ft of water reflection around the cylinders "is an effectively infinite tamper."[8] Additional information on these experiments is provided in Ref. 11.

Figure 5.3 shows the experiment arrangement as modeled for the cylinders. The temperature of the water reflector was controlled to within ±0.5°F.

*Private communication, F. E. Kruesi, April 26, 1994.



Note: All tank material 0.1575 cm thick stainless steel

Table of Dimensions	
Evaluated Solution Radius, R	
NOM DIA (in.)	Equivalent Radius (cm)
9	11.4264
11	13.9684
12	15.2390
Solution Critical Height, H_{CRIT}	
Model No.	H_{CRIT} (cm)
9-1	30.7086
9-2	35.4076
9-3	44.5770
11-1	25.6032
11-2	28.1686
11-3	27.0764
11-4	32.6390
11-5	43.0022
11-6	22.8092
11-7	25.9588
12-1	22.3520
12-2	25.2476
12-3	28.4734
12-4	33.4264

Fig. 5.3. P-11 cylinders as evaluated.

Because these experiments were fully water-reflected, support structures outside the cylinder reflector tank and the construction details of the room will have no effect on the measured critical values. Therefore, descriptions of these items are not necessary for benchmark usage.

Four counters were used in determining the count rates for the approach-to-critical measurements. The locations of these counters are shown in Ref. 8 (Fig. 5.7). A description of the approach-to-critical technique used appears to be primarily for the cylinder experiments. The description states that there was only one detector location where the results yielded a straight line; all others "both inside and outside the tamper, produced concave curves." This "most useful position" was 8 to 10 in. directly below the center of the reactor with the longitudinal axis of the counter in a horizontal plane. All monitors, however, produced extremely accurate predictions (i.e., ±0.05 in.) of the critical height after the fuel height had been increased to within about 2 in. of criticality. The steps of raising the solution height were repeated "until at some final height the system was determined to be critical, as indicated by a linear rise of flux."

5.3.1.3 Description of material data

Solutions

The precision of each of the analytic procedures that were used to determine the evaluated solution compositions is listed in Table 5.7. These are specified as values that may be exceeded in about 1% of the samples.

The reported plutonium compositions included only ^{239}Pu and ^{240}Pu with ^{240}Pu contents of 2.85 and 2.9 wt %. The measured solution characteristics were the solution density, the plutonium concentration, the total nitrate ion concentration, the hydrogen ion concentration, and the iron assay (Ref. 8, pp. 33, 34). The total hydrogen was stated to be calculated by using an "equation, based on nitric acid tables, (that) was developed giving total hydrogen in terms of nitrate and hydrogen ion concentrations only, i.e., hydrogen = 111.8 + hydrogen ion concentration – 0.0535 × nitrate ion concentration" (Ref. 8, p. 60). This equation neglected the displacement of the plutonium but was said to give "good results" compared to calculating the water content by subtracting the plutonium, iron, nitrate, hydrogen ion, and any other fuel constituent from the solution density. The total hydrogen was then calculated from the hydrogen-containing materials. This latter method was used for experiments with solutions other than nitrate solutions. It was stated that the latter method had the disadvantage of accumulation of errors (Ref. 8, p. 60).

The hydrogen ion density was not reported, but the acid normality, N, was reported. Because the hydrogen ion density divided by the atomic weight of hydrogen would be equivalent to the acid normality, the accuracy in reporting the acid normality may be considered to be the same as for the hydrogen ion density, ±1.4%.

Table 5.8 shows the data reported in Ref. 8. The data with case numbers in Column 1 identify samples that were selected for full evaluation and for which calculational models were prepared.

Nonfissile materials

The cylindrical vessels and associated metal piping were made of 347 stainless steel. The reflector was a cylindrical water reflector with a minimum thickness of at least 12 in. (30.48 cm). The reflector temperatures are noted in Table 5.8. The reactor temperature was kept at 80°F (27°C), which was controlled to ±0.5°F. The water density for each temperature was not given in the experiment report.

The ^{240}Pu content was reported as 2.85 wt % for all the samples except that the samples included from 11-6 to 12-4 contained plutonium with 2.9 wt % ^{240}Pu.

Table 5.7. Precision of measured values[8]

Element or property	Precision
Plutonium	1%
Hydrogen ion	1.4%
Iron	1.4%
Density	±0.03%
^{240}Pu (wt %)	±7%
Nitrate	±0.6%
Water[a]	±0.9%
Measured physical solution height	±0.01 in.
Critical diameter	±0.02 in.
Projected critical solution height	±0.05 in.
Measured critical volume	±0.6%
Wall thickness[b]	10%

[a]Note that this is the laboratory value based on measurement of the water content by the "Carl Fisher method." The value determined when using the difference method to calculate the water content is much less.

[b]No tolerance reported; approximate value estimated from various sources.

Table 5.8. Reported data for experiments

Case No.	Diameter (in.)	ρ_{Pu} (g/L)	Acid normality	Reflector temperature (°F)	Solution density (g/cm^3)	Total ρ_{NO_3} (g/L)	ρ_{Fe} (9/1)	Height (in.)	Critical volume (L)	Critical mass (g)
–	8[a]	77.40[a]	1.41[b]	81.0	1.175	152[b]	0.644	19.01[c]	15.66[c]	1212[c]
–	9	109.16	1.68	81.5	1.2110	166[b]	0.395	11.76	12.25	1337
9-1	9	99.09	1.37	80.0	1.1997	136.5	0.378	12.09	12.60	1249
–	9	85.14	1.29[b]	80.5	1.1859	151[b]	0.321	12.73	13.26	1128
9-2	9	73.92	1.78	81.0	1.1592	125.6	0.231	13.94	14.52	1073
–	9	61.49	1.34[b]	81.0	1.1441	134[b]	0.303	15.78	16.44	1011
9-3	9	54.53	1.36	79.5	1.1329	119.8	0.257	17.55	18.29	997
–	10	77.40	1.41[b]	83.5	1.175	152[b]	0.644	9.93	12.78	989
–	10	76.93	1.41[b]	83.0	1.165	152[b]	0.327	9.74	12.53	964
–	10	62.47	1.52[b]	83.0	1.146	146[b]	0.269	10.73	13.79	860
–	10	49.26	1.63[b]	84.0	1.130	142[b]	0.260	12.87	16.56	816
–	10	49.26	1.63[b]	84.0	1.130	142[b]	0.260	12.82	16.50	813
–	10	39.10	1.70[b]	83.0	1.110	138[b]	0.172	16.44	21.16	827
–	10	39.10[d]	1.70[b]	64.0	1.110	138[b]	0.172	16.24	20.90	817
–	10	39.10[d]	1.70[b]	122	1.110	138[b]	0.172	17.49	22.51	879
–	11	39.10	1.70[b]	85.4	1.110	138[b]	0.172	12.28	19.12	747
11-1	11[e]	54.43	1.36	80.5	1.1329	120	0.257	10.08	15.69	856
11-2	11[e]	47.21	1.38	80.5	1.1202	117	0.275	11.09	17.27	815
11-3	11	47.21	1.38	80.5	1.1202	117	0.275	10.66	16.6	784
11-4	11	41.73	2.77	81.5	1.1604	215	0.255	12.85	20.01	835
11-5	11	36.90	4.28	81.5	1.2022	300	0.263	16.93	26.36	973
–	11	33.54	1.76[b]	86	1.099	137[b]	0.193	15.57	24.24	813
–	11[f]	30.81	1.78[b]	83.5	1.098	136[b]	0.173	18.55	28.88	889
11-6	11	63.99	1.17	80.5	1.1483	121.1	0.298	8.98	13.98	895
11-7	11	48.98	1.38	80.5	1.1360	139.0	0.238	10.22	15.91	780
–	11	49.75[d]	1.27	69.5	1.1260	116.3	0.223	10.18	15.85	773
–	11	48.75[d]	1.27	114.0	1.1260	116.3	0.223	10.52	16.38	799
12-1	12	48.75	1.27	84.5	1.1260	116.3	0.223	8.80	16.31	799
12-2	12	42.29	1.36	84.0	1.1152	126.6	0.174	9.94	18.42	779
12-3	12	36.52	1.39	81.0	1.1077	107.1	0.161	11.21	20.77	758
12-4	12	31.14	1.44	82.5	1.1028	114.0	0.153	13.16	24.39	759
–	12	31.14[d]	1.44	67.0	1.1028	114.0	0.153	13.03	24.14	752
–	12	31.14[d]	1.44	16.6	1.1028	114.0	0.153	13.59	25.18	784
–	12	26.45	1.09	78.5	–	134[b]	0.154	17.5	32.43	858
–	12	109.16	1.68	82.0	1.211	166[b]	0.395	6.82	12.64	1380

[a]This cylinder was subcritical by an unknown amount.

[b]These numbers are estimates based on logbook entries.

[c]These values were estimated by some unspecified means.

[d]Assays for fuel used in temperature coefficient experiments have not been corrected to the temperature at which the experiment was made.

[e]In this experiment, a 0.065-in. layer of stainless steel was placed around the cylinder. The ends of the cylinder were not changed.

[f]This experiment was subcritical. "A reliable extrapolation to the critical height was made."

5.3.2 Benchmark Specifications

5.3.2.1 Description of model

The experiment geometries are described for validation purposes as a series of coaxial cylinders. The reflector is described as a cylindrical annulus surrounding the reactor with at least 30 cm of water radially and on the bottom (effectively infinite). The tamper piston forms the top reflector. The solution-level-detecting electrodes were not included in the analytic models. It was assumed that there is no effective difference in the neutronic effect of the tamper piston between modeling it to include the small polyethylene bodies of these detectors and modeling it with uniform water. The spiral vent tube was not included in the model. It was assumed that this tube would have a negligible neutronic effect because of its small size. The central tube was included in the model. Because the experiments were fully reflected, the walls of the water tank were not included in the model.

5.3.2.2 Dimensions

The cylindrical reactors are modeled as a series of coaxial cylinders. The bottom and sidewall thicknesses for the cylindrical reactors and for the tamper pistons are 0.062 in. (0.1575 cm). The gap between the piston and the side wall of the cylinder is 0.050 in. (0.127 cm). The reflector is modeled as a cylinder that surrounds the reactor with 30 cm of water radially and on the bottom. The central tube of the tamper piston is included in the model and is made of stainless steel, SS347, with an inner radius of 1.0465 cm and an outer radius of 1.3335 cm. It is empty as modeled. See Fig. 5.3 for complete geometry details.

5.3.2.3 Material data

Table 5.9 contains the "as modeled" data for these experiments. Table 5.10 contains the number densities determined by the Material Information Processor of SCALE. With the exception of acid normality, the data of Table 5.9 are the reported data of Table 5.8. As suggested in Sect. 5.3.1.1, more confidence is placed on the measured nitrate concentration; therefore, the acid normality values (an option in SCALE) were derived from Table 5.8 data. The atom densities of Table 5.10 are given as atoms per barn-centimeter.

Table 5.9. Modeled data

Case	^{240}Pu (wt %)	ρ_{Pu} (g/L)	Reflector temperature (°F)	Solution density (g/cm^3)	Total ρ_{NO_3} (g/L)	ρ_{Fe} (g/L)	Acid normality[a]
9-1	2.85	99.09	80.0	1.1997	136.5	0.378	0.5436
9-2	2.85	73.92	81.0	1.1592	125.6	0.231	0.7889
9-3	2.85	54.53	79.5	1.1329	119.8	0.257	1.0197
11-1	2.85	54.43	80.5	1.1329	120	0.257	1.0247
11-2	2.85	47.21	80.5	1.1202	117	0.275	1.0971
11-3	2.85	47.21	80.5	1.1202	117	0.275	1.0971
11-4	2.85	41.73	81.5	1.1604	215	0.255	2.7693
11-5	2.85	36.90	81.5	1.2022	300	0.263	4.2210
11-6	2.9	63.99	80.5	1.1483	121.1	0.298	0.8846
11-7	2.9	48.98	80.5	1.1360	139.0	0.238	1.4239
12-1	2.9	48.75	84.5	1.1260	116.3	0.223	1.0617
12-2	2.9	42.29	84.0	1.1152	126.6	0.174	1.3357
12-3	2.9	36.52	81.0	1.1077	107.1	0.161	1.1175
12-4	2.9	31.14	82.5	1.1028	114.0	0.153	1.3186

[a]Values are derived: Molarity = $1.61278e^{-2}$ mol NO_3/g NO_3 · $\rho_{NO_3} - X\ \rho_{Pu}$ · 1 mol HNO_3/1 mol NO_3, where **X** is $1.673074e^{-2}$ mol NO_3/g plutonium for 2.85 wt % ^{240}Pu and $1.669732e^{-2}$ mol NO_3/g plutonium for 2.9 wt % ^{240}Pu.

Table 5.10. Number densities for solution nuclides[a]

Case	N_{239}	N_{240}	N_N	N_H	N_o	N_{Fe}
9-1	$2.4251e^{-4}$	$7.0846e^{-6}$	$1.3257e^{-3}$	$6.4784e^{-2}$	$3.6206e^{-2}$	$4.0763e^{-6}$
9-2	$1.8091e^{-4}$	$5.2850e^{-6}$	$1.2199e^{-3}$	$6.4619e^{-2}$	$3.5731e^{-2}$	$2.4910e^{-6}$
9-3	$1.3346e^{-4}$	$3.8987e^{-6}$	$1.1634e^{-3}$	$6.4668e^{-2}$	$3.5517e^{-2}$	$2.7714e^{-6}$
11-1	$1.3321e^{-4}$	$3.8916e^{-6}$	$1.1655e^{-3}$	$6.4664e^{-2}$	$3.5520e^{-2}$	$2.7714e^{-6}$
11-2	$1.1554e^{-4}$	$3.3754e^{-6}$	$1.1364e^{-3}$	$6.4536e^{-2}$	$3.5347e^{-2}$	$2.9655e^{-6}$
11-3	$1.1554e^{-4}$	$3.3754e^{-6}$	$1.1364e^{-3}$	$6.4536e^{-2}$	$3.5347e^{-2}$	$2.9655e^{-6}$
11-4	$1.0213e^{-4}$	$2.9836e^{-6}$	$2.0882e^{-3}$	$6.1934e^{-2}$	$3.6398e^{-2}$	$2.7501e^{-6}$
11-5	$9.0308e^{-5}$	$2.6382e^{-6}$	$2.9137e^{-3}$	$6.0147e^{-2}$	$3.7544e^{-2}$	$2.8366e^{-6}$
11-6	$1.5653e^{-4}$	$4.6554e^{-6}$	$1.1774e^{-3}$	$6.4897e^{-2}$	$3.5714e^{-2}$	$3.2135e^{-6}$
11-7	$1.1981e^{-4}$	$3.5634e^{-6}$	$1.3510e^{-3}$	$6.4172e^{-2}$	$3.5710e^{-2}$	$2.5665e^{-6}$
12-1	$1.1924e^{-4}$	$3.5466e^{-6}$	$1.1306e^{-3}$	$6.4842e^{-2}$	$3.5493e^{-2}$	$1.8763e^{-6}$
12-2	$1.0344e^{-4}$	$3.0767e^{-6}$	$1.2304e^{-3}$	$6.3510e^{-2}$	$3.5044e^{-2}$	$1.7361e^{-6}$
12-3	$8.9332e^{-5}$	$2.6569e^{-6}$	$1.0409e^{-3}$	$6.5083e^{-2}$	$3.5328e^{-2}$	$1.6499e^{-6}$
12-4	$7.6172e^{-5}$	$2.2654e^{-6}$	$1.1078e^{-3}$	$6.4762e^{-2}$	$3.5308e^{-2}$	$2.4048e^{-6}$

[a]Note $e^{-x} = (10^{-x})$

The experimentalist thought that there was some uncertainty as to the average valence of the plutonium. For cases 11-4, 11-5, 11-7, and 12-2, the difference between the reported and derived acid normality is less than 5%. The nearness of the values can be explained if most of the plutonium was in the +4 valence state when the measurements were conducted.

The composition of 347 stainless steel, in weight percent, is shown in Benchmark 3 of Ref. 10 as Fe, 72.0; Cr, 18.0; and Ni, 10.0; and to have a density of 7.95 g/cm^3. Clark[12] considered the steel composition to be, also in weight percent, Fe, 70; Cr, 18; and Ni, 12 with a density of 8.0 g/cm^3. The composition shown in Ref. 12 will be used in this evaluation because the density is slightly higher and nickel has a somewhat greater microscopic neutron absorption cross section relative to iron. As a result, there should be a slightly greater neutron absorption in the shell using the composition from Ref. 12. Therefore, k_{eff} will calculate slightly lower (more conservative for validations). However, the difference in the effects on the calculated k_{eff}'s should be insignificant.

5.3.2.4 Temperature data

Temperature of the water in the reflector for each experiment is presented in Table 5.8.

5.3.2.5 Experimental and benchmark-model k_{eff}

The k_{eff} of each experiment is considered to be 1.0000. A complete set of sensitivity calculations was not performed for the cylinder experiments, so uncertainties in k-effectives for these experiments were not calculated. However, (worst-case) uncertainties were determined for other solution experiments conducted in spherical geometrics. The solution uncertainties for these spheres are considered to describe approximately the uncertainty of these cylinder experiments. The uncertainties were calculated as ±0.0047 for the 12-in. sphere experiments and ±0.0035 for the 15-in. sphere experiments. With adjustment for the slightly greater maximum uncertainty for the dimensions of the cylinders compared to the spheres, it is conservative to assume that the uncertainty in k-effective of the cylindrical experiments has a maximum value of ±0.0048.

5.3.3 Results of Calculations

The calculated results are given in Tables 5.11 and 5.12. The set of calculations using the 44-group library has a mean value of k_{eff} of 1.0162 ± 0.0057, indicating a bias of [1.62 ± 1.05]%. The set of

Table 5.11. Results of KENO-V.a calculations[a]

Case No.	44-group ENDF/B-V	238-group ENDF/B-V
9-1	1.0254 ± 0.0022	1.0235 ± 0.0021
9-2	1.0212 ± 0.0020	1.0151 ± 0.0020
9-3	1.0136 ± 0.0019	1.0083 ± 0.0019
11-1	1.0181 ± 0.0020	1.0154 ± 0.0019
11-2	1.0194 ± 0.0021	1.0137 ± 0.0023
11-3	1.0138 ± 0.0018	1.0179 ± 0.0020
11-4	1.0123 ± 0.0018	1.0059 ± 0.0021
11-5	1.0091 ± 0.0020	1.0093 ± 0.0022
11-6	1.0185 ± 0.0018	1.0163 ± 0.0021
11-7	1.0095 ± 0.0021	1.0076 ± 0.0019
12-1	1.0181 ± 0.0020	1.0109 ± 0.0019
12-2	1.0111 ± 0.0020	1.0078 ± 0.0018
12-3	1.0234 ± 0.0020	1.0243 ± 0.0020
12-4	1.0148 ± 0.0018	1.0203 ± 0.0021

[a]Calculated using archived version, SCALE-4.3R.

Table 5.12. Results of MCNP calculations[a]

Case No.	MCNP (continuous energy ENDF/B-V)
9-1	1.02380 ± 0.00104
9-2	1.02264 ± 0.00100
9-3	1.01421 ± 0.00095
11-1	1.01955 ± 0.00098
11-2	1.01671 ± 0.00091
11-3	1.01682 ± 0.00099
11-4	1.00915 ± 0.00095
11-5	1.01017 ± 0.00090
11-6	1.02230 ± 0.00101
11-7	1.00885 ± 0.00098
12-1	1.01764 ± 0.00096
12-2	1.01786 ± 0.00098
12-3	1.02107 ± 0.00091
12-4	1.01678 ± 0.00092

[a]Calculations performed by G. Radulescu, University of Texas.

calculations using the 238-group library has a mean k_{eff} value of 1.0133 ± 0.0051, indicating a bias of [1.33 ± 0.99]%. These statistics are based on the mean k_{eff} values of individual calculations and do not account for the uncertainty associated with each calculation.

Reaction rates, R(x), based on 238-group cross sections, for all materials of the assembly (solution, tank, reflector), averaged over all energies and volume of the assembly, are shown in Table 5.13, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross-section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.14 lists the leakage from the reflector surface per source neutron and the EALCF and associated deviation.

Table 5.13. Reaction rates (1/s)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	9-1		
^{239}Pu	$5.2640e^{-1}$	$3.5392e^{-1}$	$1.0230e^{0}$
^{240}Pu	$1.9984e^{-2}$	$6.7794e^{-5}$	$2.1208e^{-4}$
N	$4.7115e^{-3}$	–	–
O	$4.8128e^{-3}$	–	–
H	$4.8128e^{-1}$	–	–
Cr	$6.0244e^{-3}$	–	–
Fe	$1.7942e^{-2}$	–	–
Ni	$5.3197e^{-3}$	–	–
	9-2		
^{239}Pu	$5.1833e^{-1}$	$3.5110e^{-1}$	$1.0149e^{0}$
^{240}Pu	$1.7608e^{-2}$	$5.2161e^{-5}$	$1.6306e^{-4}$
N	$5.5859e^{-3}$	–	–
O	$4.8234e^{-3}$	–	–
H	$4.1980e^{-1}$	–	–
Cr	$6.2421e^{-3}$	–	–
Fe	$1.8591e^{-2}$	–	–
Ni	$5.5036e^{-3}$	–	–
	9-3		
^{239}Pu	$5.1088e^{-1}$	$3.4870e^{-1}$	$1.0081e^{0}$
^{240}Pu	$1.4713e^{-2}$	$3.9850e^{-5}$	$1.2445e^{-4}$
N	$7.0436e^{-3}$	–	–
O	$4.7802e^{-3}$	–	–
H	$4.2691e^{-1}$	–	–
Cr	$6.5130e^{-3}$	–	–
Fe	$1.9356e^{-2}$	–	–
Ni	$5.7357e^{-3}$	–	–
	11-1		
^{239}Pu	$5.1540e^{-1}$	$3.5148e^{-1}$	$1.0161e^{0}$
^{240}Pu	$1.5040e^{-2}$	$4.0543e^{-5}$	$1.2660e^{-4}$
N	$7.1068e^{-3}$	–	–
O	$4.6997e^{-3}$	–	–
H	$4.0297e^{-1}$	–	–
Cr	$1.0432e^{-2}$	–	–
Fe	$3.1075e^{-2}$	–	–
Ni	$9.1880e^{-3}$	–	–
	11-2		
^{239}Pu	$5.1227e^{-1}$	$3.5047e^{-1}$	$1.0132e^{0}$
^{240}Pu	$1.4061e^{-2}$	$3.5960e^{-5}$	$1.1227e^{-4}$
N	$7.9246e^{-3}$	–	–
O	$4.7308e^{-3}$	–	–
H	$4.0438e^{-1}$	–	–
Cr	$1.0629e^{-2}$	–	–
Fe	$3.1670e^{-2}$	–	–
Ni	$9.3564e^{-3}$	–	–

Table 5.13. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	11-3		
^{239}Pu	$5.1400e^{-1}$	$3.5203e^{-1}$	$1.0177e^{0}$
^{240}Pu	$1.3748e^{-2}$	$3.5430e^{-5}$	$1.1058e^{-4}$
N	$7.9691e^{-3}$	–	–
O	$4.7324e^{-3}$	–	–
H	$4.1852e^{-1}$	–	–
Cr	$7.5938e^{-3}$	–	–
Fe	$2.2650e^{-2}$	–	–
Ni	$6.6759e^{-3}$	–	–
	11-4		
^{239}Pu	$5.0774e^{-1}$	$3.4823e^{-1}$	$1.0067e^{0}$
^{240}Pu	$1.3282e^{-2}$	$3.2798e^{-5}$	$1.0231e^{-4}$
N	$1.6335e^{-2}$	–	–
O	$4.8687e^{-3}$	–	–
H	$4.1941e^{-1}$	–	–
Cr	$7.3351e^{-3}$	–	–
Fe	$2.1883e^{-2}$	–	–
Ni	$6.4492e^{-3}$	–	–
	11-5		
^{239}Pu	$5.0875e^{-1}$	$3.4948e^{-1}$	$1.0104e^{0}$
^{240}Pu	$1.2734e^{-2}$	$3.0596e^{-5}$	$9.5411e^{-5}$
N	$2.5782e^{-2}$	–	–
O	$5.0831e^{-3}$	–	–
H	$4.1091e^{-1}$	–	–
Cr	$6.8344e^{-3}$	–	–
Fe	$2.0361e^{-2}$	–	–
Ni	$6.0063e^{-3}$	–	–
	11-6		
^{239}Pu	$5.1754e^{-1}$	$3.5190e^{-1}$	$1.0173e^{0}$
^{240}Pu	$1.6216e^{-2}$	$4.6585e^{-5}$	$1.4556e^{-4}$
N	$6.1781e^{-3}$	–	–
O	$4.7506e^{-3}$	–	–
H	$4.1545e^{-1}$	–	–
Cr	$7.4598e^{-3}$	–	–
Fe	$2.2237e^{-2}$	–	–
Ni	$6.5661e^{-3}$	–	–
	11-7		
^{239}Pu	$5.0933e^{-1}$	$3.4842e^{-1}$	$1.0072e^{0}$
^{240}Pu	$1.4313e^{-2}$	$3.7175e^{-5}$	$1.1607e^{-4}$
N	$9.0611e^{-3}$	–	–
O	$4.8170e^{-3}$	–	–
H	$4.2093e^{-1}$	–	–
Cr	$7.6096e^{-3}$	–	–
Fe	$2.2692e^{-2}$	–	–
Ni	$6.6922e^{-3}$	–	–
	12-1		
^{239}Pu	$5.1146e^{-1}$	$3.5000e^{-1}$	$1.0118e^{0}$
^{240}Pu	$1.4206e^{-2}$	$3.6950e^{-5}$	$1.1534e^{-4}$
N	$7.6494e^{-3}$	–	–
O	$4.7121e^{-3}$	–	–
H	$4.8124e^{-1}$	–	–
Cr	$7.9157e^{-3}$	–	–

Table 5.13. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
Fe	$2.3583e^{-2}$	–	–
Ni	$6.9580e^{-3}$	–	–
	12-2		
^{239}Pu	$5.0779e^{-1}$	$3.4846e^{-1}$	$1.0074e^{0}$
^{240}Pu	$1.3266e^{-2}$	$3.3093e^{-5}$	$1.0326e^{-4}$
N	$9.5159e^{-3}$	–	–
O	$4.7391e^{-3}$	–	–
H	$4.2118e^{-1}$	–	–
Cr	$7.8915e^{-3}$	–	–
Fe	$2.5281e^{-2}$	–	–
Ni	$6.9348e^{-3}$	–	–
	12-3		
^{239}Pu	$5.1349e^{-1}$	$3.5374e^{-1}$	$1.0227e^{0}$
^{240}Pu	$1.2598e^{-2}$	$2.9094e^{-5}$	$9.0720e^{-5}$
N	$9.4420e^{-3}$	–	–
O	$4.7019e^{-3}$	–	–
H	$4.1809e^{-1}$	–	–
Cr	$7.6282e^{-3}$	–	–
Fe	$2.2754e^{-2}$	–	–
Ni	$6.7007e^{-3}$	–	–
	12-4		
^{239}Pu	$5.1027e^{-1}$	$3.5255e^{-1}$	$1.0193e^{0}$
^{240}Pu	$1.1716e^{-2}$	$2.5696e^{-5}$	$8.0101e^{-5}$
N	$1.1724e^{-2}$	–	–
O	$4.7522e^{-3}$	–	–
H	$4.2189e^{-1}$	–	–
Cr	$7.5338e^{-3}$	–	–
Fe	$2.2475e^{-2}$	–	–
Ni	$6.6134e^{-3}$	–	–

Table 5.14. Calculated leakage and EALCF

Case No.	Leakage	EALCF
9-1	$3.8999e^{-3} \pm 1.16e^{-4}$	$1.0960e^{-1} \pm 2.46e^{-4}$
9-2	$3.7811e^{-3} \pm 1.17e^{-4}$	$8.8861e^{-2} \pm 1.78e^{-4}$
9-3	$3.6349e^{-3} \pm 1.10e^{-4}$	$7.3582e^{-2} \pm 1.17e^{-4}$
11-1	$4.3779e^{-3} \pm 1.23e^{-4}$	$7.4813e^{-2} \pm 1.23e^{-4}$
11-2	$4.5092e^{-3} \pm 1.20e^{-4}$	$6.9468e^{-2} \pm 1.10e^{-4}$
11-3	$4.3656e^{-3} \pm 1.11e^{-4}$	$6.8007e^{-2} \pm 1.06e^{-4}$
11-4	$4.2308e^{-3} \pm 1.26e^{-4}$	$6.5694e^{-2} \pm 9.91e^{-5}$
11-5	$4.2808e^{-3} \pm 1.19e^{-4}$	$6.3222e^{-2} \pm 9.30e^{-5}$
11-6	$4.6599e^{-3} \pm 1.21e^{-4}$	$8.0519e^{-2} \pm 1.37e^{-4}$
11-7	$4.6376e^{-3} \pm 1.23e^{-4}$	$6.9831e^{-2} \pm 1.08e^{-4}$
12-1	$4.5966e^{-3} \pm 1.28e^{-4}$	$6.9202e^{-2} \pm 1.03e^{-4}$
12-2	$4.7893e^{-3} \pm 1.25e^{-4}$	$6.5141e^{-2} \pm 1.02e^{-4}$
12-3	$4.6908e^{-3} \pm 1.26e^{-4}$	$5.9865e^{-2} \pm 8.06\ e^{-5}$
12-4	$4.3246e^{-3} \pm 1.21e^{-4}$	$5.6293e^{-2} \pm 7.26\ e^{-5}$

5.4 HOMOGENEOUS PuO_2–POLYSTYRENE AT LOW HYDROGEN CONTENT (CS-3)***

5.4.1 Detailed Description

5.4.1.1 Overview of experiment

Critical experiments were conducted at the Battelle Pacific Northwest Critical Mass Laboratory with homogeneous mixtures of PuO_2–polystyrene (H/Pu = 5), containing plutonium of 11.46 wt % ^{240}Pu (Ref. 13). Criticality was determined for Plexiglas-reflected rectangular parallelepipeds of PuO_2–polystyrene compacts. Described in this evaluation are four configurations of critical assemblies. All four are considered acceptable for use as benchmark critical experiments.

5.4.1.2 Description of experimental configuration

Criticality was determined for Plexiglas-reflected rectangular parallelepipeds of plastic clad PuO_2–polystyrene compacts stacked on a remote-controlled split table machine. Because the experiments were fully reflected by Plexiglas, support structures outside the Plexiglas reflector and construction details of the room had a negligible effect on measured critical values. The control and safety rods were made of Plexiglas and were of reflector displacement type; therefore, the fuel core was void of any extraneous material other than the rubberized plastic coating of each fuel compact.

Although each experimental assembly was made critical, the critical dimensions were determined from a least-squares analysis of the approach-to-critical measurements.[14] Because the minimum available fuel compact thickness was 0.5 in. (1.27 cm), criticality was usually obtained for a partial or incomplete layer of compacts that was later corrected to an equivalent full layer of lesser thickness. Critical data, determined by least-squares analysis of the approach-to-critical measurements, are given in Table 5.15.

Table 5.15. Experimental data for assemblies of PuO_2–polystyrene compacts[a]

Case No.	Reflector	Critical dimensions (cm)			Critical mass (kg of plutonium)
		Length	Width	Height	
1	Plexiglas	25.88	25.88	19.04 ± 0.01	27.66 ± 0.01
2	Plexiglas	31.24	30.96	14.77 ± 0.02	30.94 ± 0.04
3	Plexiglas	41.66	41.28	11.03 ± 0.01	41.20 ± 0.03
4	Plexiglas	52.07	51.60	9.38 ± 0.01	54.78 ± 0.02

[a]See Ref. 13. PU-COMP-MIXED-002 (PCM002) says these values from Ref. 13 were uncorrected, and better dimensions were found in a different published document (Total critical mass values match PCM002).

5.4.1.3 Description of material data

PuO_2–polystyrene fuel compacts

The compacts were fabricated by pressing polystyrene and PuO_2 particles into cubic molds of 3.810- and 1.304-cm height. Each compact was spray painted with a 0.025-mm-thick coat of aluminum (density not provided) and covered with a rubberized plastic coating. The resulting plutonium density of a bare compact was 2.302 g/cm of plutonium.[15] The composition of an average compact is given in Table 5.16. The average bare, clad, and stacked compact dimensions[15] are given in Table 5.17. The composition of the rubberized plastic coating is given in Table 5.18. According to PCM002, these four cases used cubes with tape cladding, not Al and rubberized plastic.

*** These experiments have since been evaluated in PCM002, cases 6-9 (but this text is not from there).

Plexiglas reflector

Each of the rectangular parallelepiped assemblies had 6 in. (15.24 cm) of Plexiglas ($\rho = 1.185$ g/cm^3) reflection on each face. The Plexiglas composition[16] is given in Table 5.19.

Table 5.16. PuO_2–polystyrene compact composition[a]

Isotope/element	Atom density (atoms/barn-cm)
^{239}Pu	4.986×10^{-3}
^{240}Pu	6.623×10^{-4}
^{241}Pu	1.382×10^{-4}
^{242}Pu	1.026×10^{-5}
O	1.159×10^{-2}
C	2.920×10^{-2}
H	2.920×10^{-2}

[a]See Ref. 13.

Table 5.17. Compact dimensions[a]

Compact	Length (cm)	Width (cm)	Height (cm)[b]
Unclad	5.120	5.120	3.810, 1.304
Clad	5.174	5.156	3.846, 1.355
Stacked	5.207	5.159	3.881, 1.400

[a]See Ref. 15.
[b]Two compact heights thought used.

Table 5.18. Compact coating composition[a]

Isotope/element	Atom density (atoms/barn-cm)
H	1.777×10^{-2}
C	1.184×10^{-2}
Cl	0.592×10^{-2}

[a]See Ref. 13.

Table 5.19. Plexiglas composition[a]

Nuclide	wt %	Atom density (atoms/barn-cm)
H	8.0	5.666×10^{-2}
C	60.0	3.570×10^{-2}
O	32.0	1.428×10^{-2}

[a]See Ref. 16.

5.4.1.4 Supplemental experimental measurements

The effect of the plastic coating on criticality was obtained by determining the critical dimensions of an array as the thickness of the plastic coating was varied.[17] The variation in the plastic thickness was accomplished by inserting plastic shims between each fuel cube. The experimental data were extrapolated to a zero plastic thickness and the effect of the coating thickness on critical mass ascertained. Corrections are seen in Table 5.20. The experimentalists state that:

> Although corrections to these assemblies for stacking voids and cladding material do cause changes in the dimensions of the assemblies, the critical masses were found to remain essentially unchanged. The reason is that, in these relatively fast systems, the fuel density reduction caused by stacking voids and cladding tape was offset by the increased neutron moderation caused by the cladding material.[13]

Table 5.20. Corrected data for assemblies of PuO_2–polystyrene compacts[a]

Reflector	Critical dimensions (cm)			Critical mass[b] (kg of plutonium)
	Length	Width	Height	
Plexiglas	25.88	25.88	19.04 ± 0.01	27.66 ± 0.01
Plexiglas	31.24	30.96	14.77 ± 0.02	30.94 ± 0.04
Plexiglas	41.66	41.28	11.03 ± 0.01	41.20 ± 0.03
Plexiglas	52.07	51.60	9.38 ± 0.01	54.78 ± 0.02

[a]See Ref. 13. See footnote to Table 5.15. This "corrected" data are the same as Table 5.15.

[b]Data corrected for voids and compact coating.

5.4.1.5 Evaluation of the experimental data

Only partial data were supplied describing fuel compact configurations in experimental assemblies, therefore limiting explicit modeling. Models, instead, rely on corrected data or idealized critical experiments adjusted to account for incomplete layers and fuel compact coatings.

An attempt was made to model Case 3 of Table 5.15 explicitly and compare the calculational k_{eff} with the calculational k_{eff} of the idealistic model based on corrected data. If compensation is made for stochastic differences, then support is given to the validity of the corrections, assuming the explicit model is nearly an exact representation of the experimental configuration.

Based on compact data from Ref. 15, Case 3 was modeled with a bottom 8 × 8 × 2 array of 3.881-cm-tall compacts, followed successively by an 8 × 8 × 2 array of 1.400-cm-tall compacts, and an incomplete top layer of 21 1.400-cm-tall compacts placed near the assembly vertical centerline. The array had overall dimensions of 41.656 × 41.272 × 11.021 cm when the incomplete top layer was averaged over the assembly length and width. The critical mass for the explicit model was 41.18 kg plutonium. For the idealized model, the critical dimensions were 41.66 × 41.28 × 11.03 cm with a critical mass of 41.20 kg plutonium (Table 5.20).

To further advance the validity of the corrections, one-dimensional discrete ordinate calculations were performed using XSDRN. The experimentalists report the following:

> It turns out that the critical height in the reflected systems is a linear inverse function of the core cross-sectional area. Thus, by correcting these dimensions for cladding material and stacking voids and plotting ... the critical thickness of 5.88 ± 0.21 cm for an infinite slab of this material can be obtained by a least-squares fit extrapolation to 1/A = 0.[13]

Using XSDRN, the calculational k_{eff} of a Plexiglas-reflected, 5.88-cm-thick infinite slab of homogenized PuO_2–polystyrene, stacking void, and plastic cladding was found to be 1.0040. The

calculational k_{eff} of a Plexiglas-reflected 5.88-cm-thick infinite slab of PuO_2–polystyrene was found to be 1.0032. The k_{eff} is only 0.0008, attesting to the validity of the corrections.

The Table 5.16 ^{240}Pu number density and a 11.46%-enrichment value give a plutonium density of 2.3037 g/cm^3 that contradicts slightly with the reported density of 2.302 g/cm^3. Using XSDRN, the density difference shows a negligible k_{eff} difference of 0.0002.

In addition to the sensitivity calculations mentioned above, calculations were carried out to assess the uncertainties associated with the critical heights and masses specified in the benchmark model (Table 5.20). The sensitivity of k_{eff} to uncertainties is provided in Table 5.21.

Table 5.21. Sensitivity of k_{eff} to uncertainties

Case	Δk_{eff} for height uncertainty (XSDRN)	Δk_{eff} for mass uncertainty (XSDRN)	Δk_{eff} for benchmark-model k_{eff} uncertainty
Case 1	0.0004	0.0002	0.0006
Case 2	0.0007	0.0008	0.0015
Case 3	0.0005	0.0004	0.0009
Case 4	0.0006	0.0002	0.0008

5.4.2 Benchmark Specifications

5.4.2.1 Description of model

The models are simple rectangular parallelepipeds of PuO_2–polystyrene reflected by 6-in.-thick (15.25-cm) Plexiglas on each face.

5.4.2.2 Dimensions

The dimensions of the rectangular parallelepipeds of PuO_2–polystyrene used in the models are given in Table 5.20.

5.4.2.3 Material data

The PuO_2–polystyrene atom densities for the rectangular parallelepipeds of Table 5.20 are summarized in Table 5.22. The Table 5.22 atom densities differ from the atom densities of Table 5.16, which correspond to clad compacts of 2.302 g/cm^3 of plutonium stacked to form the critical volumes of Table 5.15 because the density (and atom densities) of the compacts in Table 5.22 has been reduced to account for the voids and removed compact coatings associated with the corrected data of Table 5.20. The atom densities used for Plexiglas are those of Table 5.19.

Table 5.22. Modeled PuO_2–polystyrene atom densities

Case	Atom densities (atoms/barn-cm)						
	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	O	C	H
1	4.694×10^{-3}	6.236×10^{-4}	1.301×10^{-4}	9.660×10^{-6}	1.091×10^{-2}	2.749×10^{-2}	2.749×10^{-2}
2	4.688×10^{-3}	6.227×10^{-4}	1.299×10^{-4}	9.646×10^{-6}	1.090×10^{-2}	2.745×10^{-2}	2.745×10^{-2}
3	4.701×10^{-3}	6.244×10^{-4}	1.303×10^{-4}	9.673×10^{-6}	1.093×10^{-2}	2.753×10^{-2}	2.753×10^{-2}
4	4.704×10^{-3}	6.249×10^{-4}	1.304×10^{-4}	9.680×10^{-6}	1.094×10^{-2}	2.755×10^{-2}	2.755×10^{-2}

5.4.2.4 Temperature data

Reference 15 reports a core center temperature of 333 K ± 10 K and a room temperature of 293 K. For the models, the reflector is assumed to be at room temperature, the core at 333 K.

5.4.2.5 Experimental and benchmark-model k_{eff}

The experiments were extrapolated to critical. Therefore, it is expected that the experimental critical k_{eff} is 1.0000. Due to insufficient experimental data, model simplifications based on corrections to experiments were used. These simplifications, along with uncertainties associated with corrections, contribute to an uncertainty in the benchmark-model k_{eff} of ±0.0013 (Case 1), ±0.00246 (Case 2), ±0.0018 (Case 3), and ±0.0018 (Case 4).

5.4.3 Results of Calculations

Tables 5.23 and 5.24 contain the results of calculations performed from model descriptions provided previously. The nominal k_{eff} values calculated with the 44-group ENDF/B-V cross section library have a mean k_{eff} of 1.0104 ± 0.0045, while the nominal k_{eff} values calculated with the 238-group ENDF/B-V cross section library have a mean k_{eff} of 1.0069 ± 0.0015. These statistics are based on the mean k_{eff} values of individual calculations and do not account for the uncertainty associated with each calculation.

Table 5.23. Calculation results for KENO-V.a

Case No.	Cross section library	
	KENO (44-group ENDF/B-V)[a]	KENO (238-group ENDF/B-V)[a]
1	1.0101 ± 0.0024	1.0041 ± 0.0025
2	1.0083 ± 0.0026	1.0070 ± 0.0025
3	1.0165 ± 0.0026	1.0109 ± 0.0024
4	1.0108 ± 0.0026	1.0086 ± 0.0027

[a]Computed with SCALE-4.3R.

Table 5.24. MCNP ENDF/B-VI calculations

Case	k-effective	
	S(α,β treatment)	
	None	In Plexiglas[a]
1	1.04364 ± 0.00108	1.00917 ± 0.00115
2	1.04733 ± 0.00111	1.01076 ± 0.00106
3	1.05648 ± 0.00103	1.01504 ± 0.00092
4	1.06322 ± 0.00107	1.01386 ± 0.00109

[a]The poly.01t card is used.

Reaction rates, R(x), based on 238-group cross sections, for all materials of the assembly (compacts and reflector), averaged over energy and volume of the assembly, are shown in Table 5.25, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.26 lists the leakage from the reflector surface per source neutron and the EALCF and associated deviation.

Table 5.25. Reaction rates (1/s)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	Case-1		
^{239}Pu	$4.5201e^{-1}$	$3.1811e^{-1}$	$9.3478e^{-1}$
^{240}Pu	$6.0093e^{-2}$	$6.6268e^{-3}$	$2.0786e^{-2}$
^{241}Pu	$2.2213e^{-2}$	$1.7116e^{-2}$	$5.0891e^{-2}$
^{242}Pu	$1.4980e^{-3}$	$8.2682e^{-5}$	$2.6273e^{-4}$
C	$2.8828e^{-3}$	-	-
O	$1.9559e^{-3}$	-	-
H	$3.6591e^{-1}$	-	-
	Case-2		
^{239}Pu	$4.5311e^{-1}$	$3.1860e^{-1}$	$9.3604e^{-1}$
^{240}Pu	$6.0067e^{-2}$	$6.5715e^{-3}$	$2.0606e^{-2}$
^{241}Pu	$2.2215e^{-2}$	$1.7104e^{-2}$	$5.0853e^{-2}$
^{242}Pu	$1.4956e^{-3}$	$8.1937e^{-5}$	$2.6027e^{-4}$
C	$2.8659e^{-3}$	-	-
O	$1.9382e^{-3}$	-	-
H	$3.6450e^{-1}$	-	-
	Case-3		
^{239}Pu	$4.5344e^{-1}$	$3.1906e^{-1}$	$9.3704e^{-1}$
^{240}Pu	$5.9719e^{-2}$	$6.3908e^{-3}$	$2.0053e^{-2}$
^{241}Pu	$2.2045e^{-2}$	$1.6963e^{-2}$	$5.0428e^{-2}$
^{242}Pu	$1.5063e^{-3}$	$7.9704e^{-5}$	$2.5336e^{-4}$
C	$2.9005e^{-3}$	-	-
O	$1.9565e^{-3}$	-	-
H	$3.6677e^{-1}$	-	-
	Case-4		
^{239}Pu	$4.5352e^{-1}$	$3.1908e^{-1}$	$9.3679e^{-1}$
^{240}Pu	$5.9843e^{-2}$	$6.2633e^{-3}$	$1.9651e^{-2}$
^{241}Pu	$2.2073e^{-2}$	$1.6973e^{-2}$	$5.0451e^{-2}$
^{242}Pu	$1.5174e^{-3}$	$7.8147e^{-5}$	$2.4837e^{-4}$
C	$2.8860e^{-3}$	-	-
O	$1.9543e^{-3}$	-	-
H	$3.6733e^{-1}$	-	-

Table 5.26. Calculated leakage and EALCF

Case No.	Leakage	EALCF
1	$9.4779e^{-2} \pm 5.14e^{-4}$	$8.4262e^{+1} \pm 7.85e^{-1}$
2	$9.4286e^{-2} \pm 4.87e^{-4}$	$7.9505e^{+1} \pm 8.21e^{-2}$
3	$9.2264e^{-2} \pm 5.23e^{-4}$	$6.3578e^{+1} \pm 6.12e^{-1}$
4	$8.9619e^{-2} \pm 5.20e^{-4}$	$5.3512e^{+1} \pm 4.82e^{-1}$

5.5 LOW-MODERATED MIXTURES OF PLUTONIUM AND URANIUM OXIDES WITH 8, 15, AND 30 wt % PLUTONIUM (CS-4)*

5.5.1 Detailed Description

5.5.1.1 Overview of experiment

The experimental program considered three different mixtures of oxides of uranium and plutonium. The fuel mixtures contained ^{235}U-depleted uranium mixed with 8.1, 15.0, and 29.3 wt % plutonium and blended homogeneously with polystyrene such that the H:(U + Pu) atomic ratios were 7.3, 2.86, and 2.8 for the three plutonium concentrations respectively. The plutonium contained ~ 11.5 wt % ^{240}Pu and the uranium was ~ 0.2 wt % ^{235}U. Critical sizes of rectangular parallelepipeds were determined for each of the fuel mixtures. Each parallelpiped was fully reflected with methacrylate plastic.

5.5.1.2 Description of experimental configuration

The experiments consisted of rectangular parallelepiped assemblies of UO_2 + PuO_2 + polystyrene moderator. Approach-to-criticality measurements were made using a remotely operated split-table machine. The assemblies contained compacts of material whose length and width measurements were in the range of 5.08 to 5.09 cm. In all cases, the height of the compacts had one of two values. One value was in the 5.08- to 5.09-cm range, and the other value was in the 1.2- to 1.4-cm range. Experimental assemblies were chosen to be of a given width and length, and the heights were then varied to approach criticality. The smaller height compacts were used as the assembly approached criticality. The compacts were clad using No. 471 tape manufactured by Minnesota Mining and Manufacturing Company. Table 5.27 shows the dimensions of the 29.3, 15.0, and 8.1 wt % plutonium fuel compacts. The two values for height are shown, and all dimensions are shown for unclad, clad, and stacked material. The stacked value is the average dimension of the space occupied by a compact.

Table 5.27. Fuel compact dimensions (cm)

	Unclad	Clad	Stacked
	29.3 wt % plutonium		
Length, cm	5.090 ± 0.005	5.114 ± 0.005	5.118 ± 0.005
Width, cm	5.083 ± 0.026	5.170 ± 0.026	5.174 ± 0.030
Height, cm	5.090 ± 0.005	5.114 ± 0.005	5.118 ± 0.005
	1.339 ± 0.026	1.363 ± 0.026	1.367 ± 0.030
	15.0 wt % plutonium		
Length, cm	5.090 ± 0.005	5.114 ± 0.005	5.129 ± 0.013
Width, cm	5.090 ± 0.005	5.114 ± 0.005	5.129 ± 0.013
Height, cm	5.082 ± 0.066	5.170 ± 0.067	5.173 ± 0.037
	1.265 ± 0.041	1.353 ± 0.044	1.395 ± 0.056
	8.1 wt % plutonium		
Length, cm	5.090 ± 0.005	5.114 ± 0.005	5.138 ± 0.089
Width, cm	5.090 ± 0.005	5.114 ± 0.005	5.138 ± 0.089
Height, cm	5.081 ± 0.003	5.168 ± 0.003	5.170 ± 0.060
	1.274 ± 0.008	1.361 ± 0.009	1.381 ± 0.064

For the 29.3 wt % plutonium and 2.8 H:(U + Pu) ratio compacts, 12 experiments were performed in which lengths and widths were varied and critical heights were determined (Table 5.28). Nine of the twelve experiments are judged acceptable as benchmarks. Two of the twelve experiments not included were for arrangements containing no reflector (Table 5.29). For the 15.0 wt % Pu and 2.86 H:(U+Pu) ratio compacts, one experiment was performed (Table 5.30) and for the 8.1 wt % Pu and 7.3 H:(U+Pu) ratio

*Data source is Ref. 19.

compacts, four experiments were performed (Table 5.31). These five experiments are acceptable for use as benchmarks.

Values in Tables 5.28–5.31 are in numbers of unclad compacts that determine the length, width, and height of critical assemblies. The lengths and widths correspond to an integral number of compacts. The heights correspond to an integral number of compacts with the larger thickness plus a nonintegral number of compacts with the smaller thickness.

Table 5.28. Critical configurations for reflected 29.3 wt % plutonium cases with H:(U+Pu) ratio of 2.8 (values are in units of length, width, and height)

Case	Length (5.090-cm units)	Width (5.083-cm units)	Height (5.090-cm units)	Height (1.339-cm units)
29-1	7	7	7	0.646 ± 0.001
29-2	8	8	5	2.548 ± 0.004
29-3	9	9	4	4.192 ± 0.011
29-4	10	10	4	1.300 ± 0.002
29-5	10	10	4	1.297 ± 0.003
29-6	12	10	4	0.038 ± 0.001
29-7	12	12	3	2.791 ± 0.004
29-8	12	13	3	2.407 ± 0.005
29-9	14	13	3	2.068 ± 0.007
[a]	Infinite	Infinite	2.540 ± 0.028	—

[a]Case represents a linear extrapolation of data from the finite assemblies. The height is expressed as equivalent full-sized compacts.

Table 5.29. Critical configurations for unreflected 29.3 wt % plutonium cases with H:(U+Pu) ratio of 2.8 (values are in units of length, width and height)

	Length (5.090-cm units)	Width (5.083-cm units)	Height (5.090-cm units)	Height (1.339-cm units)
1	10	10	8	3.768 ± 0.008
2	10	11	8	1.510 ± 0.002

Table 5.30. Critical configuration for reflected 15.0 wt % plutonium cases with H:(U+Pu) ratio of 2.86 (values are in units of length, width, and height)

Case	Length (5.090-cm units)	Width (5.090-cm units)	Height (5.082-cm units)	Height (1.265-cm units)
15-1	10	10	9	6.651 ± 0.016

Table 5.31. Critical configurations for reflected 8.1 wt % plutonium cases with H:(U+Pu) ratio of 7.3 (values are in units of length, width, and height given at top of column)

Case	Length (5.090-cm units)	Width (5.090-cm units)	Height (5.081-cm units)	Height (1.274-cm units)
8-1	10	9	9	1.135 ± 0.001
8-2	10	11	7	3.239 ± 0.001
8-3	12	12	6	2.526 ± 0.003
8-4	14	13	5	3.733 ± 0.005

5.5.1.3 Description of material data

Details on the composition of the materials used in these experiments are given in Table 5.32 in terms of atom densities. These compositions are listed under the three categories of experiments performed; i.e., plutonium values of 29.3, 15.0, and 8.1 wt % in the fuel accompanied, respectively, by H:(U+Pu) ratios of 2.8, 2.86, and 7.3. The hydrogenous moderator material mixed with the fuel is polystyrene. The size of the fuel and moderator particles (i.e., <180 μm indicates homogeneity) is also given. As explained, the cladding material is No. 471 tape of the 3M Company. The thickness of the cladding can be determined from Table 5.27. The reflector material is methacrylate plastic (Plexiglas).

5.5.1.4 Supplemental experimental measurements

Smaller height compacts were used to approach criticality, and critical heights are quoted in terms of numbers of larger and smaller compacts. However, the critical heights are also quoted in terms of equivalent full-sized compacts. The latter heights are referred to as "corrected" and are reported elsewhere.[18,19] In calculating these corrected heights, the reactivity worth of the smaller ~1.3-cm-thick compacts was determined for each fuel mixture by replacement measurements. The corrected height that is quoted in terms of equivalent full-sized compacts contains corrections for cladding material and stacking voids in the case of the 29.3 wt % plutonium but not for the other mixtures. Reactivity effects due to cladding and stacking voids were determined to be negligible for the 29.3 wt % plutonium cases. The additional hydrogen and carbon in the cladding material compensates for the reduced fuel density.

5.5.1.5 Evaluation of experimental data

Most values and dimensions are well documented. Although the experimental setup is reasonably well documented, the way in which the experiment was conducted is only explained in a cursory manner. Uncertainties are quoted for all dimensions although the manner in which they were obtained is not documented.

Void and cladding effects were not measured for the 15.0 and 8.1 wt % mixtures because limited fuel material was available. These extra height data are a useful addition to the account, but they have not been adequately explained. The experiments can only be properly recorded here in terms of full- and half-height compacts together with the appropriate amount of cladding.

The two unreflected 29.3 wt % plutonium experiments were not included in this study due to lack of data on the structural materials and room. The experiment to determine the critical thickness of a fully reflected slab of 30-wt % plutonium-uranium mixture was not used because the data were obtained from a linear extrapolation of data from the finite assemblies.

As for the thickness of the Plexiglas reflector, there are statements that the assemblies were fully reflected (at least 15.24 cm), and the photograph in Ref. 19 seems to indicate that sufficient Plexiglas was in use.

To ascertain the effect of modeling the top layer as a homogeneous mixture of fuel and cladding of reduced height and lateral dimensions corresponding to the assembly base, two Monte Carlo calculations were performed of Case 29-4 with: (1) the integral 0.300 layer of compacts modeled explicitly as 30

Table 5.32. Atom densities of material data

	29.3 wt % plutonium	15.0 wt % plutonium	8.1 wt % plutonium
	Fuel composition (10^{24} atoms/cm^3)		
^{235}U	9.401×10^{-6}	1.365×10^{-5}	9.116×10^{-6}
^{238}U	6.172×10^{-3}	7.549×10^{-3}	4.606×10^{-3}
^{238}Pu	1.833×10^{-6}	5.737×10^{-7}	3.809×10^{-7}
^{239}Pu	2.203×10^{-3}	1.118×10^{-3}	3.490×10^{-4}
^{240}Pu	2.931×10^{-4}	1.478×10^{-4}	4.678×10^{-5}
^{241}Pu	4.934×10^{-5}	2.221×10^{-5}	7.745×10^{-6}
^{242}Pu	5.636×10^{-6}	2.370×10^{-6}	1.116×10^{-6}
^{241}Am	1.019×10^{-5}	2.765×10^{-5}	3.132×10^{-6}
O	1.869×10^{-2}	1.840×10^{-2}	1.178×10^{-2}
C	2.666×10^{-2}	2.653×10^{-2}	3.567×10^{-2}
H	2.417×10^{-2}	2.534×10^{-2}	3.680×10^{-2}
	UO_2 particle size (μm)		
95%	<40	<18	<18
50%	<9	<5	<5
5%	<2	<2	<2
	PuO_2 particle size (μm)		
95%	<20	<20	<20
50%	<8	<5	<5
5%	<2	<1	<1
	Polystyrene size (μm)		
95%	<225	<225	<225
50%	<150	<150	<150
5%	<50	<50	<50
	Cladding composition (10^{24} atoms/cm^3)		
H	4.489×10^{-2}	4.489×10^{-2}	4.489×10^{-2}
C	3.111×10^{-2}	3.111×10^{-2}	3.111×10^{-2}
Cl	7.240×10^{-3}	7.240×10^{-3}	7.240×10^{-3}
	Reflector composition (10^{24} atoms/cm^3)		
H	5.666×10^{-2}	5.666×10^{-2}	5.666×10^{-2}
C	3.510×10^{-2}	3.510×10^{-2}	3.510×10^{-2}
O	1.428×10^{-2}	1.428×10^{-2}	1.428×10^{-2}

compacts, and (2) the 0.300 layer of compacts modeled as a $51.18 \times 51.74 \times 0.4089$-cm layer of homogeneously mixed fuel and clad. Case 29-4 was chosen because the top experimental layer consists of an exact number of compacts and because the effect on reactivity of smearing compacts across the top layer should be more pronounced the smaller the number of top layer compacts. The explicit model k_{eff} is 0.9895 ± 0.0013. The smeared layer model k_{eff} is 0.9915 ± 0.0012. The difference is within statistics; therefore, the Monte Carlo calculational difference between the two modeling methods is indistinguishable.

5.5.2 Benchmark Specifications

5.5.2.1 Description of model

The benchmark cases are parallelepipeds composed of nearly cubic compacts of material (uranium oxide, plutonium oxide, and moderator) that had one of two thickness values. One of the thickness values was close to the other two dimensions such that those compacts were roughly cubic. The other thickness value was roughly one-quarter of the larger value. All models include a close-fitting Plexiglas reflector.

5.5.2.2 Dimensions

The critical dimensions of the parallelepipeds models come from Tables 5.28, 5.30, and 5.31. Table entry values are in numbers of compacts that determine the length, width, and height of the critical assembly in each case. The lengths and widths correspond to an integral number of compacts. The heights correspond to an integral number of compacts with the larger thickness measurement plus a non-integral number of compacts of the smaller thickness. All layers excluding the top layer were modeled explicitly using unclad, clad, and stacked dimensions for the compacts. The top layer was modeled as a homogeneous mixture of cladding and fuel of thickness equal to the fractional layer times the outside cladding thickness of the smaller compact. A 15.24-cm-thick reflector is modeled on all six faces of the assembly.

5.5.2.3 Material data

The atom densities given in Table 5.32 were used in the models. Atom densities derived from those in Table 5.32 and based on smaller compact unclad and clad dimensions were used in the homogeneous mixture of cladding and fuel of the top fractional layer. The derived number densities were obtained by multiplying the fuel composition number densities by factors 0.9613, 0.9262, and 0.9273 for 29.3, 15.0, and 8.1 wt % plutonium and the clad number densities by factors 0.0387, 0.0738, and 0.0727 for 29.3, 15.0, and 8.1 wt % plutonium.

5.5.2.4 Temperature data

The temperature data in Table 5.33 apply to the experiments.

Table 5.33. Core center and room temperatures (°C)

Material	Core center	Room
29.3 wt % plutonium, reflected	55 ± 5	20 ± 2
15.0 wt % plutonium	50 ± 2	20 ± 2
8.10 wt % plutonium	47 ± 4	20 ± 2

5.5.3 Results of Calculations

Calculational results obtained from the benchmark specification data given in the previous section are tabulated in Tables 5.34–5.37. The nominal k_{eff} values calculated with the 44-group ENDF/B-V cross section library have a mean k_{eff} of 1.0104 ± 0.0045, while the nominal k_{eff} values calculated with the 238-group ENDF/B-V cross-section library have a mean k_{eff} of 1.0069 ± 0.0015. These statistics are based on the mean k_{eff} values of individual calculations and do not account for the uncertainty associated with each calculation.

The reaction rates, R(x), based on 238-group cross sections, for all materials of the assembly (compacts, cladding, reflector), averaged over energy and volume of the assembly, are shown in Table 5.38, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.39 lists the leakage from the reflector surface per source neutron and the EALCF and associated deviation.

Table 5.34. Results of KENO-V.a calculations

Case No.	Cross section library	
	44-group ENDF/B-V	238-group ENDF/B-V
8-1	1.0091 ± 0.0017	1.0037 ± 0.0017
8-2	1.0085 ± 0.0018	1.0035 ± 0.0021
8-3	1.0109 ± 0.0016	1.0056 ± 0.0018
8-4	1.0084 ± 0.0018	1.0074 ± 0.0019
15-1	0.9905 ± 0.0015	0.9808 ± 0.0014
29-1	1.0011 ± 0.0016	0.9928 ± 0.0015
29-2	1.0029 ± 0.0015	0.9957 ± 0.0014
29-3	1.0076 ± 0.0016	1.0023 ± 0.0016
29-4	0.9995 ± 0.0014	0.9932 ± 0.0017
29-5	1.0039 ± 0.0015	0.9960 ± 0.0016
29-6	1.0017 ± 0.0016	0.9916 ± 0.0015
29-7	1.0004 ± 0.0016	0.9913 ± 0.0016
29-8	0.9993 ± 0.0018	0.9933 ± 0.0016
29-9	1.0093 ± 0.0016	1.0002 ± 0.0018

Table 5.35. MCNP ENDF/B-VI calculations for Table 5.39 of CS4 evaluation

Case	k-effective	
	S(α,β) treatment	
	None	In reflector
1	1.02357 ± 0.00145	0.99878 ± 0.00136
2	1.02037 ± 0.00111	0.99544 ± 0.00129
3	1.02750 ± 0.00138	1.00377 ± 0.00088
4	1.02429 ± 0.00140	0.99625 ± 0.00142
5	1.02637 ± 0.00139	0.99408 ± 0.00115
6	1.02535 ± 0.00125	0.99330 ± 0.00124
7	1.02956 ± 0.00122	0.99909 ± 0.00124
8	1.02765 ± 0.00138	0.99571 ± 0.00127
9	1.03387 ± 0.00113	1.00099 ± 0.00120

Table 5.36. MCNP ENDF/B-VI calculations for Table 5.31 of CS4 evaluation

Case	k-effective	
	S(α,β) treatment	
	None	In reflector
1	1.00360 ± 0.00101	0.98673 ± 0.00135

Table 5.37. MCNP ENDF/B-VI calculations for Table 5.32 of CS4 evaluation

	k-effective	
	S(α,β) treatment	
Case	None	In reflector
1	1.02724 ± 0.00134	1.02093 ± 0.00138
2	1.02757 ± 0.00147	1.01645 ± 0.00139
3	1.02911 ± 0.00138	1.01864 ± 0.00119
4	1.02863 ± 0.00141	1.01777 ± 0.00098

Table 5.38. Reaction rates (1/s)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	Case 8-1		
^{241}Am	$4.2089e^{-3}$	$6.5259e^{-5}$	$2.1958e^{-4}$
^{238}Pu	$1.6384e^{-4}$	$1.7913e^{-5}$	$5.4307e^{-5}$
^{239}Pu	$4.9034e^{-1}$	$3.2048e^{-1}$	$9.2658e^{-1}$
^{240}Pu	$8.3817e^{-2}$	$6.9048e^{-4}$	$2.1517e^{-3}$
^{241}Pu	$1.1833e^{-2}$	$8.7262e^{-3}$	$2.5794e^{-2}$
^{242}Pu	$8.3082e^{-4}$	$1.2781e^{-5}$	$4.0491e^{-5}$
^{235}U	$5.9760e^{-3}$	$4.6746e^{-3}$	$1.1414e^{-2}$
^{238}U	$1.4499e^{-1}$	$1.2912e^{-2}$	$3.6260e^{-2}$
C	$1.8812e^{-3}$	–	–
O	$1.7560e^{-3}$	–	–
H	$2.0616e^{-1}$	–	–
Cl	$6.8726e^{-3}$	–	–
	Case 8-2		
^{241}Am	$4.2074e^{-3}$	$6.5174e^{-5}$	$2.1944e^{-4}$
^{238}Pu	$1.6459e^{-4}$	$1.7897e^{-5}$	$5.4274e^{-5}$
^{239}Pu	$4.9124e^{-1}$	$3.2125e^{-1}$	$9.2880e^{-1}$
^{240}Pu	$8.4336e^{-2}$	$6.8863e^{-4}$	$2.1478e^{-3}$
^{241}Pu	$1.1872e^{-2}$	$8.7530e^{-3}$	$2.5875e^{-2}$
^{242}Pu	$8.1887e^{-4}$	$1.2747e^{-5}$	$4.0421e^{-5}$
^{235}U	$5.9929e^{-3}$	$4.6903e^{-3}$	$1.1453e^{-2}$
^{238}U	$1.4462e^{-1}$	$1.2914e^{-2}$	$3.6331e^{-2}$
C	$1.9209e^{-3}$	–	–
O	$1.8211e^{-3}$	–	–
H	$2.0563e^{-1}$	–	–
Cl	$7.3838e^{-3}$	–	–
	Case 8-3		
^{241}Am	$4.2255e^{-3}$	$6.5230e^{-5}$	$2.1955e^{-4}$
^{238}Pu	$1.6453e^{-4}$	$1.7889e^{-5}$	$5.4246e^{-5}$
^{239}Pu	$4.9163e^{-1}$	$3.2145e^{-1}$	$9.2936e^{-1}$
^{240}Pu	$8.3602e^{-2}$	$6.8846e^{-4}$	$2.1467e^{-3}$
^{241}Pu	$1.1903e^{-2}$	$8.7763e^{-3}$	$2.5943e^{-2}$
^{242}Pu	$8.2447e^{-4}$	$1.2748e^{-5}$	$4.0411e^{-5}$
^{235}U	$6.0021e^{-3}$	$4.6972e^{-3}$	$1.1470e^{-2}$
^{238}U	$1.4475e^{-1}$	$1.2887e^{-2}$	$3.6242e^{-2}$
C	$1.9180e^{-3}$	–	–
O	$1.8097e^{-3}$	–	–
H	$2.0591e^{-1}$	–	–
Cl	$7.3033e^{-3}$	–	–

Table 5.38. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	Case 8-4		
^{241}Am	$4.1999e^{-3}$	$6.4841e^{-5}$	$2.1820e^{-4}$
^{238}Pu	$1.6477e^{-4}$	$1.7830e^{-5}$	$5.4054e^{-5}$
^{239}Pu	$4.9208e^{-1}$	$3.2184e^{-1}$	$9.3048e^{-1}$
^{240}Pu	$8.4042e^{-2}$	$6.8409e^{-4}$	$2.1327e^{-3}$
^{241}Pu	$1.1874e^{-2}$	$8.7568e^{-3}$	$2.5886e^{-2}$
^{242}Pu	$8.2707e^{-4}$	$1.2663e^{-5}$	$4.0138e^{-5}$
^{235}U	$5.9965e^{-3}$	$4.6948e^{-3}$	$1.1464e^{-2}$
^{238}U	$1.4372e^{-1}$	$1.2792e^{-2}$	$3.5970e^{-2}$
C	$1.8987e^{-3}$	–	–
O	$1.7820e^{-3}$	–	–
H	$2.0555e^{-1}$	–	–
Cl	$7.7483e^{-3}$	–	–
	Case 15-1		
^{241}Am	$1.6721e^{-2}$	$5.1036e^{-4}$	$1.7482e^{-3}$
^{238}Pu	$9.9381e^{-5}$	$2.5088e^{-5}$	$7.6654e^{-5}$
^{239}Pu	$4.5914e^{-1}$	$3.0044e^{-1}$	$8.7230e^{-1}$
^{240}Pu	$8.7147e^{-2}$	$2.3811e^{-3}$	$7.4160e^{-3}$
^{241}Pu	$1.2620e^{-2}$	$9.4650e^{-3}$	$2.8034e^{-2}$
^{242}Pu	$1.3108e^{-3}$	$3.0013e^{-5}$	$9.4877e^{-5}$
^{235}U	$4.0555e^{-3}$	$2.9150e^{-3}$	$7.1426e^{-3}$
^{238}U	$1.6784e^{-1}$	$2.2778e^{-2}$	$6.3934e^{-2}$
C	$1.7436e^{-3}$	–	–
O	$2.6061e^{-3}$	–	–
H	$2.0148e^{-1}$	–	–
Cl	$2.5336e^{-3}$	–	–
	Case 29-1		
^{241}Am	$3.3698e^{-3}$	$1.5338e^{-4}$	$5.2856e^{-4}$
^{238}Pu	$2.1086e^{-4}$	$6.3059e^{-5}$	$1.9366e^{-4}$
^{239}Pu	$4.5554e^{-1}$	$3.0699e^{-1}$	$8.9536e^{-1}$
^{240}Pu	$7.2395e^{-2}$	$4.0268e^{-3}$	$1.2560e^{-2}$
^{241}Pu	$1.6055e^{-2}$	$1.2181e^{-2}$	$3.6133e^{-2}$
^{242}Pu	$1.7330e^{-3}$	$6.1455e^{-5}$	$1.9437e^{-4}$
^{235}U	$1.7213e^{-3}$	$1.2287e^{-3}$	$3.0176e^{-3}$
^{238}U	$1.0109e^{-1}$	$1.6177e^{-2}$	$4.5384e^{-2}$
C	$2.2331e^{-3}$	–	–
O	$2.5916e^{-3}$	–	–
H	$2.7858e^{-1}$	–	–
Cl	$1.8733e^{-3}$	–	–
	Case 29-2		
^{241}Am	$3.3780e^{-3}$	$1.5314e^{-4}$	$5.2798e^{-4}$
^{238}Pu	$2.1191e^{-4}$	$6.2955e^{-5}$	$1.9339e^{-4}$
^{239}Pu	$4.5695e^{-1}$	$3.0780e^{-1}$	$8.9769e^{-1}$
^{240}Pu	$7.2299e^{-2}$	$4.0160e^{-3}$	$1.2532e^{-2}$
^{241}Pu	$1.6092e^{-2}$	$1.2214e^{-2}$	$3.6229e^{-2}$
^{242}Pu	$1.7386e^{-3}$	$6.1263e^{-5}$	$1.9388e^{-4}$
^{235}U	$1.7208e^{-3}$	$1.2291e^{-3}$	$3.0185e^{-3}$
^{238}U	$1.0117e^{-1}$	$1.6213e^{-2}$	$4.5509e^{-2}$
C	$2.2213e^{-3}$	–	–
O	$2.6119e^{-3}$	–	–

Table 5.38. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
H	$2.7661e^{-1}$	–	–
Cl	$1.7892e^{-3}$	–	–
	Case 29-3		
^{241}Am	$3.4254e^{-3}$	$1.5441e^{-4}$	$5.3193e^{-4}$
^{238}Pu	$2.1342e^{-4}$	$6.3604e^{-5}$	$1.9524e^{-4}$
^{239}Pu	$4.6004e^{-1}$	$3.0981e^{-1}$	$9.0352e^{-1}$
^{240}Pu	$7.3624e^{-2}$	$4.0520e^{-3}$	$1.2635e^{-2}$
^{241}Pu	$1.6233e^{-2}$	$1.2314e^{-2}$	$3.6524e^{-2}$
^{242}Pu	$1.8023e^{-3}$	$6.1826e^{-5}$	$1.9549e^{-4}$
^{235}U	$1.7405e^{-3}$	$1.2415e^{-3}$	$3.0489e^{-3}$
^{238}U	$1.0260e^{-1}$	$1.6221e^{-2}$	$4.5496e^{-2}$
C	$2.2300e^{-3}$	–	–
O	$2.6073e^{-3}$	–	–
H	$2.7867e^{-1}$	–	–
Cl	$1.7919e^{-3}$	–	–
	Case 29-4		
^{241}Am	$3.3496e^{-3}$	$1.5163e^{-4}$	$5.2246e^{-4}$
^{238}Pu	$2.1110e^{-4}$	$6.2235e^{-5}$	$1.9114e^{-4}$
^{239}Pu	$4.5591e^{-1}$	$3.0724e^{-1}$	$8.9594e^{-1}$
^{240}Pu	$7.1418e^{-2}$	$3.9741e^{-3}$	$1.2395e^{-2}$
^{241}Pu	$1.6042e^{-2}$	$1.2163e^{-2}$	$3.6077e^{-2}$
^{242}Pu	$1.7528e^{-3}$	$6.0647e^{-5}$	$1.9182e^{-4}$
^{235}U	$1.7094e^{-3}$	$1.2227e^{-3}$	$3.0026e^{-3}$
^{238}U	$1.0026e^{-1}$	$1.5997e^{-2}$	$4.4863e^{-2}$
C	$2.2244e^{-3}$	–	–
O	$2.5771e^{-3}$	–	–
H	$2.7865e^{-1}$	–	–
Cl	$1.6387e^{-3}$	–	–
	Case 29-5		
^{241}Am	$3.3561e^{-3}$	$1.5223e^{-4}$	$5.2445e^{-4}$
^{238}Pu	$2.1156e^{-4}$	$6.2492e^{-5}$	$1.9191e^{-4}$
^{239}Pu	$4.5670e^{-1}$	$3.0785e^{-1}$	$8.9773e^{-1}$
^{240}Pu	$7.2115e^{-2}$	$3.9924e^{-3}$	$1.2452e^{-2}$
^{241}Pu	$1.6062e^{-2}$	$1.2190e^{-2}$	$3.6156e^{-2}$
^{242}Pu	$1.7240e^{-3}$	$6.0931e^{-5}$	$1.9270e^{-4}$
^{235}U	$1.7144e^{-3}$	$1.2245e^{-3}$	$3.0070e^{-3}$
^{238}U	$1.0076e^{-1}$	$1.6057e^{-2}$	$4.5035e^{-2}$
C	$2.2383e^{-3}$	–	–
O	$2.5928e^{-3}$	–	–
H	$2.7753e^{-1}$	–	–
Cl	$1.6293e^{-3}$	–	–
	Case 29-6		
^{241}Am	$3.3379e^{-3}$	$1.5121e^{-4}$	$5.2117e^{-4}$
^{238}Pu	$2.1039e^{-4}$	$6.1781e^{-5}$	$1.8982e^{-4}$
^{239}Pu	$4.5455e^{-1}$	$3.0677e^{-1}$	$8.9461e^{-1}$
^{240}Pu	$7.0491e^{-2}$	$3.9587e^{-3}$	$1.2352e^{-2}$
^{241}Pu	$1.5935e^{-2}$	$1.2085e^{-2}$	$3.5846e^{-2}$
^{242}Pu	$1.7678e^{-3}$	$6.0457e^{-5}$	$1.9128e^{-4}$
^{235}U	$1.6981e^{-3}$	$1.2154e^{-3}$	$2.9847e^{-3}$
^{238}U	$9.8831e^{-2}$	$1.5974e^{-2}$	$4.4824e^{-2}$

Table 5.38. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
C	$2.2565e^{-3}$	–	–
O	$2.5860e^{-3}$	–	–
H	$2.8245e^{-1}$	–	–
Cl	$1.8149e^{-3}$	–	–
	Case 29-7		
^{241}Am	$3.3147e^{-3}$	$1.5083e^{-4}$	$5.1984e^{-4}$
^{238}Pu	$2.1037e^{-4}$	$6.1723e^{-5}$	$1.8961e^{-4}$
^{239}Pu	$4.5532e^{-1}$	$3.0708e^{-1}$	$8.9548e^{-1}$
^{240}Pu	$7.0772e^{-2}$	$3.9514e^{-3}$	$1.2328e^{-2}$
^{241}Pu	$1.5971e^{-2}$	$1.2113e^{-2}$	$3.5927e^{-2}$
^{242}Pu	$1.7079e^{-3}$	$6.0337e^{-5}$	$1.9088e^{-4}$
^{235}U	$1.7017e^{-3}$	$1.2181e^{-3}$	$2.9914e^{-3}$
^{238}U	$9.9429e^{-2}$	$1.5935e^{-2}$	$4.4702e^{-2}$
C	$2.2633e^{-3}$	–	–
O	$2.5919e^{-3}$	–	–
H	$2.8173e^{-1}$	–	–
Cl	$1.5059e^{-3}$	–	–
	Case 29-8		
^{241}Am	$3.3248e^{-3}$	$1.4969e^{-4}$	$5.1581e^{-4}$
^{238}Pu	$2.0902e^{-4}$	$6.1353e^{-5}$	$1.8845e^{-4}$
^{239}Pu	$4.5570e^{-1}$	$3.0732e^{-1}$	$8.9609e^{-1}$
^{240}Pu	$7.1393e^{-2}$	$3.9211e^{-3}$	$1.2232e^{-2}$
^{241}Pu	$1.5992e^{-2}$	$1.2126e^{-2}$	$3.5963e^{-2}$
^{242}Pu	$1.7250e^{-3}$	$5.9843e^{-5}$	$1.8930e^{-4}$
^{235}U	$1.6986e^{-3}$	$1.2162e^{-3}$	$2.9864e^{-3}$
^{238}U	$9.9550e^{-2}$	$1.5778e^{-2}$	$4.4262e^{-2}$
C	$2.2449e^{-3}$	–	–
O	$2.5611e^{-3}$	–	–
H	$2.7999e^{-1}$	–	–
Cl	$1.4862e^{-3}$	–	–
	Case 29-9		
^{241}Am	$3.3697e^{-3}$	$1.5052e^{-4}$	$5.1859e^{-4}$
^{238}Pu	$2.1046e^{-4}$	$6.1816e^{-5}$	$1.8983e^{-4}$
^{239}Pu	$4.5949e^{-1}$	$3.0966e^{-1}$	$9.0288e^{-1}$
^{240}Pu	$7.2410e^{-2}$	$3.9418e^{-3}$	$1.2295e^{-2}$
^{241}Pu	$1.6136e^{-2}$	$1.2229e^{-2}$	$3.6269e^{-2}$
^{242}Pu	$1.6951e^{-3}$	$6.0149e^{-5}$	$1.9023e^{-4}$
^{235}U	$1.7139e^{-3}$	$1.2257e^{-3}$	$3.0097e^{-3}$
^{238}U	$9.9595e^{-2}$	$1.5836e^{-2}$	$4.4423e^{-2}$
C	$2.2180e^{-3}$	–	–
O	$2.5668e^{-3}$	–	–
H	$2.7745e^{-1}$	–	–
Cl	$1.6926e^{-3}$	–	–

Table 5.39. Calculated leakage and EALCF

Case No.	Leakage	EALCF
8-1	4.1859E–2 ± 3.41E–4	6.5193E–1 ± 2.87E–3
8-2	4.1519E–2 ± 3.99E–4	6.4426E–1 ± 2.85E–3
8-3	4.1763E–2 ± 3.75E–4	6.4187E–1 ± 2.95E–3
8-4	4.0671E–2 ± 3.61E–4	6.3240E–1 ± 2.78E–3
15-1	4.3744E-2 ± 3.50E–4	1.5311E+1 ± 1.23E–1
29-1	6.4240E–2 ± 4.59E–4	4.1401E+1 ± 3.83E–1
29-2	6.4931E–2 ± 4.54E–4	4.0549E+1 ± 3.54E–1
29-3	6.3224E–2 ± 4.11E–4	4.0364E+1 ± 4.04E–1
29-4	6.4923E–2 ± 4.20E–4	3.7593E+1 ± 3.32E–1
29-5	6.3861E–2 ± 4.37E–4	3.8203E+1 ± 3.84E–1
29-6	6.4376E–2 ± 4.18E–4	3.6485E+1 ± 3.40E–1
29-7	6.4333E–2 ± 4.81E–4	3.5344E+1 ± 3.26E–1
29-8	6.4647E–2 ± 4.15E–4	3.4633E+1 ± 3.11E–1
29-9	6.2146E–2 ± 4.51E–4	3.5301E+1 ± 3.15E–1

5.6 PLUTONIUM NITRATE SOLUTIONS WITH LOW ^{240}Pu CONTENT

5.6.1 PU-SOL-THERM-001 Case 1

PU-SOL-THERM-001 Case 1 was a plutonium solution sphere with a stainless steel spherical shell. The shell inside radius was 14.5603 cm, and the outside radius was 14.6848 cm. An effectively infinite water reflector (30-cm thickness) surrounded the sphere. The solution contained 73.0 g/L plutonium, 73.0 g/L plutonium had a specific gravity of 1.130, and had an acid normality of 0.2. The isotopic composition of plutonium (in weight percent) was 0.006 ^{238}Pu, 95.011 ^{239}Pu, 4.668 ^{240}Pu, 0.305 ^{241}Pu, and 0.009 ^{242}Pu. The "true" critical shape was determined to be a truncated sphere with a height of 12.9807 cm above the horizontal centerline of the sphere, which was used for the solution. Table 5.40 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.41 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.42 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.40. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0045 ± 0.0030	8.73921-3 ± 0.0312
238-group ENDF/B-V	1.0076 ± 0.0030	9.48309-3 ± 0.0274

Table 5.41. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.10954-1 ± 1.8-3	3.46178-1 ± 1.8-3	1.00069 ± 1.7-3
^{241}Pu	2.60067-2 ± 5.4-3	8.40748-5 ± 3.0-3	2.62846-4 ± 3.1-3
^{241}Pu	1.83685-3 ± 1.6-3	1.35213-3 ± 1.6-3	3.99418-3 ± 1.6-3
H	4.38866-2 ± 1.6-3	0.0	0.0
O	2.84766-3 ± 1.0-2	0.0	0.0
N	3.98908-3 ± 1.6-3	0.0	0.0

Table 5.42. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.11813-1 ± 1.8-3	3.4687-1 ± 1.7-3	1.0027 ± 1.7-3
^{240}Pu	2.63521-2 ± 1.1-2	8.45187-5 ± 3.1-3	2.64515-4 ± 3.2-3
^{241}Pu	1.84057-3 ± 1.5-3	1.35522-3 ± 1.5-3	4.00334-3 ± 1.5-3
H	4.40732-2 ± 1.5-3	0.0	0.0
O	2.94819-3 ± 1.0-2	0.0	0.0
N	4.01335-3 ± 1.5-3	0.0	0.0

5.6.2 PU-SOL-THERM-002 Case 1

PU-SOL-THERM-002 Case 1 was a plutonium solution sphere with a 347 stainless steel spherical shell. The inside radius was 15.3399 cm, and the outside radius was 15.4669 cm. The sphere was surrounded by an effectively infinite water reflector (30-cm thickness). The reported plutonium composition of the solution included only two plutonium isotopes, ^{239}Pu at 96.88 wt % and ^{240}Pu at 3.12 wt %. The plutonium concentration in the solution was 49.84 g/L plutonium. The NO_3 concentration was reported as 138.5 g/L. An iron impurity with concentration of 0.189 g/L was reported. The solution density was 1131.2 g/L. The water content was calculated as the difference between the solution density and the concentration of plutonium, nitrate ion, iron, and the hydrogen associated with the excess nitric acid. The composition of 347 stainless steel (as weight percent) is Fe, 72.0; Cr, 18; and Ni, 12; with a density of 8.0 g/cm^3. Table 5.43 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.44 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.45 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.43. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0151 ± 0.0028	8.42962-3 ± 0.0298
238-group ENDF/B-V	1.0162 ± 0.0029	8.66045-3 ± 0.0287

Table 5.44. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.13759-1 ± 1.6-3	3.51007-1 ± 1.5-3	1.01471 ± 1.5-3
^{240}Pu	1.55369-2 ± 5.6-3	4.06914-5 ± 3.0-3	1.26988-4 ± 3.1-3
H	6.50047-2 ± 1.4-3	0.0	0.0
O	3.00855-3 ± 1.0-2	0.0	0.0
N	8.92529-3 ± 1.4-3	0.0	0.0

Table 5.45. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.14464-1 ± 1.6-3	3.51581-1 ± 1.5-3	1.01637 ± 1.5-3
^{240}Pu	1.55581-2 ± 1.0-2	4.08277-5 ± 3.0-3	1.27404-4 ± 3.2-3
H	6.51214-2 ± 1.5-3	0.0	0.0
O	3.00485-3 ± 1.1-2	0.0	0.0
N	8.94506-3 ± 1.4-3	0.0	0.0

5.6.3 PU-SOL-THERM-003 Case 1

PU-SOL-THERM-003 Case 1 was a plutonium solution sphere with a 347 stainless steel spherical shell. The inside radius was 16.5156 cm, and the outside radius was 16.6426 cm. The sphere was surrounded by an effectively infinite water reflector (30-cm thickness). The reported plutonium composition of the solution included only two plutonium isotopes, ^{239}Pu at 98.24 wt % and ^{240}Pu at 1.76 wt %. The plutonium concentration in the solution was 33.32 g/L plutonium. The NO_3 density was reported as 86.7g/L with an iron impurity concentration of 0.124 g/L. The solution density was 1085.3 g/L. The water content was calculated as the difference between the solution density and the concentration of plutonium, nitrate ion, iron, and the hydrogen associated with the excess nitric acid. The composition of 347 stainless steel (as weight percent) was Fe, 72.0; Cr, 18; and Ni, 12; with a density of 8.0 g/cm^3. Table 5.46 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.47 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.48 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.46. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0082 ± 0.0027	7.25476-3 ± 0.0314
238-group ENDF/B-V	1.0131 ± 0.0027	7.24546-3 ± 0.0325

Table 5.47. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.07119-1 ± 1.4-3	3.49355-1 ± 1.4-3	1.01002 ± 1.4-3
^{240}Pu	7.28517-3 ± 4.6-3	1.61140-5 ± 3.0-3	5.02223-5 ± 3.1-3
H	1.00031-1 ± 1.3-3	0.0	0.0
O	3.06597-3 ± 1.0-2	0.0	0.0
N	8.11676-3 ± 1.3-3	0.0	0.0

Table 5.48. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.07632-1 ± 1.4-3	3.50202-1 ± 1.3-3	1.0125 ± 1.3-3
^{240}Pu	7.37081-3 ± 9.9-3	1.62040-5 ± 3.0-3	5.05264-5 ± 3.1-3
H	1.00866-1 ± 1.3-3	0.0	0.0
O	3.16175-3 ± 1.0-2	0.0	0.0
N	8.18485-3 ± 1.2-3	0.0	0.0

5.6.4 PU-SOL-THERM-001 Case 6

PU-SOL-THERM-001 Case 6 was a plutonium solution sphere with a stainless steel spherical shell. The inside radius was 14.5603 cm, and the outside radius was 14.6848 cm. The sphere was surrounded by an effectively infinite water reflector (30-cm thickness). The plutonium concentration of the solution was 268.7 Pu g/L, the specific gravity was 1.484, and the acid normality was 1.1. The weight percents of plutonium isotopes relative to the total plutonium content were 0.006 ^{238}Pu, 95.011 ^{239}Pu, 4.668 ^{240}Pu, 0.305 ^{241}Pu and 0.009 ^{242}Pu. "True" critical was determined to be something less than a full sphere. A truncated sphere with a height of 13.0555 cm above the horizontal centerline of the sphere was used in the computational model. Table 5.49 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.50 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.51 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.49. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0092 ± 0.0029	9.14508-3 ± 0.0324
238-group ENDF/B-V	1.0028 ± 0.0030	8.85291-3 ± 0.0293

Table 5.50. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.28267-1 ± 2.5-3	3.46779-1 ± 2.4-3	1.00294 ± 2.4-3
^{240}Pu	4.75938-2 ± 6.0-3	3.05745-4 ± 3.2-3	9.58483-4 ± 3.3-3
^{241}Pu	1.87097-3 ± 2.2-3	1.38112-3 ± 2.2-3	4.08343-3 ± 2.2-3
H	1.00361-2 ± 2.2-3	0.0	0.0
O	3.18044-3 ± 1.0-2	0.0	0.0
N	6.0487-3 ± 2.5-3	0.0	0.0

Table 5.51. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.26342-1 ± 0.2.5-3	3.45365-1 ± 2.4-3	9.98843-1 ± 2.4-3
^{240}Pu	4.8399-2 ± 1.0-2	3.06491-4 ± 3.1-3	9.60155-4 ± 3.2-3
^{241}Pu	1.86463-3 ± 2.2-3	1.37688-3 ± 2.2-3	4.0709-3 ± 2.2-3
H	9.99582-3 ± 2.1-3	0.0	0.0
O	3.12152-3 ± 1.1-3	0.0	0.0
N	6.01623-3 ± 2.5-3	0.0	0.0

5.6.5 PU-SOL-THERM-001 Case 5

PU-SOL-THERM-001 Case 5 was a plutonium solution sphere with a stainless steel spherical shell. The inside radius was 14.5603 cm, and the outside radius was 14.6848 cm. The sphere was surrounded by an effectively infinite water reflector (30-cm thickness). The plutonium concentration in the solution was 140.0 Pu g/L, specific gravity was 1.484, and the acid normality was 1.1. The weight percents of the plutonium isotopes relative to the total plutonium were 0.006 ^{238}Pu, 95.011 ^{239}Pu, 4.668 ^{240}Pu, 0.305 ^{241}Pu, and 0.009 ^{242}Pu. "True" critical was determined to be something less than a full sphere. A truncated sphere with a height of 13.2170 cm above the horizontal centerline of the sphere was modeled. Table 5.52 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.53 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.54 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.52. Calculated system multiplication and leakage

Cross section library	k-effective	Total Leakage
44-group ENDF/B-V	1.0148 ± 0.0028	9.26791-3 ± 0.0272
238-group ENDF/B-V	1.0086 ± 0.0032	9.05917-3 ± 0.0304

Table 5.53. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.2553-1 ± 2.2-3	3.49535-1 ± 2.1-3	1.01038 ± 2.1-3
^{240}Pu	3.63423-2 ± 5.9-3	1.61648-4 ± 3.0-3	5.0604-4 ± 3.2-3
^{241}Pu	1.83159-3 ± 1.9-3	1.34848-3 ± 1.9-3	3.98467-3 ± 1.9-3
H	2.02849-2 ± 1.9-3	0.0	0.0
O	3.06633-3 ± 1.0-2	0.0	0.0
N	7.49524-3 ± 2.0-3	0.0	0.0

Table 5.54. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.21836-1 ± 2.2-3	3.47081-1 ± 2.1-3	1.00331 ± 2.1-3
^{240}Pu	3.62149-2 ± 1.1-2	1.62629-4 ± 3.1-3	5.09258-4 ± 3.2-3
^{241}Pu	1.81987-3 ± 1.9-3	1.34048-3 ± 1.8-3	3.96106-3 ± 1.8-3
H	2.01451-2 ± 1.8-3	0.0	0.0
O	3.10347-3 ± 1.0-2	0.0	0.0
N	7.46134-3 ± 2.0-3	0.0	0.0

5.7 PLUTONIUM NITRATE SOLUTIONS WITH A HIGH ^{240}Pu CONTENT

5.7.1 Gadolinium-Poisoned Plutonium Nitrate Solutions in 24-in.-diam. Water-Reflected Cylinder

5.7.1.1 Detailed description

Overview of experiment

Fifteen plutonium nitrate solution experiments performed at the Pacific Northwest Laboratory in the early 1970s are evaluated in this report. The series of experiments were carried out with measured quantities of gadolinium mixed with plutonium nitrate solution.[20] The experiments were conducted to establish the effect of the soluble neutron absorber gadolinium nitrate on the criticality of plutonium nitrate solutions. All 15 experiments are acceptable for use as benchmarks.

Description of experimental configuration

The plutonium nitrate solution was contained within a 61.028-cm-ID, 105.651-cm-inside-height, 304-L stainless steel vessel having 0.079-cm-thick sides and top and a 0.95-cm-thick bottom. The vessel had a dump valve and line (materials not specified), air vent (dimensions and materials not specified), and Lucite port cover. A stainless steel reflector tank enclosed the vessel and provided at least 20 cm of water reflection on the sides and bottom of the vessel. Details of the two vessels are provided in Fig. 5.4.

The gadolinium nitrate concentration was varied while maintaining the plutonium concentration and the critical solution height was measured. Criticality data are given in Table 5.55. No uncertainties were provided for the critical height, gadolinium concentration, or plutonium concentration measurements.

Description of material data

No information was provided about the gadolinium. Table 5.56 lists specifics of the plutonium nitrate solution. The isotopic makeup of plutonium is found in Table 5.57. Table 5.58 details the assumed composition of the 304-L stainless steel vessel. No material data were provided for the Lucite port cover.

The temperature of the core and reflector are given as 296 K ± 2 K, and room temperature is given as 294 K ± 2 K. No uncertainties were provided for any of the values in Tables 5.56 and 5.57.

Supplemental experimental measurements

None were reported.

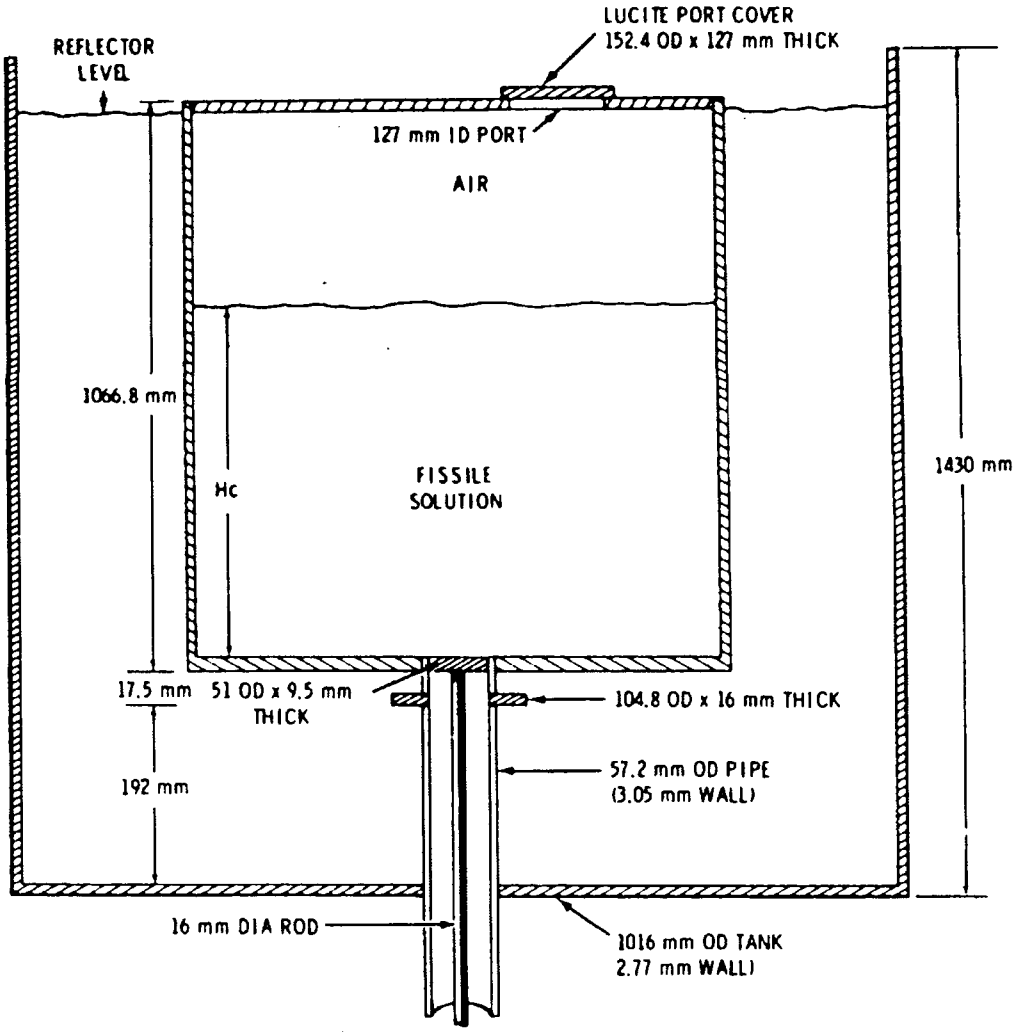


Fig. 5.4. Solution vessel and reflector tank.[21]

Table 5.55. Criticality data for gadolinium-poisoned plutonium solutions

Case	Plutonium (g/L)	Gadolinium (g/L)	Critical height (cm)	Critical volume[a] (L)	Critical mass[a] (kg Pu)
116-1	116	0.00	15.44	45.17	5.240
116-2	116	0.48	20.16	58.98	6.842
116-3	116	0.96	25.98	75.99	8.815
116-4	116	1.42	34.48	100.85	11.698
116-5	116	1.92	48.28	141.24	16.383
116-6	116	2.38	80.37	235.10	27.272
363-1	363	4.40	26.52	77.56	28.192
363-2	363	5.28	28.07	82.08	29.838
363-3	363	6.28	29.62	86.65	31.497
363-4	363	8.21	32.84	96.10	34.932
363-5	363	9.88	36.04	105.40	38.311
363-6	363	12.58	41.02	120.00	43.608
363-7	363	15.55	46.76	136.76	49.714
363-8	363	18.4	53.70	157.05	57.089
363-9	363	20.25	59.36	173.63	63.113

[a]Derived.

Table 5.56. Gadolinium-poisoned plutonium solution specifications

116 g/L plutonium	
Nitric acid normality	1.85 M
Nitrate concentration	238.9 g /L NO_3
Specific gravity	1.2552
363 g/L plutonium	
Nitric acid normality	4.1 M
Nitrate concentration	634.1 g/L NO_3
Specific gravity	1.7010

Table 5.57. Plutonium isotopics

Isotope	wt %
^{238}Pu	0.004
^{239}Pu	90.677
^{240}Pu	8.379
^{241}Pu	0.851
^{242}Pu	0.049

Table 5.58. 304-L Stainless steel[a] composition

Element	wt %
Fe	72.0
Cr	18.0
Ni	10.0

[a]Density of 7.950 g/cm^3.

Evaluation of experimental data

No discussion was available on the method used to measure the critical solution height or any measurable parameters. No measurement uncertainties were offered. The most identifiable weakness is in the measurement of the plutonium concentration, specifically for 116 g/L plutonium. An inferred plutonium density uncertainty of one part in 116 can be assigned that, when applied to cases 116-1 and 116-6, results in Δk_{effs} of 0.0049 and 0.0031, respectively. Similarly, an inferred plutonium density uncertainty of 1 part in 363 can be assigned to cases 363-1 and 363-9, for example, and the resulting Δk_{effs} are 0.0002 and 0.0015, respectively.

The description of the dump valve and line is scant. Presumably, the line was empty during experiments, and the pipe, rod, and valve material is 304-L stainless steel. The air vent dimensions and materials were also missing, as was the reflector tank material. The vent and tank are on the perimeter of the experiment and would have little impact on reactivity; the vent is in the void region exterior to the solution vessel, and the tank is beyond an effectively infinite water reflector.

If the NO_3 concentration is calculated using the plutonium concentration, assuming a valence of 4, and the acid normality, the calculated NO_3 concentration may be significantly higher than the laboratory analysis value reported in Ref. 1. This would, in turn, reduce the calculated water concentration and the calculated k_{eff}. With plutonium nitrate solutions, there is sometimes an uncertainty as to the average valence of the plutonium; therefore, the reported value for the NO_3 concentration is used in this evaluation with the corresponding acid normality derived from

$$\text{Molarity} = 1.61278e^{-2} \text{ mol } NO_3/\text{g } NO_3 \cdot \rho_{NO_3} - 1.673227e^{-2} \rho_{Pu} \cdot 1 \text{ mol } HNO_3/1 \text{ mol } NO_3 \ .$$

For 116 g/L plutonium the derived nitric acid normality is 1.912 M vs the reported 1.85 M. For 363 g/L plutonium, the derived nitric acid normality is 4.153 M vs the reported 4.1 M.

Gadolinium is assumed to be of natural isotopic abundance. From the SCALE Standard Composition Library, the natural gadolinium isotopes and weight percents are as follows: Gd-152 (0.20), ^{154}Gd (2.18), ^{155}Gd (14.80), ^{156}Gd (20.47), ^{157}Gd (15.65), ^{158}Gd (24.84), and ^{160}Gd (21.86).

5.7.1.2 Benchmark specifications

Description of model

The dimensions and materials descriptions of the previous section were modeled rigorously. To simplify the model, the Lucite cover was ignored, and the top of the vessel was treated as a 0.079-cm-thick stainless steel plate. The air vent was ignored, and would have had no effect on k_{eff} because it is far removed neutronically from the fissile solution. The 10.48-cm-O.D. dump line valve was modeled as water. Neutronically, the volume of stainless steel replaced is negligible.

Dimensions

The modeled dimensions of the solution vessel, drain line, water reflector, and reflector tank are presented in Fig. 5.5.

Material data

Solution atom densities are given in Table 5.59. These atom densities are from the SCALE output. The atom densities are calculated from the plutonium density, solution specific gravity, and nitric acid normality. The molarity was derived using the reported nitrate concentration and plutonium density (see previous discussion). The 304-L stainless steel atom densities in Table 5.60 are calculated by SCALE using the provided density and constituent's weight percent (72.0 wt % Fe, 18.0 wt % Cr, and 10.0 wt % Ni). The water atom densities in Table 5.61 are calculated by SCALE at the given temperature. The gadolinium number densities (not given) are calculated by SCALE using the isotopic weight percents specified previously, an effective molecular weight of 157.25 g/mol, and the concentrations in Table 5.55.

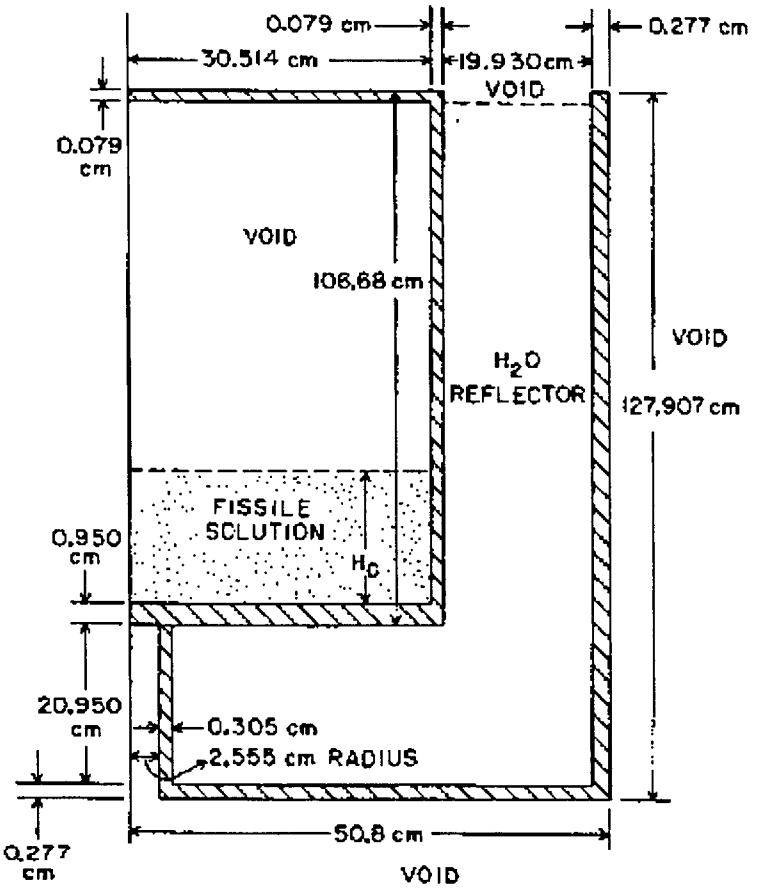


Fig. 5.5. Model dimensions.

Table 5.59. Solution atom densities (atoms/b-cm)

Isotope/element	116 g/L plutonium	363 g/L plutonium
^{238}Pu	$1.1736\ e^{-8}$	$3.6724\ e^{-8}$
^{239}Pu	$2.6504\ e^{-4}$	$8.2940\ e^{-4}$
^{240}Pu	$2.4378\ e^{-5}$	$7.6287\ e^{-5}$
^{241}Pu	$2.4657\ e^{-6}$	$7.7160\ e^{-6}$
^{242}Pu	$1.4138\ e^{-7}$	$4.4243\ e^{-7}$
N	$2.3196\ e^{-3}$	$6.1565\ e^{-3}$
O	$3.7012\ e^{-2}$	$4.1891\ e^{-2}$
H	$6.1257\ e^{-2}$	$4.9344\ e^{-2}$

Table 5.60. 304-L Stainless steel atom densities (atoms/b-cm)

Element	Atom density
Cr	$1.6574\ e^{-2}$
Ni	$8.1578\ e^{-3}$
Fe	$6.1726\ e^{-2}$

Table 5.61. Water atom densities (atoms/b-cm)

Element	Atom density
H	$6.6769\ e^{-2}$
O	$3.3384\ e^{-2}$

Temperature data

The temperature of the core and reflector are given as 296 K ± 2 K, and room temperature is given as 294 K ± 2 K.

Experimental and benchmark-model k_{eff}

The k_{eff} of each experiment is considered to be 1.0000. The uncertainties of the k-effectives of the benchmark models for the solutions of 116 g/L plutonium and 363 g/L plutonium were evaluated for several gadolinium concentration and are presented in Table 5.62. The uncertainty in k_{eff} from the uncertainty in plutonium concentration may be monotonic with increasing gadolinium concentration.

Table 5.62. Benchmark-model k_{eff}

Case	$k_{eff} \pm \sigma$
116-1	1.0000 ± 0.0049
116-6	1.0000 ± 0.0031
363-1	1.0000 ± 0.0002
363-6	1.0000 ± 0.0015

5.7.1.3 Results of calculations

Calculated neutron multiplication factors and associated deviations are shown in Table 5.63 from the Monte Carlo code KENO-V.a. The calculations were performed using the model descriptions provided previously. The set of calculations using the 44-group library have a mean k_{eff} value of 1.0035 ± 0.0040. The set of calculations using the 238-group library have a mean k_{eff} value of 1.0036 ± 0.0047. The statistics are based on the mean k_{eff} values of individual calculations and do not account for uncertainty associated with each calculation.

Reaction rates, R(x), based on 238-group cross-sections, for all materials of the assembly (solution, vessel and tank, reflector), averaged over energy and volume of the assembly, are shown in Table 5.64, where Σ_a/Σ_t is the normalized absorption cross-section, Σ_f/Σ_t is the normalized fission cross-section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.65 lists the leakage from the tank surface per source neutron and the EALCF and associated deviation.

Table 5.63. Calculational results for KENO-V.a

Case No.	44-group ENDF/B-V	238-group ENDF/B-V
116-1	1.0039 ± 0.0021	1.0006 ± 0.0018
116-2	1.0046 ± 0.0016	1.0047 ± 0.0017
116-3	1.0103 ± 0.0019	1.0079 ± 0.0017
116-4	1.0104 ± 0.0014	1.0101 ± 0.0015
116-5	1.0078 ± 0.0016	1.0100 ± 0.0017
116-6	1.0084 ± 0.0013	1.0132 ± 0.0013
363-1	1.0034 ± 0.0017	1.0028 ± 0.0019
363-2	1.0021 ± 0.0015	1.0009 ± 0.0018
363-3	1.0010 ± 0.0015	0.9994 ± 0.0014
363-4	0.9987 ± 0.0015	1.0003 ± 0.0016
363-5	1.0024 ± 0.0015	1.0031 ± 0.0016
363-6	1.0003 ± 0.0016	1.0010 ± 0.0017
363-7	1.0020 ± 0.0015	0.9976 ± 0.0014
363-8	0.9991 ± 0.0017	0.9993 ± 0.0012
363-9	0.9988 ± 0.0014	1.0024 ± 0.0013

Table 5.64. Reaction rates (1/s)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	116-1		
^{238}Pu	$7.3678e^{-6}$	$4.8984e^{-7}$	$1.4761e^{-6}$
^{239}Pu	$5.1333e^{-1}$	$3.4192e^{-1}$	$9.8832e^{-1}$
^{240}Pu	$5.5663e^{-2}$	$2.6435e^{-4}$	$8.2802e^{-4}$
^{241}Pu	$5.2173e^{-3}$	$3.8405e^{-3}$	$1.1348e^{-2}$
^{242}Pu	$8.3075e^{-5}$	$1.1735e^{-6}$	$3.7448e^{-6}$
N	$7.5842e^{-3}$	–	–
O	$4.7722e^{-3}$	–	–
H	$3.1202e^{-1}$	–	–
Cr	$8.2348e^{-3}$	–	–
Fe	$2.5262e^{-2}$	–	–
Ni	$6.0882e^{-3}$	–	–
	116-2		
^{238}Pu	$7.0134e^{-6}$	$5.0342e^{-7}$	$1.5199e^{-6}$
^{239}Pu	$5.2173e^{-1}$	$3.4444e^{-1}$	$9.9545e^{-1}$

Table 5.64. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
^{240}Pu	$6.0494e^{-2}$	$2.8447e^{-4}$	$8.9108e^{-4}$
^{241}Pu	$5.1752e^{-3}$	$3.8075e^{-3}$	$1.1251e^{-2}$
^{242}Pu	$9.0563e^{-5}$	$1.2612e^{-6}$	$4.0256e^{-6}$
N	$7.5689e^{-3}$	–	–
Gd	$6.2122e^{-2}$	–	–
O	$4.8006e^{-3}$	–	–
H	$2.5935e^{-1}$	–	–
Cr	$6.0884e^{-3}$	–	–
Fe	$1.8674e^{-2}$	–	–
Ni	$4.5036e^{-3}$	–	–
116-3			
^{238}Pu	$6.6446e^{-6}$	$5.1118e^{-7}$	$1.5458e^{-6}$
^{239}Pu	$5.2422e^{-1}$	$3.4352e^{-1}$	$9.9266e^{-1}$
^{240}Pu	$6.4716e^{-2}$	$2.9995e^{-4}$	$9.3959e^{-4}$
^{241}Pu	$5.0923e^{-3}$	$3.7436e^{-3}$	$1.1062e^{-2}$
^{242}Pu	$9.9252e^{-5}$	$1.3273e^{-6}$	$4.2375e^{-6}$
N	$7.4907e^{-3}$	–	–
Gd	$1.1235e^{-1}$	–	–
O	$4.8663e^{-3}$	–	–
H	$2.1731e^{-1}$	–	–
Cr	$4.5979e^{-3}$	–	–
Fe	$1.4086e^{-2}$	–	–
Ni	$3.4059e^{-3}$	–	–
116-4			
^{238}Pu	$6.4270e^{-6}$	$5.2098e^{-7}$	$1.5769e^{-6}$
^{239}Pu	$5.3160e^{-1}$	$3.4639e^{-1}$	$1.0008e^{0}$
^{240}Pu	$6.8824e^{-2}$	$3.1326e^{-4}$	$9.8111e^{-4}$
^{241}Pu	$5.0811e^{-3}$	$3.7329e^{-3}$	$1.1031e^{-2}$
^{242}Pu	$1.0701e^{-4}$	$1.3845e^{-6}$	$4.4200e^{-6}$
N	$7.4969e^{-3}$	–	–
Gd	$1.5467e^{-1}$	–	–
O	$4.8946e^{-3}$	–	–
H	$1.8103e^{-1}$	–	–
Cr	$3.1601e^{-3}$	–	–
Fe	$9.6947e^{-3}$	–	–
Ni	$2.3418e^{-3}$	–	–
116-5			
^{238}Pu	$6.1608e^{-6}$	$5.2708e^{-7}$	$1.5976e^{-6}$
^{239}Pu	$2.3133e^{-1}$	$3.4442e^{-1}$	$9.9508e^{-1}$
^{240}Pu	$7.2157e^{-2}$	$3.2595e^{-4}$	$1.0212e^{-3}$
^{241}Pu	$5.0077e^{-3}$	$3.6775e^{-3}$	$1.0868e^{-2}$
^{242}Pu	$1.1149e^{-4}$	$1.4399e^{-6}$	$4.5990e^{-6}$
N	$7.4616e^{-3}$	–	–
Gd	$1.9232e^{-1}$	–	–
O	$4.9688e^{-3}$	–	–
H	$1.5132e^{-1}$	–	–
Cr	$2.1536e^{-3}$	–	–
Fe	$6.5992e^{-3}$	–	–
Ni	$1.5969e^{-3}$	–	–

Table 5.64. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	116-6		
^{238}Pu	$5.9708e^{-6}$	$5.3488e^{-7}$	$1.6230e^{-6}$
^{239}Pu	$5.3451e^{-1}$	$3.4505e^{-1}$	$9.9685e^{-1}$
^{240}Pu	$7.4837e^{-2}$	$3.3814e^{-4}$	$1.0595e^{-3}$
^{241}Pu	$4.9791e^{-3}$	$3.6549e^{-3}$	$1.0802e^{-2}$
^{242}Pu	$1.1455e^{-4}$	$1.4934e^{-6}$	$4.7708e^{-6}$
N	$7.4604e^{-3}$	–	–
Gd	$2.2253e^{-1}$	–	–
O	$5.0009e^{-3}$	–	–
H	$1.2513e^{-1}$	–	–
Cr	$1.1803e^{-3}$	–	–
Fe	$3.6183e^{-3}$	–	–
Ni	$8.7680e^{-4}$	–	–
	363-1		
^{238}Pu	$6.8457e^{-6}$	$1.2950e^{-6}$	$3.9750e^{-6}$
^{239}Pu	$5.3321e^{-1}$	$3.4107e^{-1}$	$9.8724e^{-1}$
^{240}Pu	$9.6794e^{-2}$	$1.0207e^{-3}$	$3.1999e^{-3}$
^{241}Pu	$5.7122e^{-3}$	$4.2375e^{-3}$	$1.2539e^{-2}$
^{242}Pu	$2.8476e^{-4}$	$4.6239e^{-6}$	$1.4733e^{-5}$
N	$1.1312e^{-2}$	–	–
Gd	$7.3381e^{-2}$	–	–
O	$5.6698e^{-3}$	–	–
H	$2.1315e^{-1}$	–	–
Cr	$3.7095e^{-3}$	–	–
Fe	$1.1368e^{-2}$	–	–
Ni	$2.7692e^{-3}$	–	–
	363-2		
^{238}Pu	$6.8178e^{-6}$	$1.3123e^{-6}$	$4.0283e^{-6}$
^{239}Pu	$5.3441e^{-1}$	$3.4138e^{-1}$	$9.8813e^{-1}$
^{240}Pu	$9.8011e^{-2}$	$1.0355e^{-3}$	$3.2459e^{-3}$
^{241}Pu	$5.7201e^{-3}$	$4.2434e^{-3}$	$1.2557e^{-2}$
^{242}Pu	$2.9223e^{-4}$	$4.6913e^{-6}$	$1.4946e^{-5}$
N	$1.1388e^{-2}$	–	–
Gd	$8.2790e^{-2}$	–	–
O	$5.7022e^{-3}$	–	–
H	$2.0508e^{-1}$	–	–
Cr	$3.3537e^{-3}$	–	–
Fe	$1.0261e^{-2}$	–	–
Ni	$2.5004e^{-3}$	–	–
	363-3		
^{238}Pu	$6.7753e^{-6}$	$1.3238e^{-6}$	$4.0635e^{-6}$
^{239}Pu	$5.3363e^{-1}$	$3.4033e^{-1}$	$9.8509e^{-1}$
^{240}Pu	$1.0026e^{-1}$	$1.0454e^{-3}$	$3.2768e^{-3}$
^{241}Pu	$5.7058e^{-3}$	$4.2354e^{-3}$	$1.2534e^{-2}$
^{242}Pu	$2.9417e^{-4}$	$4.7330e^{-6}$	$1.5079e^{-5}$
N	$1.1406e^{-2}$	–	–
Gd	$9.2622e^{-2}$	–	–
O	$5.6984e^{-3}$	–	–
H	$1.9606e^{-1}$	–	–
Cr	$3.1415e^{-3}$	–	–

Table 5.64. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
Fe	$9.6259e^{-3}$	–	–
Ni	$2.3441e^{-3}$	–	–
	363-4		
^{238}Pu	$6.6723e^{-6}$	$1.3424e^{-6}$	$4.1212e^{-6}$
^{239}Pu	$5.3344e^{-1}$	$3.3936e^{-1}$	$9.8228e^{-1}$
^{240}Pu	$1.0224e^{-1}$	$1.0634e^{-3}$	$3.3330e^{-3}$
^{241}Pu	$5.6851e^{-3}$	$4.2192e^{-3}$	$1.2486e^{-2}$
^{242}Pu	$3.0153e^{-4}$	$4.8125e^{-6}$	$1.5332e^{-5}$
N	$1.1503e^{-2}$	–	–
Gd	$1.0821e^{-1}$	–	–
O	$5.6859e^{-3}$	–	–
H	$1.8403e^{-1}$	–	–
Cr	$2.7984e^{-3}$	–	–
Fe	$8.5632e^{-3}$	–	–
Ni	$2.0865e^{-3}$	–	–
	363-5		
^{238}Pu	$6.6412e^{-6}$	$1.3629e^{-6}$	$4.1852e^{-6}$
^{239}Pu	$5.3461e^{-1}$	$3.3951e^{-1}$	$9.8276e^{-1}$
^{240}Pu	$1.0310e^{-1}$	$1.0811e^{-3}$	$3.3892e^{-3}$
^{241}Pu	5.6987^{-3}	$4.2286e^{-3}$	$1.2515e^{-2}$
^{242}Pu	$3.1170e^{-4}$	$4.8932e^{-6}$	$1.5593e^{-5}$
N	$1.1626e^{-2}$	–	–
Gd	$1.1991e^{-1}$	–	–
O	$5.7707e^{-3}$	–	–
H	$1.7189e^{-1}$	–	–
Cr	$2.4295e^{-3}$	–	–
Fe	$7.4376e^{-3}$	–	–
Ni	$1.8127e^{-3}$	–	–
	363-6		
^{238}Pu	$6.5482e^{-6}$	$1.3837e^{-6}$	$4.2500e^{-6}$
^{239}Pu	$5.3568e^{-1}$	$3.3947e^{-1}$	$9.8264e^{-1}$
^{240}Pu	$1.0582e^{-1}$	$1.1008e^{-3}$	$3.4514e^{-3}$
^{241}Pu	$5.6958e^{-3}$	$4.2257e^{-3}$	$1.2506e^{-2}$
^{242}Pu	$3.1612e^{-4}$	$4.9801e^{-6}$	1.5873^{-5}
N	$1.1729e^{-2}$	–	–
Gd	$1.3609e^{-1}$	–	–
O	$5.8614e^{-3}$	–	–
H	$1.5861e^{-1}$	–	–
Cr	$2.0438e^{-3}$	–	–
Fe	$6.2522e^{-3}$	–	–
Ni	$1.5246e^{-3}$	–	–
	363-7		
^{238}Pu	$6.5396e^{-6}$	$1.4110e^{-6}$	$4.3345e^{-6}$
^{239}Pu	$5.3759e^{-1}$	$3.3990e^{-1}$	$9.8391e^{-1}$
^{240}Pu	$1.0836e^{-1}$	$1.1256e^{-3}$	$3.5291e^{-3}$
^{241}Pu	$5.7132e^{-3}$	$4.2388e^{-3}$	$1.2546e^{-2}$
^{242}Pu	$3.1736e^{-4}$	$5.0895e^{-6}$	$1.6223e^{-5}$
N	$1.1868e^{-2}$	–	–
Gd	$1.5120e^{-1}$	–	–
O	$5.8682e^{-3}$	–	–

Table 5.64. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
H	$1.4441e^{-1}$	–	–
Cr	$1.6723e^{-3}$	–	–
Fe	$5.1195e^{-3}$	–	–
Ni	$1.2518e^{-3}$	–	–
	363-8		
^{238}Pu	$6.4838e^{-6}$	$1.4256e^{-6}$	$4.3801e^{-6}$
^{239}Pu	$5.3656e^{-1}$	$3.3887e^{-1}$	$9.8096e^{-1}$
^{240}Pu	$1.1025e^{-1}$	$1.1387e^{-3}$	$3.5707e^{-3}$
^{241}Pu	$5.6981e^{-3}$	$4.2284e^{-3}$	$1.2515e^{-2}$
^{242}Pu	$3.2330e^{-4}$	$5.1493e^{-6}$	$1.6416e^{-5}$
N	$1.1947e^{-2}$	–	–
Gd	$1.6241e^{-1}$	–	–
O	$5.9329e^{-3}$	–	–
H	$1.3408e^{-1}$		–
Cr	$1.4536e^{-3}$	–	–
Fe	$4.4469e^{-3}$	–	–
Ni	$1.0873e^{-3}$	–	–
	363-9		
^{238}Pu	$6.4761e^{-6}$	$1.4400e^{-6}$	$4.4241e^{-6}$
^{239}Pu	$5.3928e^{-1}$	$3.4007e^{-1}$	$9.8443e^{-1}$
^{240}Pu	$1.1046e^{-1}$	$1.1491e^{-3}$	$3.6028e^{-3}$
^{241}Pu	$5.7072e^{-3}$	$4.2349e^{-3}$	$1.2535e^{-2}$
^{242}Pu	$3.3148e^{-4}$	$5.1976e^{-6}$	$1.6567e^{-5}$
N	$1.1988e^{-2}$	–	–
Gd	$1.6945e^{-1}$	–	–
O	$5.9236e^{-3}$	–	–
H	$1.2753e^{-1}$	–	–
Cr	$1.2279e^{-3}$	–	–
Fe	$3.7658e^{-3}$	–	–
Ni	$9.1982e^{-4}$	–	–

Table 5.65. Leakage and EALCF for gadolinium-poisoned solution experiments

Case No.	Leakage	EALCF
116-1	$6.2220e^{-2} \pm 4.65e^{-4}$	$6.2220e^{-2} \pm 4.65e^{-4}$
116-2	$5.0222e^{-2} \pm 4.07e^{-4}$	$5.0222e^{-2} \pm 4.07e^{-4}$
116-3	$4.0606e^{-2} \pm 3.89e^{-4}$	$4.0606e^{-2} \pm 3.89e^{-4}$
116-4	$3.1973e^{-2} \pm 3.58e^{-4}$	$3.1973e^{-2} \pm 3.58e^{-4}$
116-5	$2.4602e^{-2} \pm 2.87e^{-4}$	$2.4602e^{-2} \pm 2.87e^{-4}$
116-6	$1.9525e^{-2} \pm 2.87e^{-4}$	$1.9425e^{-2} \pm 2.87e^{-4}$
363-1	$1.4412 \pm 4.45e^{-3}$	$4.2415e^{-2} \pm 3.65e^{-4}$
363-2	$1.5332 \pm 4.42e^{-3}$	$4.0898e^{-2} \pm 3.56e^{-5}$
363-3	$1.6316 \pm 4.68e^{-3}$	$3.9386e^{-2} \pm 3.81e^{-4}$
363-4	$1.7771 \pm 5.11e^{-3}$	$3.5610e^{-2} \pm 3.36e^{-4}$
363-5	$1.9121 \pm 5.03e^{-3}$	$3.2896e^{-2} \pm 3.55e^{-4}$
363-6	$2.0826 \pm 5.78e^{-3}$	$2.9933e^{-2} \pm 3.58e^{-4}$
363-7	$2.2538 \pm 5.93e^{-3}$	$2.7342e^{-2} \pm 3.12e^{-4}$
363-8	$2.3918 \pm 6.59e^{-3}$	$2.5056e^{-2} \pm 3.09e^{-4}$
383-9	$2.4725 \pm 6.57e^{-3}$	$2.3967e^{-2} \pm 3.16e^{-4}$

5.7.2 Unreflected Plutonium Nitrate Solution Cylinders of 13.4- and 17.9-in. Diameters

5.7.2.1 Detailed description

Overview of the experiment

No detailed description of the experiments was provided in Refs. 22 and 23. The experiments consisted of 4.88 and 13.74 wt % ^{240}Pu plutonium nitrate solutions. The plutonium was dissolved in excess aqueous nitric acid and believed to be in the tetravalent form, except for solutions containing greater than 150 g/L plutonium where up to 25% of the solution may have been in the hexavalent form. Twenty-six experiments were evaluated; four are thought to contain erroneous data, and the remaining twenty-two experiments are judged to be unacceptable as criticality safety benchmark experiments until additional experimental data can be obtained.

Description of experimental configuration

The dimensions of the 304-L stainless steel solution vessel are provided in Fig. 5.6. All dimensions are in inches. Two solution cylinders were used in the experiments, one of 13.4-in.-ID and one of 17.9-in.-ID The method used to determine the critical condition was not given, and neither were uncertainties in measurements. The delayed critical heights are reported in Table 5.66, along with solution specifications, for combinations of plutonium enrichment and cylinder diameter.

Description of material data

Solution specifications are given in Table 5.66. The 304-L stainless steel constituents are given in Table 5.67 by weight percent.

Evaluation of experimental data

The method of measurement was not specified. Therefore, experimental parameter identification is impossible. Presumably, the specific gravity and plutonium concentration of the solutions were measured along with the critical heights of the solutions. Uncertainties in the measurement of any of these parameters were not discussed. It is unclear whether the solutions contained any ^{238}Pu, ^{241}Pu, ^{242}Pu, or Am, and if so, whether these nuclides were accounted for in the reported ^{240}Pu values. The state of the solutions was noted in Ref. 22 where it is stated that solutions containing greater than 150 g/L plutonium may have up to 25% of the plutonium in the hexavalent state. It is unclear whether the derived total nitrate ion concentration accounts for the plutonium states. The precision of several reported plutonium concentrations is of concern. For example, case 14-18_9 has a reported plutonium concentration of 22 g/L. An inferred uncertainty of 1 part in 22 may be applied, resulting in a calculational difference in k_{eff} of 0.0083.

Several weaknesses in published data are geometry related. No details of the experiment outside the reactor vessel are given. These data are relevant to the room return of neutrons to the reactor vessel. It is unclear whether a correction has been made to the solution critical height for the feed pipe, probe tube, or nonuniformity in reactor vessel wall thickness. The solution heights of cases 5-18_2 through 5-18_5 have been evaluated and determined to not correspond to the solution specifications reported in Ref. 22. By KENO-V.a searches, critical heights of cases 5-18_2 through 5_18-5 solutions were found to be approximately 25, 29, 36, and 47 cm, respectively.

The acid normality was calculated (Table 5.66) from the plutonium concentration, assuming a valence of 4, and the derived NO_3 concentration to be

$$\text{Normality} = \{\text{Nitrate [mol } NO_3/L] - 1.67231(10^{-2}) \text{ [mol } NO_3/\text{g Pu]} \cdot \rho_{Pu} \text{ [g /L plutonium]}\} \cdot 1 \text{ mol } HNO_3/1 \text{ mol } NO_3 \ .$$

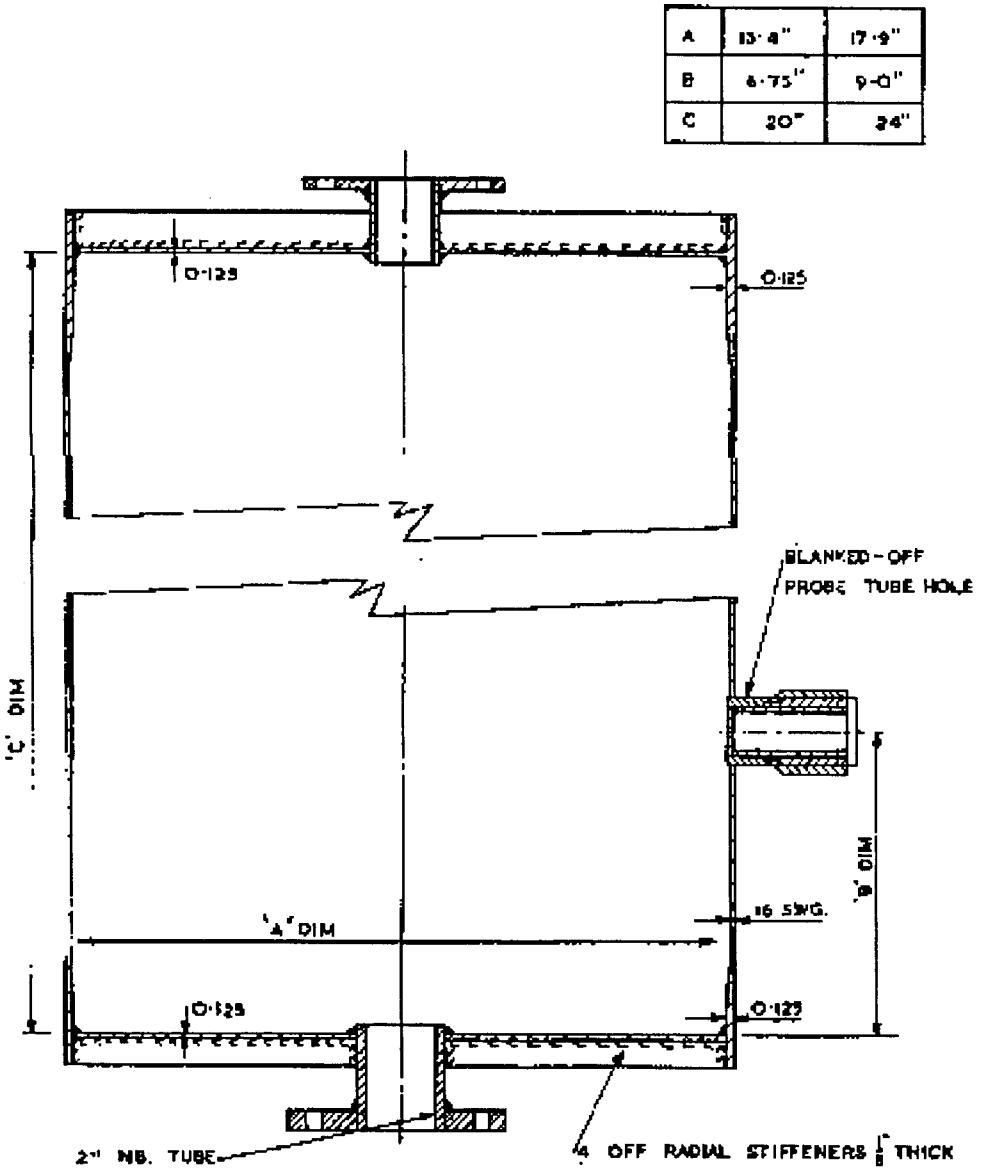


Fig. 5.6. Solution vessel.

Table 5.66. Solution specifications

Case	Specific gravity	Plutonium (g/L)	Nitrate[a] (g-mol/L)	Acid (N)[b]	H/Pu	Diameter (cm)	Height (cm)
			4.88 wt % ^{240}Pu				
5-13_1	1.415	226	5.22	1.4392	106	34.036	31.25
5-13_2	1.317	165	4.02	1.2597	151	34.036	28.9
5-13_3	1.253	133	3.25	1.0250	189	34.036	28.1
5-13_4	1.182	91.4	2.37	0.8409	280	34.036	28.0
5-13_5	1.153	73.5	2.01	0.7804	351	34.036	28.7
5-13_6	1.125	60.4	1.61	0.5996	429	34.036	30.2
5-13_7	1.090	43.3	1.21	0.4856	602	34.036	34.9
5-18_1	1.104	50.7	1.40	0.5518	514	45.466	21.95
5-18_2	1.078	35.1	1.05	0.4628	746	45.466	24.4[c]
5-18_3	1.061	26.9	0.86	0.4100	975	45.466	27.65[c]
5-18_4	1.048	21.0	0.74	0.3887	1219	45.466	34.05[c]
5-18_5	1.044	17.5	0.68	0.3872	1396	45.466	41.25[c]
			13.74 wt % ^{240}Pu				
14-13_1	1.284	163	3.32	0.5941	134	34.036	41.83
14-13_2	1.204	114	2.45	0.5436	197	34.036	37.95
14-13_3	1.156	80.2	1.87	0.5288	286	34.036	38.26
14-13_4	1.132	65.6	1.60	0.5030	352	34.036	40.25
14-13_5	1.120	58.6	1.48	0.5000	395	34.036	42.02
14-18_1	1.392	215.5	5.03	1.4262	95.9	45.466	27.3
14-18_2	1.323	174.5	4.17	1.2518	124	45.466	25.84[d]
14-18_3	1.250	135	3.3	1.0424	161	45.466	24.86
14-18_4	1.195	102.5	2.59	0.8759	218	45.466	24.3
14-18_5	1.141	73.0	1.92	0.6992	310	45.466	24.54
14-18_6	1.098	53.5	1.48	0.5853	425	45.466	25.85
14-18_7	1.090	43.6	1.27	0.5409	517	45.466	27.7
14-18_8	1.065	28.5	1.03	0.5534	811	45.466	36.4
14-18_9	1.053	22	0.85	0.4821	1061	45.466	52.0

[a]Analytical results amended to give a reasonable fit with history of solution preparation.
[b]Normality = {nitrate [mol NO_3/L] – 1.67231e^{-2} [mol NO_3/g Pu] · ρ_{Pu} [g/L Pu]) · 1 mol HNO_3/L mol NO_3.
[c]Evaluated to be erroneous data.
[d]Typographical error, reported as 35.84 cm.

Table 5.67. 304-L stainless steel[a]

Element	wt %
Fe	74.0
Cr	18.0
Ni	8.0

[a]7.930 g/cm^3.

Because of the dependence on an inferred quantity, total nitrate, the solution is under specified because the H/Pu ratio is also inferred. The solution has an uncertainty as to the average valence of the plutonium that complicates the determination of the acid normality. The derived H/Pu ratios based on acid normality values of Table 5.66 are listed in Table 5.68 along with the percent change of H/Pu over the reference values of Table 5.66. A discrepancy exists in the H/Pu reported between Ref. 22 and Ref. 23 for case 14-18_8, which indicates that the H/Pu ratios reported in Table 5.66 may be in error. Acid normalities

based on the H/Pu ratio from Table 5.66 were found to be inconsistent with reported values, and the inconsistencies are unacceptably large. Furthermore, the total nitrate ion concentration is recommended for the calculation of acid normality.

At this point, the evaluation should be terminated until missing data, weaknesses, and concerns presented in this section can be addressed. As an illustration of modeling techniques and calculation of experiments, the evaluation will be completed with available data.

5.7.2.2 Benchmark specifications

Description of model

The solution vessel was treated as a right cylinder with uniform wall thickness. The feed tube and probe tube were ignored. The 16 standard wire gage (S.W.G.) wall is modeled as 0.064-in-thick. Code input parameters for the plutonium nitrate solution included plutonium density, specific gravity, and derived acid normality.

Table 5.68. Derived H/Pu ratio

Case No.	H/Pu	% Δ (H/Pu)[a]
5-13_1	103	−2.8
5-13_2	147	−2.6
5-13_3	185	−2.1
5-13_4	276	−1.4
5-13_5	347	−1.1
5-13_6	426	−0.7
5-13_7	598	−0.7
5-18_1	509	−1.0
14-13_1	150	11.9
14-13_2	220	11.7
14-13_3	319	8.0
14-13_4	393	11.6
14-13_5	441	11.4
14-18_1	108	12.6
14-18_2	137	10.4
14-18_3	181	12.4
14-18_4	243	11.4
14-18_5	347	11.9
14-18_6	475	11.8
14-18_7	592	14.5
14-18_8	911	12.3, 0.1[b]
14-18_9	1186	11.8

[a]Note $\% \Delta(\text{H/Pu}) = \frac{\text{reported} - \text{derived}}{\text{reported}}$.

[b]Based on H/Pu ratio of Ref. 23.

Dimensions

The 304-L stainless steel solution vessel was modeled as a 13.4 in. (34.036 cm) or 17.9 in. (45.466 cm) inside diameter right cylinder of 20 in. (50.80 cm) or 24 in. (60.96 cm) height with uniform side thickness of 0.064 in. (0.1626 cm) and uniform top and bottom thicknesses of 0.125 in. (0.3175 cm). Solution heights of Table 5.66 were used in the models.

Material data

The 304-L stainless steel number densities are given in Table 5.69. Number densities for the plutonium nitrate solutions of Table 5.66 are listed in Table 5.70. Number densities of Table 5.69 and 5.70 were generated by the Materials Information Processor and Standard Composition Library of SCALE from the input specifications taken from Tables 5.66 and 5.67.

Table 5.69. The 304-L stainless steel number densities

Element	Number density (atoms/b-cm)
Fe	$6.3281e^{-2}$
Cr	$1.6532e^{-2}$
Ni	$6.5099e^{-3}$

Temperature data

No temperature data is provided, so room temperature (293 K) is assumed.

Results of sample calculations

Calculated neutron multiplication factors and associated deviations are shown in Table 5.71 from the Monte Carlo code KENO-V.a. The calculations were performed using the model descriptions provided previously. The set of calculations using the 44-group library have a mean k_{eff} value of 1.0028 ± 0.0057. The set of calculations using the 238-group library have a mean k_{eff} value of 1.0014 ± 0.0062. The statistics are based on the mean k_{eff} values of individual calculations and do not account for uncertainty associated with each calculation.

Table 5.70. Solution number densities (atoms/b-cm)

Case	^{239}Pu	^{240}Pu	N	O	H
5-13_1	$5.4154e^{-4}$	$2.7668e^{-5}$	$3.1436e^{-3}$	$3.8328e^{-2}$	$5.8662e^{-2}$
5-13_2	$3.9538e^{-4}$	$2.0200\ e^{-5}$	$2.4209e^{-3}$	$3.7416e^{-2}$	$6.1066e^{-2}$
5-13_3	$3.1870e^{-4}$	$1.6282e^{-5}$	$1.9572e^{-3}$	$3.6559e^{-2}$	$6.1992e^{-2}$
5-13_4	$2.1902e^{-4}$	$1.1189e^{-5}$	$1.4272e^{-3}$	$3.5816e^{-2}$	$6.3574e^{-2}$
5-13_5	$1.7612e^{-4}$	$8.9981e^{-6}$	$1.2104e^{-3}$	$3.5543e^{-2}$	$6.4292e^{-2}$
5-13_6	$1.4473e^{-4}$	$7.3934e^{-6}$	$9.6959e^{-4}$	$3.5157e^{-2}$	$6.4857e^{-2}$
5-13_7	$1.0376e^{-4}$	$5.3009e^{-6}$	$7.2867e^{-4}$	$3.4668e^{-2}$	$6.5257e^{-2}$
5-18_1	$1.2149e^{-4}$	$6.2068e^{-6}$	$8.4309e^{-4}$	$3.4836e^{-2}$	$6.4946e^{-2}$
14-13_1	$3.5421e^{-4}$	$5.6184e^{-5}$	$1.9993e^{-3}$	$3.6588e^{-2}$	$6.1538e^{-2}$
14-13_2	$2.4773e^{-4}$	$3.9294e^{-5}$	$1.4754e^{-3}$	$3.5784e^{-2}$	$6.3044e^{-2}$

Table 5.70. (continued)

Case	^{239}Pu	^{240}Pu	N	O	H
14-13_3	$1.7428e^{-4}$	$2.7644e^{-5}$	$1.1261e^{-3}$	$3.5464e^{-2}$	$6.4490e^{-2}$
14-13_4	$1.4255e^{-4}$	$2.2612e^{-5}$	$9.6356e^{-4}$	$3.5223e^{-2}$	$6.4967e^{-2}$
14-13_5	$1.2734e^{-4}$	$2.0199e^{-5}$	$8.9126e^{-4}$	$3.5088e^{-2}$	$6.5129e^{-2}$
14-18_1	$4.6829e^{-4}$	$7.4281e^{-5}$	$3.0292e^{-3}$	$3.7961e^{-2}$	$5.8607e^{-2}$
14-18_2	$3.7919e^{-4}$	$6.0148e^{-5}$	$2.5112e^{-3}$	$3.7260e^{-2}$	$6.0206e^{-2}$
14-18_3	$2.9336e^{-4}$	$4.6533e^{-5}$	$1.9873e^{-3}$	$3.6378e^{-2}$	$6.1459e^{-2}$
14-18_4	$2.2274e^{-4}$	$3.5331e^{-5}$	$1.5598e^{-3}$	$3.5820e^{-2}$	$6.2808e^{-2}$
14-18_5	$1.5863e^{-4}$	$2.5162e^{-5}$	$1.1562e^{-3}$	$3.5184e^{-2}$	$6.3853e^{-2}$
14-18_6	$1.1626e^{-4}$	$1.8441e^{-5}$	$8.9127e^{-4}$	$3.4520e^{-2}$	$6.4044e^{-2}$
14-18_7	$9.4744e^{-5}$	$1.5029e^{-5}$	$7.6483e^{-4}$	$3.4641e^{-2}$	$6.5018e^{-2}$
14-18_8	$6.1932e^{-5}$	$9.8237e^{-6}$	$6.2029e^{-4}$	$3.4373e^{-2}$	$6.5357e^{-2}$
14-18_9	$4.7807e^{-5}$	$7.5832e^{-6}$	$5.1189e^{-4}$	$3.4239e^{-2}$	$6.5697e^{-2}$

Table 5.71. Calculational multiplication factors using KENO-V.a for unreflected cylinders on plutonium nitrate

Case No.	44-group ENDF/B-V	238-group ENDF/B-V
5-13_1	1.0088 ± 0.0025	1.0082 ± 0.0021
5-13_2	1.0069 ± 0.0024	1.0040 ± 0.0023
5-13_3	0.9990 ± 0.0019	1.0008 ± 0.0021
5-13_4	1.0029 ± 0.0022	1.0035 ± 0.0022
5-13_5	1.0052 ± 0.0023	1.0060 ± 0.0020
5-13_6	1.0128 ± 0.0020	1.0090 ± 0.0022
5-13_7	1.0078 ± 0.0020	1.0036 ± 0.0019
5-18_1	0.9931 ± 0.0020	0.9961 ± 0.0021
14-13_1	1.0071 ± 0.0019	1.0062 ± 0.0022
14-13_2	1.0042 ± 0.0019	0.9994 ± 0.0021
14-13_3	1.0085 ± 0.0019	1.0071 ± 0.0022
14-13_4	1.0086 ± 0.0018	1.0079 ± 0.0020
14-13_5	1.0066 ± 0.0019	1.0116 ± 0.0020
14-18_1	1.0006 ± 0.0019	0.9976 ± 0.0018
14-18_2	0.9993 ± 0.0021	0.9961 ± 0.0023
14-18_3	0.9977 ± 0.0021	0.9947 ± 0.0021
14-18_4	0.9954 ± 0.0022	0.9926 ± 0.0022
14-18_5	0.9961 ± 0.0022	0.9957 ± 0.0020
14-18_6	0.9909 ± 0.0021	0.9872 ± 0.0020
14-18_7	1.0013 ± 0.0019	0.9979 ± 0.0021
14-18_8	1.0041 ± 0.0019	1.0008 ± 0.0019
14-18_9	1.0050 ± 0.0020	1.0058 ± 0.0017

Reaction rates, R(x), based on 238-group cross sections, for all materials of the assembly (solution and vessel), averaged over energy and volume of the assembly, are shown in Table 5.72, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.73 lists the leakage from the vessel surface per source neutron and the EALCF and associated deviation.

Table 5.72. Reaction rates (1/s) for unreflected plutonium nitrate cylinders

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
		5-13_1	
^{239}Pu	$5.3554e^{-1}$	$3.4803e^{-1}$	$1.0064e^{0}$
^{240}Pu	$5.3347e^{-2}$	$3.3082e^{-4}$	$1.0374e^{-3}$
N	$6.6314e^{-3}$	–	–
O	$3.8815e^{-3}$	–	–
H	$1.1356e^{-2}$	–	–
Cr	$1.6140e^{-4}$	–	–
Fe	$5.0459e^{-4}$	–	–
Ni	$1.2642e^{-4}$	–	–
		5-13_2	
^{239}Pu	$5.3021e^{-1}$	$3.4741e^{-1}$	$1.0043e^{0}$
^{240}Pu	$4.6425e^{-2}$	$2.3465e^{-4}$	$7.3550e^{-4}$
N	$6.0512e^{-3}$	–	–
O	$3.6858e^{-3}$	–	–
H	$1.6344e^{-2}$	–	–
Cr	$2.0692e^{-4}$	–	–
Fe	$6.4119e^{-4}$	–	–
Ni	$1.5343e^{-4}$	–	–
		5-13_3	
^{239}Pu	$5.2504e^{-1}$	$3.4635e^{-1}$	$1.0011e^{0}$
^{240}Pu	$4.0867e^{-2}$	$1.8824e^{-4}$	$5.8991e^{-4}$
N	$5.6476e^{-3}$	–	–
O	$3.5927e^{-3}$	–	–
H	$2.0870e^{-2}$	–	–
Cr	$2.4707e^{-4}$	–	–
Fe	$7.6671e^{-4}$	–	–
Ni	$1.7719e^{-4}$	–	–
		5-13_4	
^{239}Pu	$5.1925e^{-1}$	$3.4692e^{-1}$	$1.0027e^{0}$
^{240}Pu	$3.4241e^{-2}$	$1.2965e^{-4}$	$4.0601e^{-4}$
N	$5.5362e^{-3}$	–	–
O	$3.5220e^{-3}$	–	–
H	$3.2524e^{-2}$	–	–
Cr	$3.2252e^{-4}$	–	–
Fe	$1.0041e^{-3}$	–	–
Ni	$2.2005e^{-4}$	–	–
		5-13_5	
^{239}Pu	$5.1668e^{-1}$	$3.4774e^{-1}$	$1.0052e^{0}$
^{240}Pu	$3.0384e^{-2}$	$1.0415e^{-4}$	$3.2596e^{-4}$
N	$5.6763e^{-3}$	–	–
O	$3.4748e^{-3}$	–	–
H	$4.2121e^{-2}$	–	–
Cr	$3.7377e^{-4}$	–	–
Fe	$1.1725e^{-3}$	–	–
Ni	$2.4827e^{-4}$	–	–
		5-13_6	
^{239}Pu	$5.1542e^{-1}$	$3.4903e^{-1}$	$1.0089e^{0}$
^{240}Pu	$2.7868e^{-2}$	$8.6511e^{-5}$	$2.7056e^{-4}$
N	$5.4599e^{-3}$	–	–

Table 5.72. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
O	$3.4491e^{-3}$	–	–
H	$5.3095e^{-2}$	–	–
Cr	$4.1720e^{-4}$	–	–
Fe	$1.3097e^{-3}$	–	–
Ni	$2.7283e^{-4}$	–	–
	5-13_7		
^{239}Pu	$5.0748e^{-1}$	$3.4698e^{-1}$	$1.0031e^{0}$
^{240}Pu	$2.3076e^{-2}$	$6.3725e^{-5}$	$1.9914e^{-4}$
N	$5.6039e^{-3}$	–	–
O	$3.4892e^{-3}$	–	–
H	$7.6828e^{-2}$	–	–
Cr	$4.9373e^{-4}$	–	–
Fe	$1.5512e^{-3}$	–	–
Ni	$3.1491e^{-4}$	–	–
	5-18_1		
^{239}Pu	$5.0660e^{-1}$	$3.4473e^{-1}$	$9.9653e^{-1}$
^{240}Pu	$2.5204e^{-2}$	$7.3581e^{-5}$	$2.3013e^{-4}$
N	$5.5338e^{-3}$	–	–
O	$3.5002e^{-3}$	–	–
H	$6.3705e^{-2}$	–	–
Cr	$5.3987e^{-4}$	–	–
Fe	$1.6937e^{-3}$	–	–
Ni	$3.4793e^{-4}$	–	–
	14-18_1		
^{239}Pu	$5.2867e^{-1}$	$3.4413e^{-1}$	$9.9502e^{-1}$
^{240}Pu	$1.0609e^{-1}$	$9.1971e^{-4}$	$2.8873e^{-3}$
N	$7.0062e^{-3}$	–	–
O	$4.0341e^{-3}$	–	–
H	$1.2950e^{-2}$	–	–
Cr	$1.6300e^{-4}$	–	–
Fe	$5.0412e^{-4}$	–	–
Ni	$1.2511e^{-4}$	–	–
	14-18_2		
^{239}Pu	$5.2477e^{-1}$	$3.4372e^{-1}$	$9.9366e^{-1}$
^{240}Pu	$9.8274e^{-2}$	$7.3004e^{-4}$	$2.2921e^{-3}$
N	$6.5351e^{-3}$	–	–
O	$3.9389e^{-3}$	–	–
H	$1.6600e^{-2}$	–	–
Cr	$1.9393e^{-4}$	–	–
Fe	$6.0441e^{-4}$	–	–
Ni	$1.4545e^{-4}$	–	–
	14-18_3		
^{239}Pu	$5.2035e^{-1}$	$3.4357e^{-1}$	$9.9309e^{-1}$
^{240}Pu	$8.9675e^{-2}$	$5.5863e^{-4}$	$1.7526e^{-3}$
N	$6.1339e^{-3}$	–	–
O	$3.7652e^{-3}$	–	–
H	$2.2357e^{-2}$	–	–
Cr	$2.3697e^{-4}$	–	–

Table 5.72. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
Fe	$7.4176e^{-4}$	–	–
Ni	$1.7078e^{-4}$	–	–
		14-18_4	
^{239}Pu	$5.1431e^{-1}$	$3.4293e^{-1}$	$9.9122e^{-1}$
^{240}Pu	$7.9530e^{-2}$	$4.2151e^{-4}$	$1.3223e^{-3}$
N	$5.9644e^{-3}$	–	–
O	$3.7200e^{-3}$	–	–
H	$3.1028e^{-2}$	–	–
Cr	$3.0355e^{-4}$	–	–
Fe	$9.5088e^{-4}$	–	–
Ni	$2.0936e^{-4}$	–	–
		14-18_5	
^{239}Pu	$5.1009e^{-1}$	$3.4388e^{-1}$	$9.9400e^{-1}$
^{240}Pu	$7.0399e^{-2}$	$3.0051e^{-4}$	$9.4210e^{-4}$
N	$5.9271e^{-3}$	–	–
O	$3.6504e^{-3}$	–	–
H	$4.6206e^{-2}$	–	–
Cr	$3.8341e^{-4}$	–	–
Fe	$1.2008e^{-3}$	–	–
Ni	$2.5547e^{-4}$	–	–
		14-18_6	
^{239}Pu	$5.0106e^{-1}$	$3.4107e^{-1}$	$9.8596e^{-1}$
^{240}Pu	$6.2608e^{-2}$	$2.2481e^{-4}$	$7.0415e^{-4}$
N	$6.0657e^{-3}$	–	–
O	$3.6389e^{-3}$	–	–
H	$6.5055e^{-2}$	–	–
Cr	$4.6957e^{-4}$	–	–
Fe	$1.4679e^{-3}$	–	–
Ni	$3.0376e^{-4}$	–	–
		14-18_7	
^{239}Pu	$5.0332e^{-1}$	$3.4460e^{-1}$	$9.9622e^{-1}$
^{240}Pu	$5.8412e^{-2}$	$1.8481e^{-4}$	$5.7815e^{-4}$
N	$6.3897e^{-3}$	–	–
O	$3.6140e^{-3}$	–	–
H	$8.3695e^{-2}$	–	–
Cr	$5.0784e^{-4}$	–	–
Fe	$1.5961e^{-3}$	–	–
Ni	$3.2370e^{-4}$	–	–
		14-18_8	
^{239}Pu	$4.9993e^{-1}$	$3.4582e^{-1}$	$9.9989e^{-1}$
^{240}Pu	$5.0828e^{-2}$	$1.2755e^{-4}$	$3.9840e^{-4}$
N	$7.9202e^{-3}$	–	–
O	$3.7692e^{-3}$	–	–
H	$1.3429e^{-1}$	–	–
Cr	$5.5473e^{-4}$	–	–
Fe	$1.7458e^{-3}$	–	–
Ni	$3.4526e^{-4}$	–	–

Table 5.72. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	14-18_9		
^{239}Pu	$4.9984e^{-1}$	$3.4762e^{-1}$	$1.0052e^{0}$
^{240}Pu	$4.7472e^{-2}$	$1.0269e^{-4}$	$3.2038e^{-4}$
N	$8.5288e^{-3}$	–	–
O	$3.9138e^{-3}$	–	–
H	$1.7943e^{-1}$	–	–
Cr	$5.5173e^{-4}$	–	–
Fe	$1.7376e^{-3}$	–	–
Ni	$3.3952e^{-4}$	–	–
	14-13_1		
^{239}Pu	$5.2874e^{-1}$	$3.4739e^{-1}$	$1.0042e^{0}$
^{240}Pu	$9.4784e^{-2}$	$6.7166e^{-4}$	$2.1084e^{-3}$
N	$5.4619e^{-3}$	–	–
O	$3.7803e^{-3}$	–	–
H	$1.8507e^{-2}$	–	–
Cr	$1.7933e^{-4}$	–	–
Fe	$5.5595e^{-4}$	–	–
Ni	$1.3247e^{-4}$	–	–
	14-13_2		
^{239}Pu	$5.1970e^{-1}$	$3.4532e^{-1}$	$9.9811e^{-1}$
^{240}Pu	$8.2842e^{-2}$	$4.6309e^{-4}$	$1.4524e^{-3}$
N	$5.1846e^{-3}$	–	–
O	$3.6232e^{-3}$	–	–
H	$2.7864e^{-2}$	–	–
Cr	$2.3693e^{-4}$	–	–
Fe	$7.3909e^{-4}$	–	–
Ni	$1.6646e^{-4}$	–	–
	14-13_3		
^{239}Pu	$5.1759e^{-1}$	$3.4810e^{-1}$	$1.0062e^{0}$
^{240}Pu	$7.2345e^{-2}$	$3.2598e^{-4}$	$1.0215e^{-3}$
N	$5.3525e^{-3}$	–	–
O	$3.5605e^{-3}$	–	–
H	$4.2620e^{-2}$	–	–
Cr	$3.0614e^{-4}$	–	–
Fe	$9.5704e^{-4}$	–	–
Ni	$2.0487e^{-4}$	–	–
	14-13_4		
^{239}Pu	$5.1425e^{-1}$	$3.4816e^{-1}$	$1.0064e^{0}$
^{240}Pu	$6.7638e^{-2}$	$2.6838e^{-4}$	$8.4058e^{-4}$
N	$5.5045e^{-3}$	–	–
O	$3.5662e^{-3}$	–	–
H	$5.3875e^{-2}$	–	–
Cr	$3.4963e^{-4}$	–	–
Fe	$1.0944e^{-3}$	–	–
Ni	$2.2990e^{-4}$	–	–
	14-13_5		
^{239}Pu	$5.1427e^{-1}$	$3.4936e^{-1}$	$1.0099e^{0}$
^{240}Pu	$6.5581e^{-2}$	$2.4203e^{-4}$	$7.5801e^{-4}$
N	$5.6821e^{-3}$	–	–
O	$3.6103e^{-3}$	–	–

Table 5.72. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
H	$6.1429e^{-2}$	–	–
Cr	$3.7466e^{-4}$	–	–
Fe	$1.1740e^{-3}$	–	–
Ni	$2.4401e^{-4}$	–	–

Table 5.73. Leakage and EALCF for unreflected plutonium nitrate cylinders

Case No.	Leakage	EALCF
5-13_1	3.8808E–1 ± 1.09E–3	4.1149E–1 ± 1.28E–3
5-13_2	3.9635E–1 ± 1.06E–3	2.5163E–1 ± 7.08E–4
5-13_3	4.0334E–1 ± 1.11E–3	1.9032E–1 ± 4.85E–4
5-13_4	4.0320E–1 ± 1.04E–3	1.2568E–1 ± 2.76E–4
5-13_5	3.9964E–1 ± 1.03E–3	1.0238E–1 ± 1.93E–4
5-13_6	3.9303E–1 ± 1.00E–3	8.7342E–2 ± 1.64E–4
5-13_7	3.8076E–1 ± 1.03E–3	7.0120E–2 ± 1.02E–4
5-18_1	3.9289E–1 ± 1.05E–3	7.7867E–2 ± 1.25E–4
14-13_1	3.4847E–1 ± 1.09E–3	2.3416E–1 ± 6.25E–4
14-13_2	3.5963E–1 ± 1.01E–3	1.5087E–1 ± 3.29E–4
14-13_3	3.5639E–1 ± 1.05E–3	1.0570E–1 ± 2.06E–4
14-13_4	3.5256E–1 ± 1.06E–3	8.9267E–2 ± 1.58E–4
14-13_5	3.4791E–1 ± 1.01E–3	8.2178E–2 ± 1.34E–4
14-18_1	3.4158E–1 ± 1.00E–3	3.7245E–1 ± 1.12E–3
14-18_2	3.4872E–1 ± 1.01E–3	2.6664E–1 ± 7.79E–4
14-18_3	3.5681E–1 ± 1.02E–3	1.8858E–1 ± 4.62E–4
14-18_4	3.6431E–1 ± 1.07E–3	1.3626E–1 ± 3.25E–4
14-18_5	3.6216E–1 ± 1.02E–3	9.9039E–2 ± 1.94E–4
14-18_6	3.5929E–1 ± 1.05E–3	7.8440E–2 ± 1.29E–4
14-18_7	3.4154E–1 ± 1.06E–3	6.8448E–2 ± 9.77E–5
14-18_8	3.0069E–1 ± 1.01E–3	5.5048E–2 ± 6.37E–5
14-18_9	2.5740E–1 ± 1.02E–3	4.9607E–2 ± 5.00E–5

5.7.3 Plutonium Nitrate Solution in 24-in.-diam. Water-Reflected Cylinder

5.7.3.1 Detailed description

Overview of experiment

Nine plutonium nitrate solution experiments performed at the Pacific Northwest Laboratory in the early 1970s are evaluated in this report. The series of experiments were completed with plutonium nitrate solution of extremely high burnup fuel.[24] The experiments were conducted to establish the effects of various heavy metal isotopes on the criticality of plutonium nitrate solutions. Described in this evaluation are nine critical experiments, of which, at this point, cannot be considered acceptable for use as benchmark critical experiments unless additional experimental data can be obtained.

Description of experimental configuration

The plutonium nitrate solution was contained within a 61.028-cm-I.D., 105.651-cm-inside-height, 304-L stainless steel vessel having 0.079-cm-thick sides and top, and a 0.95-cm-thick bottom. The tank had

a dump valve and line (materials not specified), air vent (dimensions and materials not specified), and Lucite port cover. A reflector tank enclosed the vessel and provided at least 20 cm of water reflection on the sides and bottom of the vessel. Details of the two vessels are provided in Fig. 5.7.

Among the experiments, the plutonium concentration and nitric acid normality were varied and the critical solution height measured. The solutions were contaminated by trace amounts of gadolinium of 0.0089 wt % Pu from previous poisoned solution experiments. In addition, ^{241}Am, resulting from the beta decay of ^{241}Pu, was present in the solutions in the amount of 1.08 wt % Pu. Criticality data are given in Table 5.74. No uncertainties were provided for the critical height measurements, plutonium concentration measurements, or nitric acid normality.

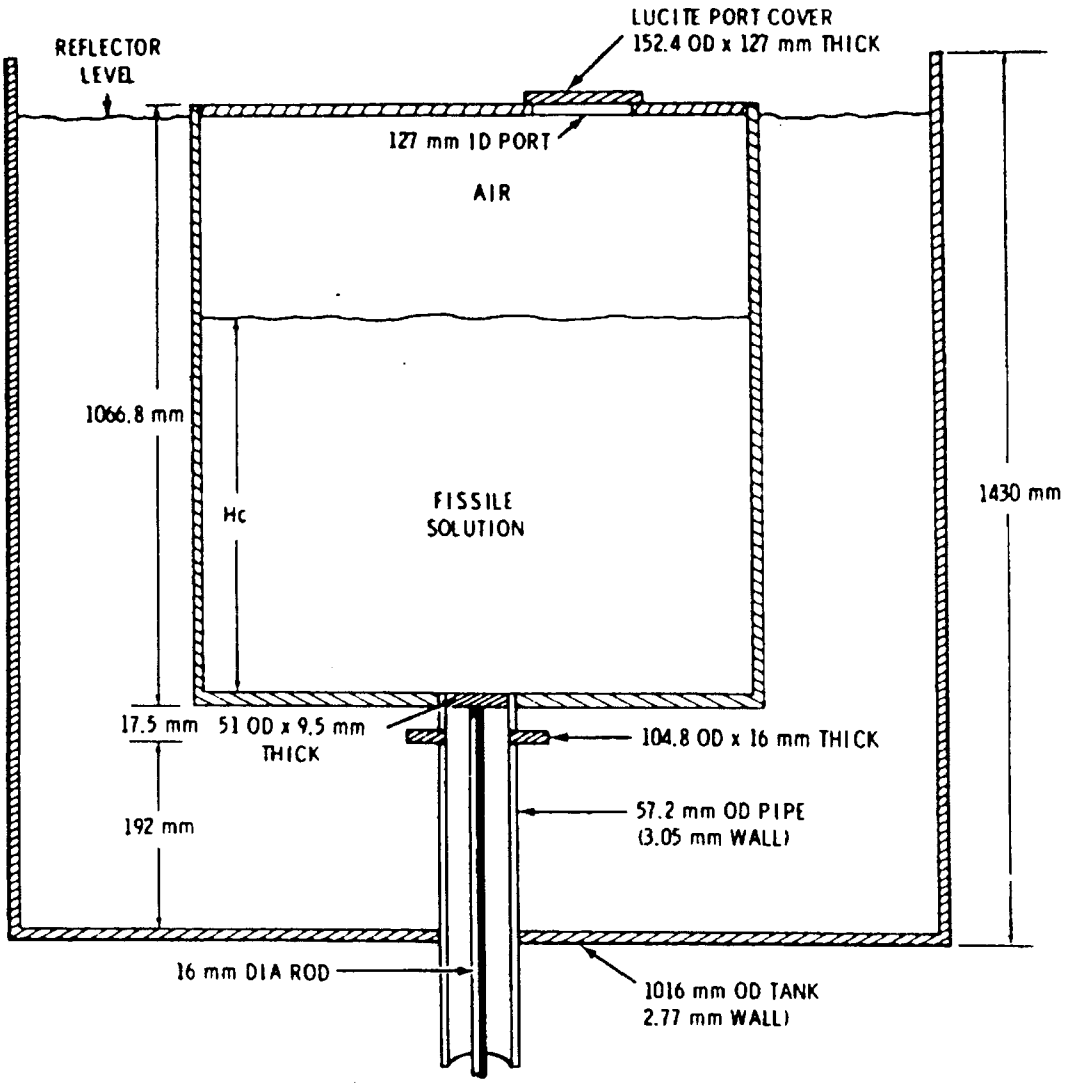


Fig. 5.7. Solution vessel and reflector tank[21].

Table 5.74. Criticality data for plutonium solutions

Case	Plutonium (g/L plutonium)	Nitric acid normality[a]	Critical height (cm)	Critical volume[b] (L)	Critical mass[b] (kg plutonium)
1	40.6	1.46	80.92	236.7	9.61
2	46.8	1.70	63.47	185.7	8.69
3	56.3	2.05	52.83	154.5	8.69
4	65.1	2.41	49.12	143.7	9.35
5	75.6	2.74	47.29	138.3	10.46
6	85.5	3.12	47.00	137.5	11.76
7	99.3	3.67	48.26	141.2	14.02
8	116.0	4.14	50.55	147.9	17.16
9	140.0	5.02	54.70	158.3	22.16

[a]Uncertain if quantity measured.
[b]Derived.

Description of material data

The isotopic makeup of the plutonium of Table 5.74 is presented in Table 5.75. Table 5.76 details the composition of the 304-L stainless steel vessel. No material data were provided for the Lucite port cover.

The temperature of the core and reflector are reported as 296 K ± 2 K, and room temperature is reported as 294 K ± 2 K. No uncertainties were provided for the data of Tables 5.74, 5.75, and 5.76.

Table 5.75. Plutonium isotopic weight percents

Isotope	wt %
^{238}Pu	0.2
^{239}Pu	41.4
^{240}Pu	42.9
^{241}Pu	10.8
^{242}Pu	4.7

Table 5.76. 304-L stainless steel[a] composition

Element	wt %
Fe	74.0
Cr	18.0
Ni	8.0

[a]Density of 7.930 g/cm^3.

Supplemental experimental measurements

None were reported.

Evaluation of experimental data

For case 9, a 54.70-cm critical height does not correspond to a 158.3 critical volume. A 1% difference in critical volumes results.

Gadolinium is assumed to be of natural isotopic abundance. From the SCALE Standard Composition Library, the natural gadolinium isotopes and weight percents (wt %) are as follows: ^{152}Gd (0.20), ^{154}Gd (2.18), ^{155}Gd (14.80), ^{156}Gd (20.47), ^{157}Gd (15.65), ^{158}Gd (24.84), and ^{160}Gd (21.86).

No discussion was available on the method used to measure the critical solution height or any measurable parameter. In addition, no uncertainties were reported for any of the measurements. It is unclear as to which parameters were measured and which were derived from measured data. For instance, in Ref. 24 it appears that the reported nitric acid normality is a measured value, but in Ref. 21 it appears that the nitric acid normality has been derived by having the "water and hydrogen ion concentration adjusted to obtain density and total nitrate reported by data source."

Reference 24 states that, "The data from the critical experiments with the plutonium have been reduced ... The results are given in (Table 5.74)." A review of logbooks and conversations with experimentalists are required to ascertain the origin of data presented in Ref. 24 and experimentally measured parameters. At this point, the evaluation should be terminated until the basis of the data presented can be obtained from additional sources; however, the evaluation will proceed for exploratory purposes only.

5.7.3.2 Benchmark specifications

Description of model

The dimensions and materials descriptions of previous sections were rigorously modeled. To simplify the model, the Lucite cover was ignored, and the top of the vessel was treated as a 0.079-cm-thick stainless steel plate. The air vent was ignored and would have had no effect on k_{eff} because it is far removed neutronically from the fissile solution. The 10.48-cm-OD dump line valve was modeled as water. The volume of stainless steel replaced by water will have a negligible effect on k_{eff}.

Dimensions

The modeled dimensions of the solution vessel, drain line, water reflector, and reflector tank are seen in Fig. 5.8.

Material data

Solution atom densities are given in Table 5.77. These atom densities are from the SCALE output. The atom densities are calculated from the plutonium density and nitric acid normality. There is an uncertainty as to whether the normality was derived using a measured nitrate concentration and plutonium density or was actually measured. The 304-L stainless steel atom densities in Table 5.78 are calculated by SCALE using the provided density and constituent's weight percent. The water atom densities in Table 5.79 are calculated by SCALE at the given temperature. The gadolinium number densities (not given) are calculated by SCALE using the isotopic weight percents specified earlier, an effective molecular weight of 157.25 g/mol, and a density of gadolinium metal of 7.900 g/cm^3. The ^{241}Am number densities of Table 5.80 were calculated assuming an Avogadro's number of 6.0221×10^{23} atoms/g-mole and an atomic weight of 241.0568 g/mole.*

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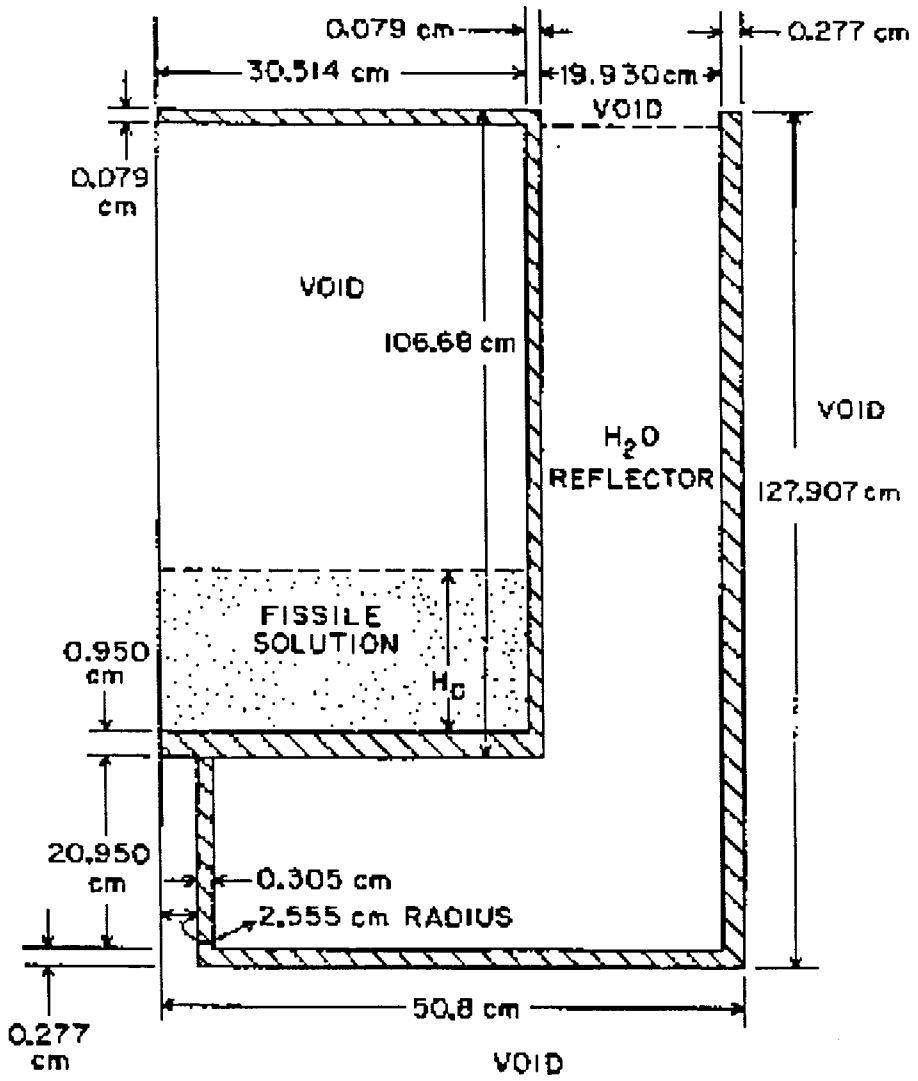


Fig. 5.8. Model dimensions.

Table 5.77. Solution atom densities (atoms/b-cm)

Case	Isotope/element							
	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	N	O	H
1	2.0542e^{-7}	4.2343e^{-5}	4.3694e^{-5}	1.0954e^{-5}	4.7474e^{-6}	1.2870e^{-2}	3.5660e^{-2}	6.4477e^{-2}
2	2.3679e^{-7}	4.8809e^{-5}	5.0367e^{-5}	1.2627e^{-5}	5.4724e^{-6}	1.4938e^{-2}	3.6007e^{-2}	6.4075e^{-2}
3	2.8485e^{-7}	5.8717e^{-5}	6.0591e^{-5}	1.5191e^{-5}	6.5832e^{-6}	1.8000e^{-2}	3.6522e^{-2}	6.3479e^{-2}
4	3.2938e^{-7}	6.7895e^{-5}	7.0062e^{-5}	1.7565e^{-5}	7.6122e^{-6}	2.1052e^{-2}	3.7034e^{-2}	6.2889e^{-2}
5	3.8250e^{-7}	7.8846e^{-5}	8.1362e^{-5}	2.0398e^{-5}	8.8400e^{-6}	2.4094e^{-2}	3.7548e^{-2}	6.2290e^{-2}
6	4.3260e^{-7}	8.9171e^{-5}	9.2016e^{-5}	2.3069e^{-5}	9.9976e^{-6}	2.7377e^{-2}	3.8100e^{-2}	6.1652e^{-2}
7	5.0241e^{-7}	1.0356e^{-4}	1.0687e^{-4}	2.6793e^{-5}	1.1611e^{-5}	3.2074e^{-2}	3.8889e^{-2}	6.0743e^{-2}
8	5.8691e^{-7}	1.2098e^{-4}	1.2484e^{-4}	3.1299e^{-5}	1.3564e^{-5}	3.6583e^{-2}	3.9651e^{-2}	5.9846e^{-2}
9	7.0833e^{-7}	1.4601e^{-4}	1.5067e^{-4}	3.7774e^{-5}	1.6370e^{-5}	4.4293e^{-2}	4.0948e^{-2}	5.8344e^{-2}

Table 5.78. 304-L stainless steel atom densities (atoms/b-cm)

Element	Atom density
Cr	1.6574e^{-2}
Ni	8.1578e^{-3}
Fe	6.1726e^{-2}

Table 5.79. Water atom densities (atoms/b-cm)

Element	Atom density
H	6.6769e^{-2}
O	3.3384e^{-2}

Table 5.80. Natural gadolinium and ^{241}Am atom densities (atom/b-cm)

Case	Gd	^{241}Am
1	1.3838e-^{8}	1.0954e-^{6}
2	1.5951e-^{8}	1.2627e-^{6}
3	1.9189e-^{8}	1.5190e-^{6}
4	2.2189e-^{8}	1.7564e-^{6}
5	2.5767e-^{8}	2.0397e-^{6}
6	2.9142e-^{8}	2.3068e-^{6}
7	3.3845e-^{8}	2.6792e-^{6}
8	3.9537e-^{8}	3.1298e-^{6}
9	4.7717e-^{8}	3.7773e-^{6}

Temperature data

The temperature of the core and reflector are given as 296 K ± 2 K, and room temperature is given as 294 K ± 2 K.

Experimental and benchmark-model k_{eff}

The k_{eff} of each experiment is considered to be 1.0000.

5.7.3.3 Results of calculations

Calculated neutron multiplication factors and associated deviations are shown in Table 5.81 from the Monte Carlo code KENO-V.a. The calculations were performed using the model descriptions provided previously. The set of calculations using the 44-group library has a mean k_{eff} value of 1.0183 ± 0.0068, which indicates a possible bias of 1.83%. The set of calculations using the 238-group library has a mean k_{eff} value of 1.0169 ± 0.0065, which indicates a possible bias of 1.69%. The statistics are based on the mean k_{eff} values of individual calculations and do not account for uncertainty associated with each calculation.

Reaction rates, R(x), based on 238-group cross-sections, for all materials of the assembly (solution, vessel and tank, reflector), averaged over energy and volume of the assembly, are shown in Table 5.82, where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.83 lists the leakage from the tank surface per source neutron and the EALCF and associated deviation.

Table 5.81. Calculational results for KENO-V.a for 24-in.-diam water-reflected cylinder

Case No.	44-group ENDF/B-V	238-group ENDF/B-V
1	1.0096 ± 0.0014	1.0085 ± 0.0014
2	1.0114 ± 0.0012	1.0135 ± 0.0014
3	1.0118 ± 0.0014	1.0098 ± 0.0018
4	1.0154 ± 0.0016	1.0128 ± 0.0013
5	1.0159 ± 0.0016	1.0174 ± 0.0015
6	1.0233 ± 0.0015	1.0180 ± 0.0017
7	1.0247 ± 0.0014	1.0200 ± 0.0017
8	1.0247 ± 0.0014	1.0259 ± 0.0020
9	1.0276 ± 0.0015	1.0266 ± 0.0017

Table 5.82. Reaction rates (1/s) for 24-in.-diam water-reflected cylinder

Element/Nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	Case-1		
^{241}Am	$6.0430e^{-3}$	$4.6011e^{-5}$	$1.4828e^{-4}$
^{238}Pu	$7.4099e^{-4}$	$2.7942e^{-5}$	$8.2160e^{-5}$
^{239}Pu	$3.7747e^{-1}$	$2.6077e^{-1}$	$7.5396e^{-1}$
^{240}Pu	$1.8800e^{-1}$	$5.9909e^{-4}$	$1.8743e^{-3}$
^{241}Pu	$1.1567e^{-1}$	$8.5227e^{-2}$	$2.5171e^{-1}$
^{242}Pu	$4.2625e^{-3}$	$4.8656e^{-5}$	$1.5551e^{-4}$
Gd	$3.4799e^{-3}$	-	-

Table 5.82. (continued)

Element/Nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
N	$1.7999e^{-2}$	–	–
O	$4.7848e^{-3}$	–	–
H	$2.5184e^{-1}$	–	–
Cr	$2.1884e^{-3}$	–	–
Fe	$6.9085e^{-3}$	–	–
Ni	$1.2843e^{-3}$	–	–
	Case-2		
^{241}Am	$6.1545e^{-3}$	$4.8445e^{-5}$	$1.5663e^{-4}$
^{238}Pu	$7.2997e^{-4}$	$2.8475e^{-5}$	$8.3876e^{-5}$
^{239}Pu	$3.7921e^{-1}$	$2.6111e^{-1}$	$7.5491e^{-1}$
^{240}Pu	$1.9218e^{-1}$	$6.7685e^{-4}$	$2.1187e^{-3}$
^{241}Pu	$1.1524e^{-1}$	$8.4894e^{-2}$	$2.5073e^{-1}$
^{242}Pu	$4.6534e^{-3}$	$5.5289e^{-5}$	$1.7670e^{-4}$
Gd	$3.3992e^{-3}$	–	–
N	$1.8132e^{-2}$	–	–
O	$4.8084e^{-3}$	–	–
H	$2.4045e^{-1}$	–	–
Cr	$2.6524e^{-3}$	–	–
Fe	$8.3758e^{-3}$	–	–
Ni	$1.5573e^{-3}$	–	–
	Case-3		
^{241}Am	$6.3253e^{-3}$	$5.2348e^{-5}$	$1.7002e^{-4}$
^{238}Pu	$7.1432e^{-4}$	$2.9357e^{-5}$	$8.6702e^{-5}$
^{239}Pu	$3.8266e^{-1}$	$2.6215e^{-1}$	$7.5786e^{-1}$
^{240}Pu	$1.9893e^{-1}$	$8.0250e^{-4}$	$2.5135e^{-3}$
^{241}Pu	$1.1472e^{-1}$	$8.4490e^{-2}$	$2.4955e^{-1}$
^{242}Pu	$5.3711e^{-3}$	$6.6008e^{-5}$	$2.1092e^{-4}$
Gd	$3.2833e^{-3}$	–	–
N	$1.8223e^{-2}$	–	–
O	$4.8821e^{-3}$	–	–
H	$2.2583e^{-1}$	–	–
Cr	$2.8995e^{-3}$	–	–
Fe	$9.1468e^{-3}$	–	–
Ni	$1.7031e^{-3}$	–	–
	Case-4		
^{241}Am	$6.4958e^{-3}$	$5.6108e^{-5}$	$1.8287e^{-4}$
^{238}Pu	$7.0105e^{-4}$	$3.0240e^{-5}$	$8.9520e^{-5}$
^{239}Pu	$3.8583e^{-1}$	$2.6316e^{-1}$	$7.6072e^{-1}$
^{240}Pu	$2.0512e^{-1}$	$9.2091e^{-4}$	$2.8848e^{-3}$
^{241}Pu	$1.1433e^{-1}$	$8.4183e^{-2}$	$2.4865e^{-1}$
^{242}Pu	$6.0477e^{-3}$	$7.6152e^{-5}$	$2.4320e^{-4}$
Gd	$3.1815e^{-3}$	–	–
N	$1.8515e^{-2}$	–	–
O	$4.8909e^{-3}$	–	–
H	$2.1602e^{-1}$	–	–
Cr	$2.9958e^{-3}$	–	–
Fe	$9.4498e^{-3}$	–	–
Ni	$1.7626e^{-3}$	–	–

Table 5.82. (continued)

Element/Nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	Case-5		
^{241}Am	$6.6786e^{-3}$	$6.0485e^{-5}$	$1.9795e^{-4}$
^{238}Pu	$6.8601e^{-4}$	$3.1354e^{-5}$	$9.3068e^{-5}$
^{239}Pu	$3.8825e^{-1}$	$2.6359e^{-1}$	$7.6193e^{-1}$
^{240}Pu	$2.1135e^{-1}$	$1.0641e^{-3}$	$3.3358e^{-3}$
^{241}Pu	$1.1377e^{-1}$	$8.3754e^{-2}$	$2.4739e^{-1}$
^{242}Pu	$6.7627e^{-3}$	$8.8412e^{-5}$	$2.8245e^{-4}$
Gd	$3.0647e^{-3}$	–	–
N	$1.8343e^{-2}$	–	–
O	$5.0114e^{-3}$	–	–
H	$2.0569e^{-1}$	–	–
Cr	$2.9904e^{-3}$	–	–
Fe	$9.4437e^{-3}$	–	–
Ni	$1.7620e^{-3}$	–	–
	Case-6		
^{241}Am	$6.8617e^{-3}$	$6.4965e^{-5}$	$2.1331e^{-4}$
^{238}Pu	$6.7480e^{-4}$	$3.2562e^{-5}$	$9.6883e^{-5}$
^{239}Pu	$3.9188e^{-1}$	$2.6494e^{-1}$	$7.6579e^{-1}$
^{240}Pu	$2.1613e^{-1}$	$1.2084e^{-3}$	$3.7890e^{-3}$
^{241}Pu	$1.1377e^{-1}$	$8.3742e^{-2}$	$2.4737e^{-1}$
^{242}Pu	$7.3257e^{-3}$	$1.0084e^{-4}$	$3.2203e^{-4}$
Gd	$2.9687e^{-3}$	–	–
N	$1.8622e^{-2}$	–	–
O	$5.0443e^{-3}$	–	–
H	$1.9575e^{-1}$	–	–
Cr	$2.8943e^{-3}$	–	–
Fe	$9.1270e^{-3}$	–	–
Ni	$1.7057e^{-3}$	–	–
	Case-7		
^{241}Am	$7.1542e^{-3}$	$7.1179e^{-5}$	$2.3454e^{-4}$
^{238}Pu	$6.6200e^{-4}$	$3.4332e^{-5}$	$1.0243e^{-4}$
^{239}Pu	$3.9700e^{-1}$	$2.6701e^{-1}$	$7.7174e^{-1}$
^{240}Pu	$2.2412e^{-1}$	$1.4036e^{-3}$	$4.4010e^{-3}$
^{241}Pu	$1.1379e^{-1}$	$8.3743e^{-2}$	$2.4738e^{-1}$
^{242}Pu	$8.3407e^{-3}$	$1.1754e^{-4}$	$3.7522e^{-4}$
Gd	$2.8482e^{-3}$	–	–
N	$1.9081e^{-2}$	–	–
O	$5.0749e^{-3}$	–	–
H	$1.8498e^{-1}$	–	–
Cr	$2.6944e^{-3}$	–	–
Fe	$8.4993e^{-3}$	–	–
Ni	$1.5890e^{-3}$	–	–
	Case-8		
^{241}Am	$7.4148e^{-3}$	$7.8359e^{-5}$	$2.5932e^{-4}$
^{238}Pu	$6.4361e^{-4}$	$3.6463e^{-5}$	$1.0914e^{-4}$
^{239}Pu	$3.9941e^{-1}$	$2.6710e^{-1}$	$7.7196e^{-1}$
^{240}Pu	$2.3346e^{-1}$	$1.6475e^{-3}$	$5.1675e^{-3}$
^{241}Pu	$1.1328e^{-1}$	$8.3364e^{-2}$	$2.4628e^{-1}$
^{242}Pu	$9.4753e^{-3}$	$1.3844e^{-4}$	$4.4196e^{-4}$
Gd	$2.6918e^{-3}$	–	–

Table 5.82. (continued)

Element/Nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
N	$1.8926e^{-2}$	–	–
O	$5.2500e^{-3}$	–	–
H	$1.7388e^{-1}$	–	–
Cr	$2.4762e^{-3}$	–	–
Fe	$7.8040e^{-3}$	–	–
Ni	$1.4624e^{-3}$	–	–
	Case-9		
^{241}Am	$7.8475e^{-3}$	$8.9471e^{-5}$	$2.9752e^{-4}$
^{238}Pu	$6.2375e^{-4}$	$3.9937e^{-5}$	$1.2001e^{-4}$
^{239}Pu	$4.0299e^{-1}$	$2.6758e^{-1}$	$7.7334e^{-1}$
^{240}Pu	$2.4244e^{-1}$	$2.0155e^{-3}$	$6.3226e^{-3}$
^{241}Pu	$1.1281e^{-1}$	$8.3031e^{-2}$	$2.4532e^{-1}$
^{242}Pu	$1.1120e^{-2}$	$1.7007e^{-4}$	$5.4270e^{-4}$
Gd	$2.4923e^{-3}$	–	–
N	$1.9549e^{-2}$	–	–
O	$5.3921e^{-3}$	–	–
H	$1.6062e^{-1}$	–	–
Cr	$2.1109e^{-3}$	–	–
Fe	$6.6561e^{-3}$	–	–
Ni	$1.2482e^{-3}$	–	–

Table 5.83. Leakage and EALCF for 24-in.-diam water-reflected cylinder

Case No.	Leakage	EALCF
1	$1.9853e^{-2} \pm 2.70e^{-4}$	$5.6157e^{-2} \pm 5.65e^{-5}$
2	$2.0970e^{-2} \pm 2.99e^{-4}$	$6.0409e^{-2} \pm 6.90e^{-5}$
3	$2.4228e^{-2} \pm 3.26e^{-4}$	$6.7428e^{-2} \pm 8.38e^{-5}$
4	$2.5855e^{-2} \pm 3.41e^{-4}$	$7.4454e^{-2} \pm 1.05e^{-4}$
5	$2.5527e^{-2} \pm 3.14e^{-4}$	$8.3232e^{-2} \pm 1.21e^{-4}$
6	$2.5197e^{-2} \pm 3.16e^{-4}$	$9.2310e^{-2} \pm 1.43e^{-4}$
7	$2.5361e^{-2} \pm 3.21e^{-4}$	$1.0695e^{-1} \pm 1.82e^{-4}$
8	$2.4629e^{-2} \pm 3.27e^{-4}$	$1.2552e^{-1} \pm 2.53e^{-4}$
9	$2.3446e^{-2} \pm 3.24e^{-4}$	$1.5834e^{-1} \pm 3.48e^{-4}$

5.8 MIXED PLUTONIUM AND URANIUM AT A PLUTONIUM FRACTION OF 0.2 AND 0.5

5.8.1 MIX-SOL-THERM-002 Experiment 58

MIX-SOL-THERM-002 Experiment 58 is a water-reflected mixed plutonium and uranium nitrate solution in a large 304 stainless steel cylindrical tank. The solution was a 11.88-g/L plutonium, 11.05-g/L uranium concentration with a critical height of 76.80 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 1.27 cm below the top of the vessel. Table 5.84 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.85 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.86 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.84. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0052 ± 0.0018	2.05838-2 ± 0.0219
238-group ENDF/B-V	1.0094 ± 0.0027	1.84231-2 ± 0.0266

Table 5.85. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)[a]

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.89882-1 ± 8.5-4	3.43451-1 ± 8.3-4	9.9322-1 ± 8.2-4
^{240}Pu	2.32796-2 ± 2.7-3	3.69290-5 ± 2.7-3	1.14741-4 ± 2.9-3
^{241}Pu	3.05852-3 ± 7.8-4	2.25584-3 ± 7.8-4	6.66197-3 ± 7.8-4
H	3.19942-1 ± 8.0-4	0.0	0.0
O	4.11258-3 ± 1.1-2	0.0	0.0
N	1.38095-2 ± 7.9-4	0.0	0.0

[a]In this and succeeding tables x.yyy-Z = x.yyy (10^{-Z}).

Table 5.86. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.90594-1 ± 8.1-4	3.44342-1 ± 7.8-4	9.95816-1 ± 7.8-4
^{240}Pu	2.33062-2 ± 5.8-3	3.69734-5 ± 2.9-3	1.14923-3 ± 3.0-3
^{241}Pu	3.06899-3 ± 7.4-4	2.26371-3 ± 7.4-4	6.68522-3 ± 7.4-4
H	3.22064-1 ± 7.6-4	0.0	0.0
O	4.19205-3 ± 1.1-2	0.0	0.0
N	1.38971-2 ± 7.5-4	0.0	0.0

5.8.2 MIX-SOL-THERM-002 Experiment 59

MIX-SOL-THERM-002 Experiment 59 is a water-reflected mixed plutonium and uranium nitrate solution in a large 304 stainless steel cylindrical tank. The solution was a 11.73-g/L plutonium, 10.78-g/L uranium concentration with a critical height of 83.14 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 1.27 cm below the top of the vessel. Table 5.87 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.88 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.89 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.87. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0078 ± 0.0016	1.94862-2 ± 0.0234
238-group ENDF/B-V	1.0100 ± 0.0019	1.91261-2 ± 0.0245

Table 5.88. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.9111-1 ± 8.1-4	3.44350-1 ± 7.8-4	9.95823-1 ± 7.8-4
^{240}Pu	2.31688-2 ± 2.8-3	3.66137-5 ± 2.8-3	1.13817-4 ± 2.9-3
^{241}Pu	3.06749-3 ± 7.4-4	2.26246-3 ± 7.4-4	6.68151-3 ± 7.4-4
H	3.25079-1 ± 7.5-4	0.0	0.0
O	4.20414-3 ± 1.1-2	0.0	0.0
N	1.37593-2 ± 7.4-4	0.0	0.0

Table 5.89. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.91653-1 ± 7.9-4	3.45119-1 ± 7.7-4	9.98063-1 ± 7.7-4
^{240}Pu	2.34912-2 ± 5.9-3	3.65371-5 ± 2.8-3	1.13530-4 ± 3.0-3
^{241}Pu	3.07583-3 ± 7.3-4	2.26878-3 ± 7.3-4	6.70017-3 ± 7.3-4
H	3.27139-1 ± 7.4-4	0.0	0.0
O	4.17666-3 ± 1.1-2	0.0	0.0
N	1.38383-2 ± 7.4-4	0.0	0.0

5.8.3 MIX-SOL-THERM-002 Experiment 61

MIX-SOL-THERM-002 Experiment 61 is a water-reflected mixed plutonium and uranium nitrate solution in a large 304 stainless steel cylindrical tank. The solution was a 12.19-g/L plutonium, 41.04-g/L uranium concentration with a critical height of 81.72 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 1.27 cm below the top of the vessel. Table 5.90 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.91 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.92 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.90. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0104 ± 0.0018	1.95576-2 ± 0.0212
238-group ENDF/B-V	1.0078 ± 0.0021	1.96913-2 ± 0.0242

Table 5.91. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.89973-1 ± 8.7-4	3.43285-1 ± 8.5-4	9.92731-1 ± 8.5-4
^{240}Pu	2.35470-2 ± 2.8-3	3.81069-5 ± 2.8-3	1.18521-4 ± 3.0-3
^{241}Pu	3.05331-3 ± 8.1-4	2.25185-3 ± 8.1-4	6.65021-3 ± 8.1-4
H	3.07571-1 ± 8.3-4	0.0	0.0
O	4.29064-3 ± 1.1-2	0.0	0.0
N	1.84800-2 ± 8.2-4	0.0	0.0

Table 5.92. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.88597-1 ± 8.4-4	3.42620-1 ± 8.2-4	9.90821-1 ± 8.2-4
^{240}Pu	2.37562-2 ± 6.2-3	3.82355-5 ± 2.7-3	1.18900-4 ± 2.9-3
^{241}Pu	3.04791-3 ± 7.8-4	2.24796-3 ± 7.8-4	6.63873-3 ± 7.8-4
H	3.0788-1 ± 8.1-4	0.0	0.0
O	4.28998-3 ± 1.0-2	0.0	0.0
N	1.84994-2 ± 8.0-4	0.0	0.0

5.9 MIXED PLUTONIUM AND URANIUM SOLUTION IN ANNULAR CYLINDRICAL GEOMETRY

5.9.1 MIX-SOL-THERM-001 Experiment 87

MIX-SOL-THERM-001 Experiment 87 is a water-reflected experiment conducted with mixed plutonium and uranium nitrate solution. The experimental vessel was a stainless steel 304 annular tank with a borated concrete (2 wt % B_4C) inside the annulus. The solution contained 102.19 g/L plutonium and 365.20 g/L uranium. The measured critical height was 48.55 cm. A rectangular reflector tank had dimensions of 98.76 cm by 101.31 cm. The top of the reflector tank was 24.1 cm below the top of the annular vessel. Table 5.93 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector tank and experimental vessel.* Table 5.94 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.95 provides similar data from calculations performed with a 238-group ENDF/B-V library also derived from ENDF/B-V.

Table 5.93. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0038 ± 0.0024	2.41020-2 ± 0.0185
238-group ENDF/B-V	1.0000 ± 0.0027	2.44296-2 ± 0.0185

Table 5.94. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.06668-1 ± 2.0-3	3.37643-1 ± 1.9-3	9.75937-1 ± 1.8-3
^{240}Pu	5.31193-2 ± 4.9-3	2.50148-4 ± 3.1-3	7.82049-4 ± 3.3-3
^{241}Pu	2.71171-3 ± 1.7-3	1.99508-3 ± 1.7-3	5.89477-3 ± 1.7-3
H	2.56014-2 ± 1.7-3	0.0	0.0
O	3.6799-3 ± 1.0-2	0.0	0.0
N	1.20654-2 ± 1.8-3	0.0	0.0

Table 5.95. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	5.05816-1 ± 1.9-3	3.36996-1 ± 1.9-3	9.74066-1 ± 1.9-3
^{240}Pu	5.32153-2 ± 8.8-3	2.49375-4 ± 3.1-3	7.79739-4 ± 3.2-3
^{241}Pu	2.70518-3 ± 1.7-3	1.99064-3 ± 1.7-3	5.88164-3 ± 1.7-3
H	2.55215-2 ± 1.7-3	0.0	0.0
O	3.69508-3 ± 1.1-2	0.0	0.0
N	1.20113-2 ± 1.8-3	0.0	0.0

5.9.2 MIX-SOL-THERM-001 Experiment 95

MIX-SOL-THERM-001 Experiment 95 is a water-reflected mixed plutonium and uranium nitrate solution in a 304 stainless steel annular tank with a 2% B_4C concrete insert. Interior to the insert was a stainless steel bottle-3, containing an additional plutonium-uranium nitrate solution. The bottle-3 solution was a 194.92-g/L plutonium, 5.1-g/L uranium concentration with a height of 36.8 cm. The outer annulus was a 195.61-g/L plutonium, 6.5-g/L uranium concentration with a critical height of 27.51 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 24.1 cm below the top of the annular vessel. Table 5.96 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.97 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.98 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.96. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0058 ± 0.0032	2.69566-2 ± 0.0184
238-group ENDF/B-V	1.0059 ± 0.0030	2.74089-2 ± 0.0179

Table 5.97. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.79418-1 ± 2.4-3	3.14863-1 ± 2.4-3	9.10301-1 ± 2.4-3
^{240}Pu	5.92045-2 ± 5.7-3	3.82078-4 ± 3.2-3	1.19673-3 ± 3.3-3
^{241}Pu	2.22455-3 ± 2.1-3	1.63984-3 ± 2.1-3	4.84714-3 ± 2.1-3
H	1.23908-2 ± 2.2-3	0.0	0.0
O	3.18040-3 ± 1.1-2	0.0	0.0
N	8.1969-3 ± 2.3-3	0.0	0.0
	Fuel in bottle-3		
^{239}Pu	4.20681-2 ± 8.9-3	2.73051-2 ± 8.6-3	7.89336-2 ± 8.6-3
	2.86902-2 ± 2.3-2	1.85961-2 ± 2.3-2	5.37595-2 ± 2.3-2
^{240}Pu	5.9038-3 ± 1.7-2	3.77238-5 ± 1.0-2	1.17981-4 ± 1.1-2
	3.88066-3 ± 4.8-2	2.64385-5 ± 2.5-2	8.27911-5 ± 2.6-2

Table 5.97. (continued)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in bottle-3		
^{241}Pu	1.91423-4 ± 7.5-3	1.41080-4 ± 7.4-3	4.17064-4 ± 7.4-3
	1.28753-4 ± 2.0-2	9.51881-5 ± 2.0-2	2.81413-4 ± 2.0-2
H	1.03001-3 ± 7.7-3	0.0	0.0
	6.91431-4 ± 2.0-2	0.0	0.0
O	3.02736-4 ± 3.3-2	0.0	0.0
	2.18210-4 ± 7.6-2	0.0	0.0
N	7.29629-4 ± 8.0-3	0.0	0.0
	5.06466-4 ± 2.1-2	0.0	0.0

Table 5.98. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.76455-1 ± 2.4-3	3.12882-1 ± 2.4-3	9.04591-1 ± 2.3-3
^{240}Pu	6.02587-2 ± 9.4-3	3.84664-4 ± 3.2-3	1.20536-3 ± 3.3-3
^{241}Pu	2.2157-3 ± 2.1-3	1.63348-3 ± 2.1-3	4.82841-3 ± 2.1-3
H	1.23199-2 ± 2.1-3	0.0	0.0
O	3.25770-3 ± 1.1-2	0.0	0.0
N	8.17289-3 ± 2.3-3	0.0	0.0
	Fuel in bottle-3		
^{239}Pu	4.35435-3 ± 8.5-3	2.82908-2 ± 8.2-3	8.1785-2 ± 8.2-3
	2.98423-2 ± 2.1-2	1.93373-2 ± 2.1-2	5.59021-2 ± 2.1-2
^{240}Pu	6.18341-3 ± 2.8-2	3.89828-5 ± 9.6-3	1.21982-4 ± 9.9-3
	4.49572-3 ± 7.8-2	2.82126-5 ± 2.4-2	8.79585-5 ± 2.4-2
^{241}Pu	1.98239-4 ± 7.2-3	1.46112-4 ± 7.1-3	4.31943-4 ± 7.1-3
	1.37421-4 ± 1.8-2	1.01632-4 ± 1.8-2	3.00447-4 ± 1.8-2
H	1.07258-3 ± 7.2-3	0.0	0.0
	7.34523-4 ± 1.8-2	0.0	0.0
O	3.25151-4 ± 3.1-2	0.0	0.0
	1.92253-4 ± 7.6-2	0.0	0.0
N	7.61916-4 ± 7.9-3	0.0	0.0
	5.34959-4 ±1.9-2	0.0	0.0

5.9.3 MIX-SOL-THERM-001 Experiment 97

MIX-SOL-THERM-001 Experiment 97 is a water-reflected mixed plutonium and uranium nitrate solution in a 304 stainless steel annular tank with a 2% B_4C concrete insert. Interior to the insert was a stainless steel bottle-3, containing an additional plutonium-uranium nitrate solution. The bottle-3 solution was a 194.92-g/L plutonium, 5.1-g/L uranium concentration with a height of 36.8 cm. The outer annulus was a 58.30-g/L plutonium, 2.3-g/L uranium concentration with a critical height of 28.94 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 24.1 cm below the top of the annular vessel. Table 5.99 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.100 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.101 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.99. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0012 ± 0.0025	2.56564-2 ± 0.0172
238-group ENDF/B-V	1.0011 ± 0.0028	2.61551-2 ± 0.0186

Table 5.100. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in anuular tank		
^{239}Pu	4.61652-1 ± 1.8-3	3.13623-1 ± 1.7-3	9.06581-1 ± 1.7-3
^{240}Pu	3.5633-2 ± 5.2-3	1.14648-4 ± 3.2-3	3.58305-4 ± 3.3-3
^{241}Pu	2.22838-3 ± 1.6-3	1.6402-3 ± 1.6-3	4.84489-3 ± 1.6-3
H	5.16259-2 ± 1.6-3	0.0	0.0
O	2.90234-3 ± 1.1-2	0.0	0.0
N	6.91447-3 ± 1.5-3	0.0	0.0
	Fuel in bottle-3		
^{239}Pu	4.3023-2 ± 8.7-3	2.78922-2 ± 8.4-3	8.06239-2 ± 8.4-3
	2.76587-2 ± 2.5-2	1.79623-2 ± 2.4-2	5.19331-2 ± 2.4-2
^{240}Pu	5.85277-3 ± 1.9-2	3.72667-5 ± 1.0-2	1.16394-4 ± 1.0-2
	3.77914-3 ± 5.8-2	2.61214-5 ± 2.6-2	8.17945-5 ± 2.7-2
^{241}Pu	1.95458-4 ± 7.3-3	1.43971-4 ± 7.3-3	4.25589-4 ± 7.3-3
	1.28667-4 ± 2.1-2	9.50435-5 ± 2.1-2	2.80983-4 ± 2.1-2
H	1.04524-3 ± 7.4-3	0.0	0.0
	6.82617-4 ± 2.2-2	0.0	0.0
O	2.90352-4 ± 3.1-2	0.0	0.0
	2.12516-4 ± 7.5-2	0.0	0.0
N	7.29148-4 ± 7.9-3	0.0	0.0
	5.00664-4 ± 2.1-2	0.0	0.0

Table 5.101. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.63723-1 ± 1.7-3	3.1546-1 ± 1.6-3	9.11915-1 ± 1.6-3
^{240}Pu	3.57994-2 ± 9.5-3	1.15174-4 ± 3.2-3	3.59829-4 ± 3.3-3
^{241}Pu	2.24646-3 ± 1.5-3	1.65390-3 ± 1.5-3	4.88535-3 ± 1.5-3
H	5.22528-2 ± 1.5-3	0.0	0.0
O	2.86931-3 ± 1.1-2	0.0	0.0
N	6.98804-3 ± 1.5-3	0.0	0.0
	Fuel in bottle-3		
^{239}Pu	4.02051-2 ± 8.4-3	2.61065-2 ± 8.2-3	7.54724-2 ± 8.2-3
	2.70388-2 ± 2.5-2	1.76402-2 ± 2.4-2	5.09991-2 ± 2.4-2
^{240}Pu	5.98896-3 ± 3.2-2	3.68615-5 ± 9.9-3	1.15223-4 ± 1.0-2
	3.04347-3 ± 7.1-2	2.48751-5 ± 2.6-2	7.76474-5 ± 2.7-2
^{241}Pu	1.84004-4 ± 7.3-3	1.35788-4 ± 7.2-3	4.01425-4 ± 7.2-3
	1.24914-4 ± 2.2-2	9.21181-5 ± 2.2-2	2.72319-4 ± 2.2-2
H	9.96345-4 ± 7.3-3	0.0	0.0
	6.78562-4 ± 2.2-2	0.0	0.0
O	2.95201-4 ± 3.3-2	0.0	0.0
	1.95398-4 ± 8.4-2	0.0	0.0
N	7.06996-4 ± 7.9-3	0.0	0.0
	4.79486-4 ± 2.2-2	0.0	0.0

5.9.4 MIX-SOL-THERM-001 Experiment 99

MIX-SOL-THERM-001 Experiment 99 is a water-reflected mixed plutonium and uranium nitrate solution in a 304 stainless steel annular tank with a cadmium-covered polyethylene insert. Interior to the insert was a stainless steel bottle-2, containing an additional plutonium-uranium nitrate solution. The bottle-2 solution was a 103.36-g/L plutonium, 363.30-g/L uranium concentration with a height of 59.4 cm. The outer annulus was a 73.64-g/L plutonium, 250.30-g/L uranium concentration with a critical height of 79.18 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 24.1 cm below the top of the annular vessel. Table 5.102 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.103 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.104 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.102. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0132 ± 0.0023	1.92446-2 ± 0.0252
238-group ENDF/B-V	1.0094 ± 0.0027	1.84231-2 ± 0.0266

Table 5.103. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.12562-1 ± 2.1-3	2.77926-1 ± 2.0-3	8.03346-1 ± 2.0-3
	7.84247-2 ± 5.9-3	5.28039-2 ± 5.7-3	1.52628-1 ± 5.7-3
^{240}Pu	3.74411-2 ± 5.9-3	1.42693-4 ± 3.5-3	4.46417-4 ± 3.6-3
	7.16856-3 ± 1.7-2	2.74916-5 ± 8.9-3	8.58905-5 ± 9.1-3
^{241}Pu	2.10873-3 ± 1.9-3	1.55151-3 ± 1.9-3	4.58338-3 ± 1.9-3
	3.99973-4 ± 5.5-3	2.94304-4 ± 5.5-3	8.69415-4 ± 5.5-3
H	3.25302-2 ± 1.9-3	0.0	0.0
	6.16593-3 ± 5.8-3	0.0	0.0
O	2.92189-3 ± 1.2-2	0.0	0.0
	5.48186-4 ± 2.5-2	0.0	0.0
N	9.02877-3 ± 1.9-3	0.0	0.0
	1.71487-3 ± 5.3-3	0.0	0.0
	Fuel in bottle-2		
^{239}Pu	4.46523-6 ± 2.4-1	2.94891-6 ± 2.4-1	8.54204-6 ± 2.4-1
	1.80454-2 ± 1.2-2	1.18861-2 ± 1.1-2	3.43517-2 ± 1.1-2
^{240}Pu	6.95549-7 ± 6.1-1	7.04397-9 ± 1.8-1	2.21728-8 ± 1.8-1
	2.3127-3 ± 3.0-2	1.00677-5 ± 1.5-2	3.15912-5 ± 1.5-2
^{241}Pu	2.47284-8 ± 2.4-1	8.75791-5 ± 1.0-2	6.43082-5 ± 1.0-2
	8.75791-5 ± 1.0-2	6.43082-5 ± 1.0-2	1.90031-4 ± 1.0-2
H	2.33990-7 ± 2.6-1	0.0	0.0
	8.46517-4 ± 1.0-2	0.0	0.0
O	1.0034-7 ± 5.7-1	0.0	0.0
	1.64497-4 ± 4.5-2	0.0	0.0
N	1.74606-7 ± 1.7-1	0.0	0.0
	4.23238-4 ± 1.0-2	0.0	0.0

Table 5.104. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.15209-1 ± 2.1-3	2.7998-1 ±1.9-3	8.09299-1 ± 1.9-3
	7.42639-2 ± 5.8-3	5.00176-2 ± 5.7-3	1.44579-1 ± 5.7-3
^{240}Pu	3.78613-2 ± 1.0-2	1.44591-4 ± 3.6-3	4.52426-4 ± 3.7-3
	6.76704-3 ± 2.4-2	2.65914-5 ± 8.7-3	8.33257-5 ± 9.0-3
^{241}Pu	2.12394-3 ± 1.9-3	1.56313-3 ± 1.8-3	4.61773-3 ± 1.8-3
	3.79085-4 ± 5.5-3	2.78970-4 ± 5.5-3	8.24133-4 ± 5.5-3
H	3.28964-2 ± 1.9-3	0.0	0.0
	5.83992-3 ± 5.8-3	0.0	0.0
O	2.96219-3 ± 1.2-2	0.0	0.0
	5.60433-4 ± 2.8-2	0.0	0.0
N	9.14078-3 ± 1.9-3	0.0	0.0
	1.63879-3 ± 5.4-3	0.0	0.0
	Fuel in bottle-2		
^{239}Pu	6.17241-6 ± 2.1-1	4.18818-6 ± 2.0-1	1.21153-5 ± 2.0-1
	1.73414-2 ± 1.2-2	1.1414-2 ± 1.1-2	3.29865-2 ± 1.1-2
^{240}Pu	1.47887-6 ± 7.5-1	5.15011-9 ± 1.3-1	1.59875-8 ± 1.3-1
	2.01125-3 ± 4.5-2	9.62278-6 ± 1.5-2	3.02266-5 ± 1.5-2
^{241}Pu	4.27306-8 ± 1.9-1	3.24968-8 ± 1.9-1	9.60218-8 ± 1.9-1
	8.38119-5 ± 1.0-2	6.15392-5 ± 1.0-2	1.81850-4 ± 1.0-2
H	3.54687-7 ± 1.9-1	0.0	0.0
	8.06253-4 ± 1.0-2	0.0	0.0
O	5.43835-8 ± 3.9-1	0.0	0.0
	1.6296-4 ± 4.4-2	0.0	0.0
N	1.90265-7 ± 1.4-1	0.0	0.0
	4.03281-4 ± 1.0-2	0.0	0.0

5.9.5 MIX-SOL-THERM-001 Experiment 108

MIX-SOL-THERM-001 Experiment 108 is a water-reflected mixed plutonium and uranium nitrate solution in a 304 stainless steel annular tank with a 2% B_4C concrete insert. Interior to the insert was a stainless steel bottle-2, containing an additional plutonium-uranium nitrate solution. The bottle-2 solution was a 103.36-g/L plutonium, 363.3-g/L uranium concentration with a height of 59.4 cm. The outer annulus was a 47.08-g/L plutonium, 161.72-g/L uranium concentration with a critical height of 45.09 cm. The rectangular water reflector tank was 98.76 cm by 101.31 cm and 1.9 cm below the top of the annular vessel. Table 5.105 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.106 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.107 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.105. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	0.9997 ± 0.0027	1.50408-2 ± 0.0222
238-group ENDF/B-V	1.0007 ± 0.0025	1.50161-2 ± 0.0247

Table 5.106. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.55895-1 ± 1.6-3	3.11015-1 ± 1.6-3	8.99084-1 ± 1.6-3
^{240}Pu	3.47264-2 ± 4.7-3	1.05527-4 ± 3.1-3	3.29506-4 ± 3.3-3
^{241}Pu	2.40039-3 ± 1.5-3	1.76722-3 ± 1.5-3	5.2199-3 ± 1.5-3
H	6.20034-2 ± 1.5-3	0.0	0.0
O	3.15830-3 ± 1.1-2	0.0	0.0
N	1.06052-2 ± 1.5-3	0.0	0.0
	Fuel in bottle-2		
^{239}Pu	3.78636-2 ± 8.2-3	2.49625-2 ± 7.9-3	7.21451-2 ± 7.9-3
	1.17254-2 ± 2.4-2	7.72282-3 ± 2.3-2	2.23188-2 ± 2.3-2
^{240}Pu	4.38600-3 ± 1.8-2	2.16575-5 ± 1.0-2	6.76583-5 ± 1.1-2
	1.44912-3 ± 5.8-2	6.94641-6 ± 3.0-2	2.16188-5 ± 3.1-2
^{241}Pu	1.86666-4 ± 7.0-3	1.37287-4 ± 7.0-3	4.05673-4 ± 7.0-3
	5.72069-5 ± 2.1-2	4.21182-5 ± 2.1-2	1.24456-4 ± 2.1-2
H	1.78969-3 ± 7.3-3	0.0	0.0
	5.53913-4 ± 2.1-2	0.0	0.0
O	3.1223-4 ± 3.2-2	0.0	0.0
	8.74066-5 ± 9.8-2	0.0	0.0
N	8.91351-4 ± 6.8-3	0.0	0.0
	2.76274-4 ± 2.0-2	0.0	0.0

Table 5.107. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
	Fuel in annular tank		
^{239}Pu	4.54886-1 ± 1.6-3	3.10480-1 ± 1.5-3	8.97543-1 ± 1.5-3
^{240}Pu	3.4860-2 ± 9.1-3	1.05542-4 ± 3.1-3	3.29662-4 ± 3.3-3
^{241}Pu	2.39418-3 ± 1.4-3	1.7628-3 ± 1.4-3	5.20683-3 ± 1.4-3
H	6.19824-2 ± 1.4-3	0.0	0.0
O	3.1965-2 ± 1.1-2	0.0	0.0
N	1.06004-2 ± 1.4-3	0.0	0.0
	Fuel in bottle-2		
^{239}Pu	3.86818-2 ± 7.3-3	2.54850-2 ± 7.1-3	7.36525-2 ± 7.1-3
	1.15970-2 ± 2.2-2	7.66989-3 ± 2.1-2	2.21669-2 ± 2.1-2
^{240}Pu	4.73061-3 ± 2.9-2	2.24122-5 ± 9.4-3	6.99706-5 ± 9.7-3
	1.23734-3 ± 8.7-2	6.64103-6 ± 2.9-2	2.06833-5 ± 3.0-2
^{241}Pu	1.89558-4 ± 6.4-3	1.39467-4 ± 6.4-3	4.12119-4 ± 6.4-3
	5.70078-5 ± 1.9-2	4.19181-5 ± 1.9-2	1.23862-4 ± 1.9-2
H	1.81553-3 ± 6.6-3	0.0	0.0
	5.61960-4 ± 2.0-2	0.0	0.0
O	3.10209-4 ± 3.1-2	0.0	0.0
	8.28485-5 ± 9.4-2	0.0	0.0
N	9.10115-4 ± 6.4-3	0.0	0.0
	2.78690-4 ± 2.0-2	0.0	0.0

5.10 SQUARE LATTICE OF (PuO_2+UO_2) RODS IN WATER WITH 20 wt % PLUTONIUM

5.10.1 MIX-COMP-THERM-001 Case 1

MIX-COMP-THERM-001 Case 1 is a lattice of water-reflected, mixed plutonium-uranium oxide (20 wt % plutonium) fuel pins. The configuration was comprised of an array of fast test reactor fuel pins within a large tank of water. The fuel pins were located on a square pitch with a pin pitch of 0.9525 cm. The pins were supported by a number of grid plates. The fuel pins were 0.5842 cm in diameter and ~2.4 m in length with the fuel region having a length of 91.44 cm and located near the bottom of the pin. The remainder of the pin consisted of end caps, plenum, natural UO_2 insulators, and Inconel reflectors. Table 5.108 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.109 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.110 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.108. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	0.9933 ± 0.0026	3.1978-3 ± 0.0496
238-group ENDF/B-V	0.9931 ± 0.0025	3.50959-3 ± 0.0481

Table 5.109. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.7329-1 ± 3.9-3	3.178-1 ± 3.8-3	9.20969-1 ± 3.8-3
^{240}Pu	6.26708-2 ± 6.5-3	1.43056-3 ± 3.3-3	4.48375-3 ± 3.4-3
^{241}Pu	1.30625-2 ± 3.6-3	9.72349-3 ± 3.6-3	2.87692-2 ± 3.6-3
O	8.92797-4 ± 1.1-2	0.0	0.0

Table 5.110. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.71123-1 ± 3.9-3	3.16271-1 ± 3.8-3	9.16527-1 ± 3.8-3
^{240}Pu	6.30413-2 ± 9.6-3	1.42592-3 ± 3.4-3	4.47015-3 ± 3.5-3
^{241}Pu	1.28275-2 ± 3.7-3	9.54480-3 ± 3.7-3	2.82415-2 ± 3.6-3
O	9.00594-4 ± 1.1-2	0.0	0.0

5.10.2 MIX-COMP-THERM-001 Case 2

MIX-COMP-THERM-001 Case 2 is a water-reflected mixed plutonium-uranium oxide (20 wt % plutonium) fuel pins. The configuration was comprised of an array of fast test reactor fuel pins within a large tank of water. The fuel pins were located on a square pitch with a pin pitch of 1.2588 cm. The pins were supported by a number of grid plates. The fuel pins were 0.5842 cm in diameter and ~2.4 m in length with the actual fuel region restricted to a 91.44-cm length near the bottom of the pin. The remainder of the pin consisted of end caps, plenum, natural UO_2 insulators, and Inconel reflectors. Table 5.111 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.112 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.113 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.111. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	0.9931 ± 0.0024	2.46432-3 ± 0.0572
238-group ENDF/B-V	0.9980 ± 0.0026	2.76157 ± 0.0517

Table 5.112. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.72346-1 ± 4.3-3	3.21593-1 ± 4.2-3	9.30987-1 ± 4.2-3
^{240}Pu	4.7405-2 ± 6.9-3	8.41407-4 ± 3.5-3	2.64503-3 ± 3.5-3
^{241}Pu	1.24767-2 ± 4.0-3	9.25759-3 ± 4.0-3	2.73715-2 ± 4.0-4
O	5.61383-4 ± 1.1-2	0.0	0.0

Table 5.113. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.72774-1 ± 4.2-3	3.22191-1 ± 4.2-3	9.3272-1 ± 4.2-3
^{240}Pu	4.65441-2 ± 1.1-2	8.39755-4 ± 3.5-3	2.63949-3 ± 3.6-3
^{241}Pu	1.24599-2 ± 4.1-3	9.24478-3 ± 4.0-3	2.73336-2 ± 4.0-3
O	5.54681-4 ± 1.1-2	0.0	0.0

5.10.3 MIX-COMP-THERM-001 Case 3

MIX-COMP-THERM-001 Case 3 is a water-reflected mixed plutonium-uranium oxide (20 wt % plutonium) fuel pins. The configuration was comprised of an array of fast test reactor fuel pins within a large tank containing water. The fuel pins were located on a square pitch with a fuel pin pitch of 1.5342 cm. The pins were supported by a number of grid plates. The fuel pins were 0.5842 cm in diameter and ~2.4 m in length with the actual fuel region restricted to a 91.44-cm length near the bottom of the pin. The remainder of the pin consisted of end caps, plenum, natural UO_2 insulators and Inconel reflectors. Table 5.114 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.115 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.116 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.114. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0009 ± 0.0024	2.89221-3 ± 0.0503
238-group ENDF/B-V	0.9992 ± 0.0024	3.44624-3 ± 0.0459

Table 5.115. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.75995-1 ± 4.3-3	3.27212-1 ± 4.3-3	9.46957-1 ± 4.3-3
^{240}Pu	3.97541-2 ± 7.5-3	6.32782-4 ± 3.8-3	1.98994-3 ± 3.9-3
^{241}Pu	1.252-2 ± 4.2-3	9.28006-3 ± 4.2-3	2.74296-2 ± 4.2-3
O	4.20972-4 ± 1.2-2	0.0	0.0

Table 5.116. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.76731-1 ± 4.4-3	3.2785-1 ± 4.4-3	9.48797-1 ± 4.4-3
^{240}Pu	3.96594-2 ± 1.2-2	6.29757-4 ± 3.7-3	1.97997-3 ± 3.8-3
^{241}Pu	1.24618-2 ± 4.3-3	9.24065-3 ± 4.3-3	2.7313-2 ± 4.3-3
O	4.13809-4 ± 1.2-2	0.0	0.0

5.10.4 MIX-COMP-THERM-001 Case 4

MIX-COMP-THERM-001 Case 4 is a water-reflected mixed plutonium-uranium oxide (20 wt % plutonium) fuel pins. The configuration was comprised of an array of fast test reactor fuel pins within a large tank of water. The fuel pins were located on a square pitch with a fuel pin pitch of 1.9050 cm. The pins were supported by a number of grid plates. The fuel pins were 0.5842 cm in diameter and ~2.4 m in length with the actual fuel region restricted to a 91.44-cm length near the bottom of the pin. The remainder of the pin consisted of end caps, plenum, natural UO_2 insulators, and Inconel reflectors. Table 5.117 presents calculated multiplication factors and neutron leakage *from the external surface of the water reflector.* Table 5.118 provides reaction rates per fission neutron for a 44-energy group library derived from ENDF/B-V. Table 5.119 provides similar data from calculations performed with a 238-group library also derived from ENDF/B-V.

Table 5.117. Calculated system multiplication and leakage

Cross section library	k-effective	Total leakage
44-group ENDF/B-V	1.0052 ± 0.0026	3.75993-3 ± 0.0498
238-group ENDF/B-V	1.0046 ± 0.0025	3.36117-3 ± 0.0510

Table 5.118. Reaction rates with fractional standard deviation (44-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.74715-1 ± 4.2-3	3.28903-1 ± 4.2-3	9.51744-1 ± 4.2-3
^{240}Pu	3.3502-2 ± 8.4-3	5.0093-4 ± 3.8-3	1.57849-3 ± 3.9-3
^{241}Pu	1.24829-2 ± 4.1-3	9.25118-3 ± 4.1-3	2.73394-2 ± 4.1-3
O	3.47739-4 ± 1.1-2	0.0	0.0

Table 5.119. Reaction rates with fractional standard deviation (238-group ENDF/B-V data)

Material	R(SIG_abs)	R(SIG_fiss)	R(NU*SIG_fis)
^{239}Pu	4.74211-1 ± 4.3-3	3.28652-1 ± 4.3-3	9.50999-1 ± 4.3-3
^{240}Pu	3.35352-2 ± 1.2-2	5.00752-4 ± 3.8-3	1.57581-3 ± 3.9-3
^{241}Pu	1.24497-2 ± 4.2-3	9.22784-3 ± 4.2-3	2.72702-2 ± 4.2-3
O	3.31885-4 ± 1.2-2	0.0	0.0

5.11 SQUARE LATTICES OF MOX RODS WITH 2 wt % PuO_2*

5.11.1 Description of Experimental Configuration

Experiments were performed in a reactor tank 6 ft in diameter and 9 ft in depth. Fuel rod dimensions are given in Fig. 5.9. The natural UO_2 powder at the fuel rod base is about 0.5 cm in depth.[25,26] The vertical dimensions of the assembly in terms of the moderator height are given in Fig. 5.10 in inches. The fuel rods were positioned in the lattice by two aluminum "eggcrate" grids plates of dimensions provided in Fig. 5.11.

The same grid plates were used for the 0.70-in. and 0.99-in. pitch lattices. To attain a 0.99-in. pitch, the rods were placed in every other hole of the 0.70-in. rectangular grid, and every other row was offset 0.70 in. This created an effective pitch of 0.98995 in. Similarly, the 0.87-in. pitch lattices were attained by using 0.615-in. pitch grid plates with rods placed in every other hole, and every other row was offset 0.615 in. This created an effective pitch of 0.86974 in.

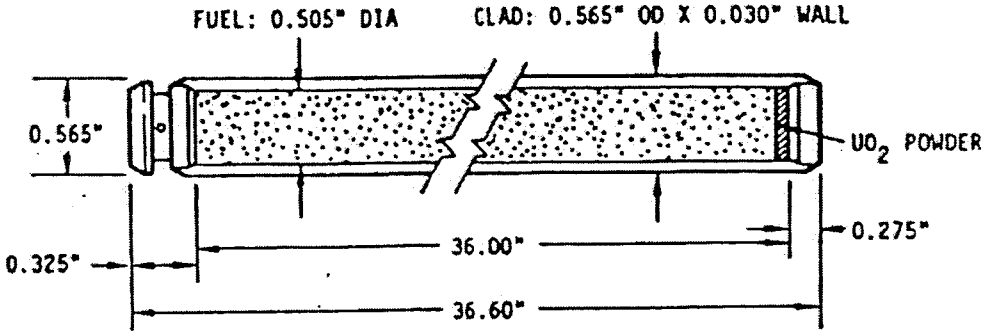
To determine the critical condition, experimentalists measured minor variations in boron concentration and extrapolated to the critical condition from slightly supercritical. Experimental data are provided in Table 5.120. Core configurations are given in Figs. 5.12–5.17.

*Since this work was performed, this experimental data has been published as MIX-COMP-THERM-002 in the *International Handbook of Evaluated Criticality Safety Benchmark Experiments.*

FUEL SPECIFICATIONS: UO_2 - 2 WT% PuO_2

FUEL RODS

1. ROD DIMENSIONS



2. CLADDING: ZIRCALOY-2 TUBING WITH PLUGS SEAL WELDED AT BOTH ENDS.
3. TOTAL WEIGHT OF LOADED FUEL RODS: 1340 gms (AVERAGE)

FUEL LOADINGS

1. PuO_2 MIXED IN NATURAL UO_2 AND VIBRATIONALLY COMPACTED.
2. 1128 gms OF UO_2-PuO_2 MIX/ROD.
3. CHEMICAL COMPOSITION WT%: Pu/PuO_2 = 88.1 U/UO_2 = 88.0 Pu/MIX = 1.760.
4. PuO_2 IS 2.00 WT% OF TOTAL MIXTURE.
5. FUEL DENSITY - 9.54 gm/cc (~87% THEORETICAL DENSITY).
6. UO_2 POWDER AT THE END OF FUEL COLUMN.
7. THE ISOTOPIC DISTRIBUTION OF PLUTONIUM

8% (NOMINAL) ^{240}Pu ATOM PERCENT
91.615 ^{239}Pu
7.654 ^{240}Pu
0.701 ^{241}Pu
0.031 ^{242}Pu

8. ANALYSIS DATE: JANUARY 1965
9. SEPARATIONS DATE: APRIL 1962
10. ^{241}Am CONTENT: NOT KNOWN

Fig. 5.9. Fuel rod specifications.

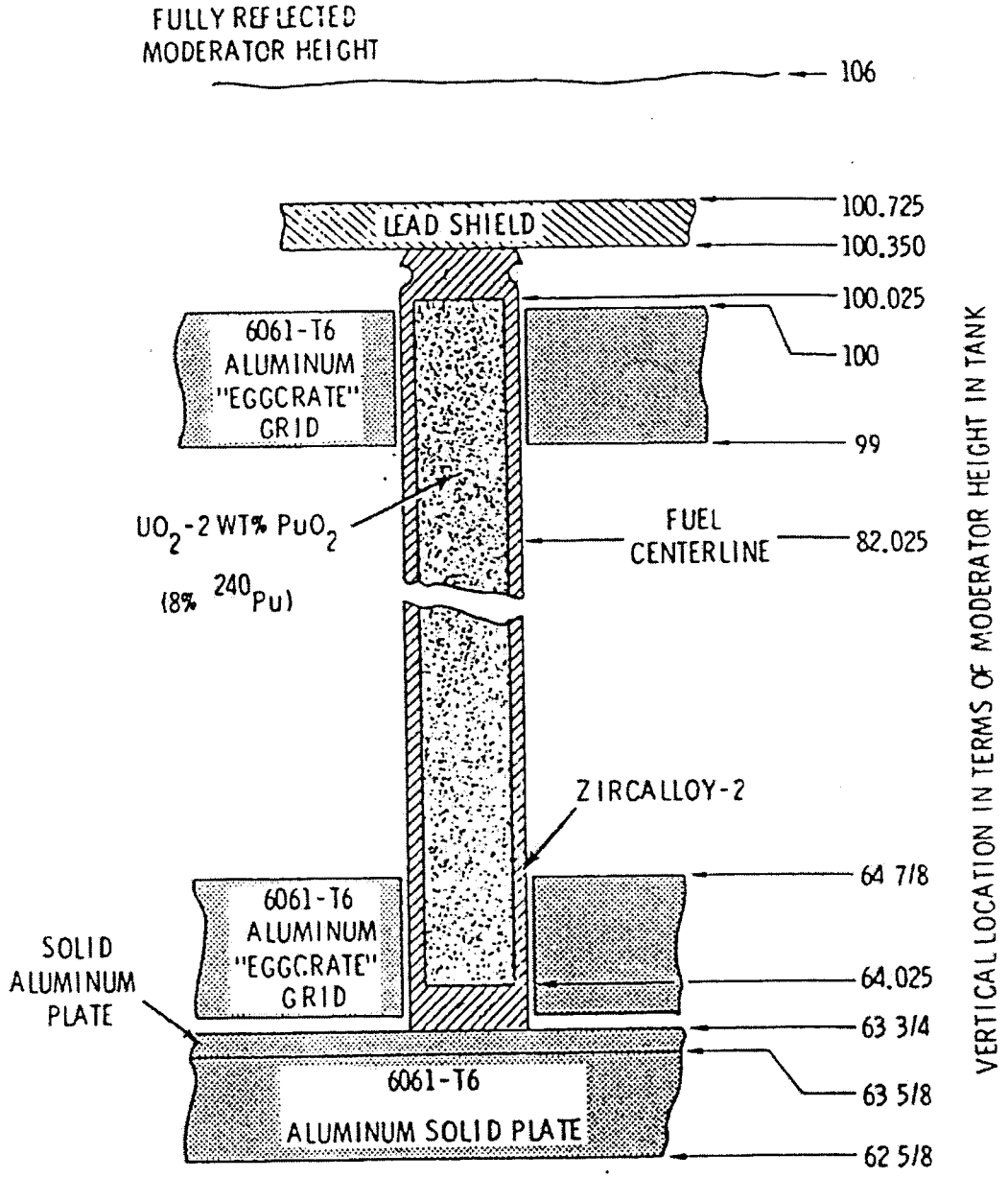
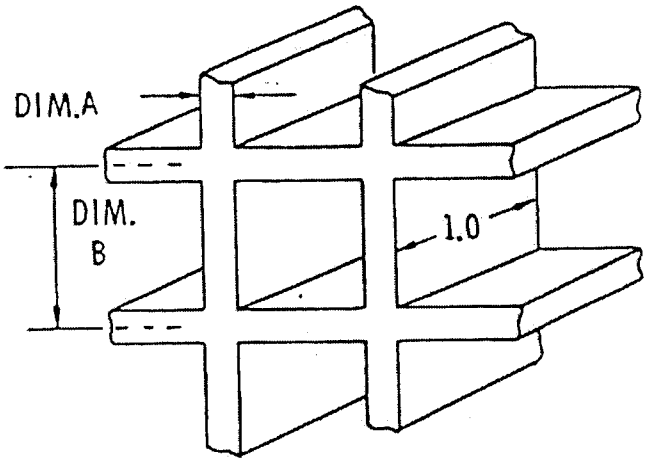


Fig. 5.10. Vertical dimensions (in.)



FUEL TYPE	PITCH	GRID	DIM.A	DIM B
UO_2-2.35% ^{235}U	0.615 0.87	UPPER LOWER	0.032 0.090	0.615
UO_2-2 WT% PuO_2 (8% ^{240}Pu)	0.87	UPPER LOWER	0.032 0.032	0.615
UO_2-2 WT% PuO_2 (8% ^{240}Pu)	0.70 0.99	UPPER LOWER	0.125 0.125	0.70

Fig. 5.11. "Eggcrate" grid plates.

Table 5.120. Experimental data

Experiment	Pitch (in.)	Rods	Boron (ppm)	Reflector[a] (in.)	Temperature (°C)
PNL-30	0.70	469	1.7 ± 0.1	6.0	20.98
PNL-31	0.70	761	687.9 ± 2	6.0	21.9
PNL-32	0.87	195	0.9 ± 0.2	2.25	22.75
PNL-33	0.87	761	1090.4 ± 2	6.0	22.66
PNL-34	0.99	160	1.6 ± 0.1	0.9	22.15
PNL-35	0.99	689	767.2 ± 2	6.0	23.4

[a]Top reflector above the top of the fuel.

Table 5.121. Fuel rod isotopic concentration

Isotope	wt %
^{238}Pu	0.009 ± 0.002
^{239}Pu	91.835 ± 0.018
^{240}Pu	7.760 ± 0.018
^{241}Pu	0.367 ± 0.004
^{242}Pu	0.028 ± 0.002
^{241}Am	64.6 ± 0.3 ppm[a]
^{234}U	0.0059 ± 0.0006
^{235}U	0.708 ± 0.004
^{236}U	<10 ppm
^{238}U	99.284 ± 0.004
Uranium	86.02 ± 0.06
Plutonium	1.788 ± 0.001

[a]Note: ppm UO_2-PuO_2 mixture.

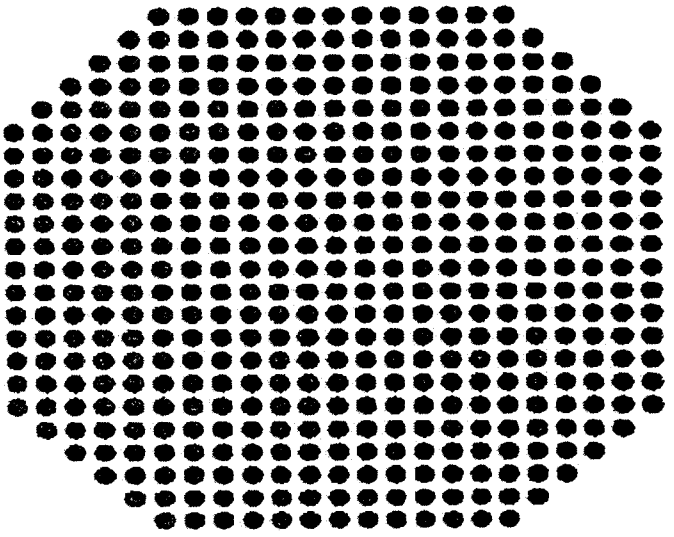


Fig. 5.12. PNL-30 core configuration.

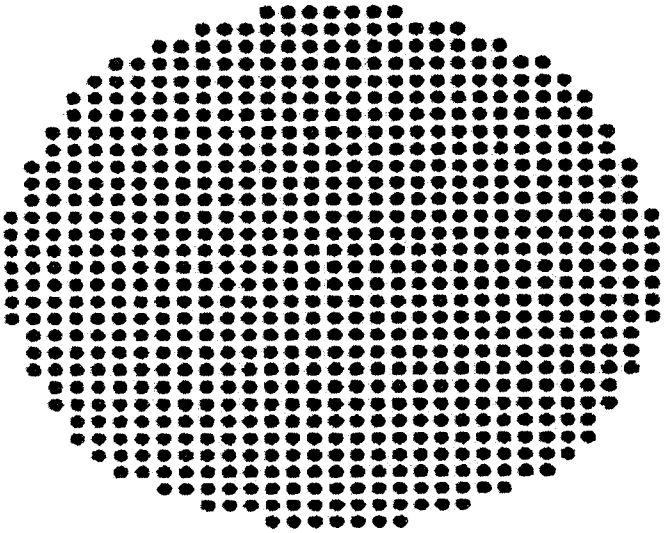


Fig. 5.13. PNL-31 core configuration.

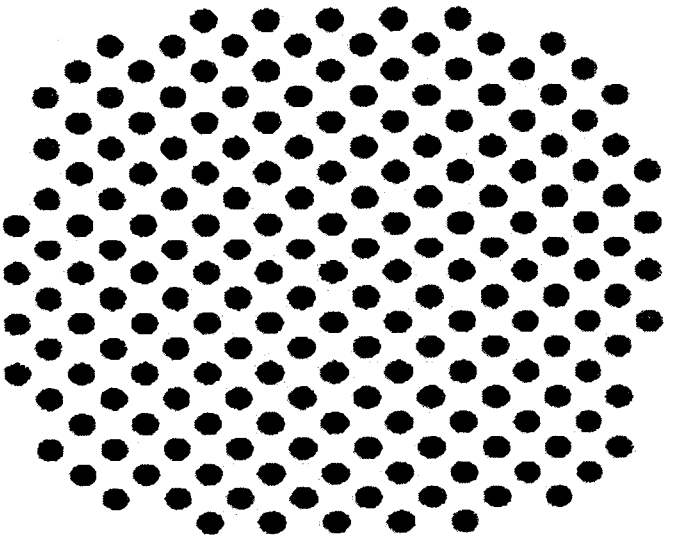


Fig. 5.14. PNL-32 core configuration.

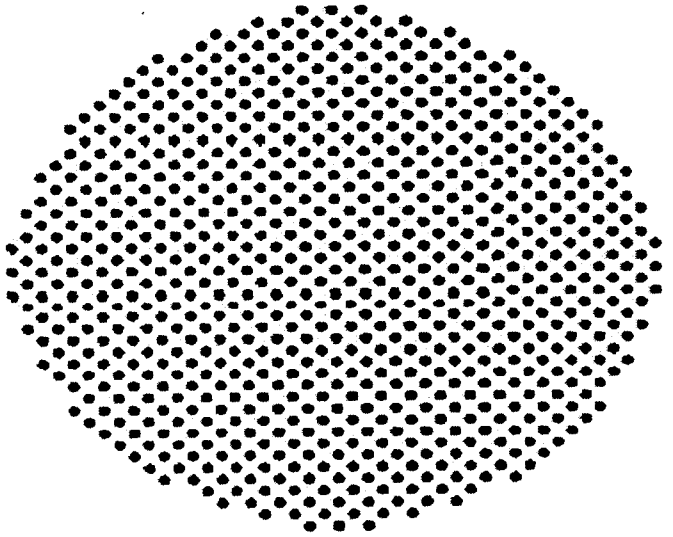


Fig. 5.15. PNL-33 core configuration.

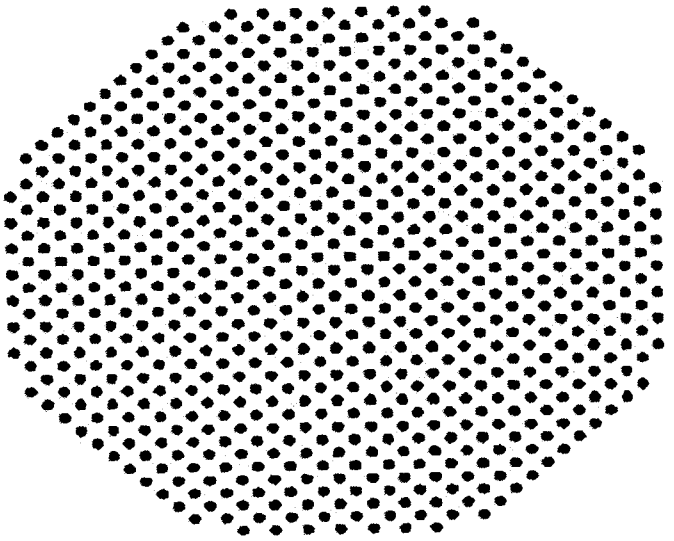


Fig. 5.16. PNL-34 core configuration.

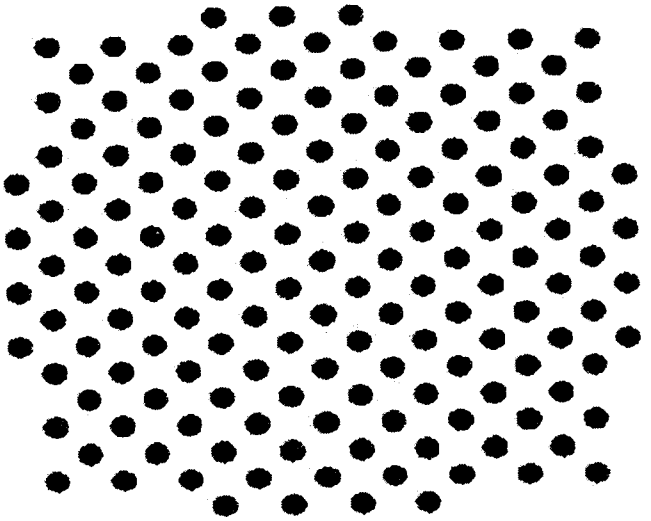


Fig. 5.17. PNL-35 core configuration.

5.11.1.1 Description of material data

The fuel rod material data of Fig. 5.9 are specifications for rods manufactured in 1962. The experiments were performed in 1975–1976. A sample analysis was performed in 1976 and reported in Ref. 26, to determine the isotopic concentration of the fuel. The results are provided in Table 5.121. Reference 25 reports 6 g of natural UO_2 in the bottom ~0.5 cm of each rod, giving a density of 9.286 g/cm^3.

The "eggcrate" lattice plates and support plate were 6061-T6 aluminum of 2.69 g/cm^3 and nominally 97.305 wt % Al, 0.6 wt % Si, 0.25 wt % Cu, 1.0 wt % Mg, 0.2 wt % Cr, and 0.645 wt % others. The fuel rod cladding and end plugs were made from Zircaloy-2. From the Standard Composition Library of SCALE, Zircaloy-2 is 99.225 wt % Zr, 1.5 wt % Sn, 0.125 wt % Fe, 0.100 wt % Cr, 0.05 wt % Ni, and of 6.56-g/cm^3 density. The lead shield has a density of 11.07 g/cm^3 and is 99.87 wt % Pb, 0.014 wt % Cu, 0.071 wt % Sb, and 0.045 wt % others. The atom fraction of ^{10}B in the moderator was found by isotopic analysis of the boric acid powder to be 19.8 ± 0.1%.

5.11.1.2 Supplemental experimental measurement

Foil activation measurements were conducted.

5.11.1.3 Evaluation of experimental data

No more is said in the references about the outer core structures than that the lattice support rods are about 1.5 in. from the core periphery, and the neutron sensing chambers were located at the core midplane in the radial reflector. Both the chambers and support rods effects on reactivity were measured and determined to be negligible. The lattice grid plates are shown to extend only slightly beyond the support rods; however, the top face of the reactor, presumably the lead shield and reactor lid, is shown to extend further beyond the support rods. No data are given on either the shield or grid plates dimensions aside from the thickness.

From LEU-COMP-THERM-015, the moderator nuclear densities for H, O, ^{10}B, and ^{11}B can be calculated from the following formula for H_3BO_3 crystals dissolved in pure water at 22°C:

$$N_H = 0.066714 - C_B \cdot 3.7647E{-}5,$$
$$N_O = 0.033357 - C_B \cdot 4.2253E{-}5,$$
$$N_{10_B} = 9.7387E{-}6 \cdot C_B \cdot 0.198,$$
$$N_{11_B} = 9.7387E{-}6 \cdot C_B \cdot 0.802,$$

where C_B is the mass in grams of H_3BO_3 added to 1000 cm^3 of water (Table 5.122).

Table 5.122. C_B values

Case	Boron (ppm)	C_B (g)
PNL-30	1.7	$9.7004e^{-3}$
PNL-31	687.9	3.9252
PNL-32	0.9	$5.1355e^{-3}$
PNL-33	1090.4	6.2219
PNL-34	1.6	$9.1298e^{-3}$
PNL-35	767.2	4.3777

A detailed sensitivity study has been performed in Ref. 27. The simplifications of uniform top end plug, 100 wt % lead compositions, and 30-cm water reflection below and to the sides were all judged to have negligible effects on k_{eff}. The experimental uncertainties that contribute to an uncertainty in the benchmark-model k_{eff} are given in Table 5.123.

Table 5.123. Uncertainty in benchmark-model k_{eff}

Uncertainty parameter	Δk_{eff} (%)					
	PNL-30	PNL-31	PNL-32	PNL-33	PNL-34	PNL-35
Fuel rod	0.143	0.115	0.153	0.330	0.313	0.490
Soluble boron	—	0.032	—	0.087	—	0.85
Reflector	0.054	0.026	0.044	0.027	0.061	0.025
Random pitch	0.131	0.070	0.091	0.095	0.027	0.071
PuO_2-UO_2 particle effect	0.04	0.04	0.11	0.11	0.14	0.14
Total	0.205	0.146	0.214	0.372	0.349	0.522

5.11.2 Benchmark Specifications

5.11.2.1 Description of model

The models are of Zircaloy-2 clad fuel pins in square lattices of 0.70-, 0.87-, or 0.99-in. pitch with borated water moderation. For the later two lattices, water holes were modeled between fuel rod positions of the 0.615- and 0.70-in. pitch lattices to obtain the desired pitch (0.87- and 0.99-in.). The modeled core configurations are shown in Figs. 5.12–5.17 for PNL-30–35.

5.11.2.2 Dimensions

Tight adherence was kept to the dimensions of Figs. 5.9 and 5.10. The lattice plates and fuel rod support plate were assumed to be square in cross section with sides equal the pitch times the length or

width. For all cores the length equaled the width. The core periphery was radially and axially (Z-direction) reflected by 30.48 cm of full-density water. The fuel pin top end plug was modeled as a solid cylinder of Zircaloy-2. Again, the natural UO_2 layer was taken to be 0.5 cm thick.

The same grid plates were used for the 0.70- and 0.99-in. pitch lattices. To attain a 0.99-in. pitch, the rods were placed in every other hole of the 0.70-in. rectangular grid, and every other row was offset 0.70 in. With the inclusion of water holes between fuel pins, the pin placement created an effective pitch of 0.98995 in. Similarly, the 0.87-in. pitch lattices were attained by using 0.615-in. pitch grid plates with rods placed in every other hole, and every other row was offset 0.615 in. With the inclusion of water holes between fuel pins, the pin placement creates an effective pitch of 0.86974 in.

5.11.2.3 Material data

Lead and aluminum were modeled as pure substances at the densities reported. The natural UO_2 assumed an isotopic distribution of uranium at 0.0055 wt % ^{234}U, 0.720 wt % ^{235}U, and 99.2745 wt % ^{238}U, default of the SCALE Material Information Processor. The moderator was taken to be 22°C for all cases (a maximum deviation of −1.4°C). The number densities of the moderator for each experimental model are given in Table 5.124. All other materials were treated at the reported experimental temperature. The number densities for the structural material, cladding, and fuel are given in Table 5.125.

Table 5.124. Moderator number densities (atoms/b-cm)

Case	H	O	^{10}B	^{11}B
PNL-30	6.6714E-2	3.3357E-2	1.8705E-8	7.5764E-8
PNL-31	6.6566E-2	3.3191E-2	7.5689E-6	3.0658E-5
PNL-32	6.6714E-2	3.3357E-2	9.9026E-9	4.0110E-8
PNL-33	6.6480E-2	3.3094E-2	1.9985E-5	4.8596E-5
PNL-34	6.6714E-2	3.3357E-2	1.7605E-8	7.1307E-8
PNL-35	6.6549E-2	3.3172E-2	8.4414E-6	3.4192E-5

Table 5.125. Fuel, clad, and structural material number densities (atoms/b-cm)

Element/nuclide	Number density
UO_2-PuO_2	
^{238}Pu	3.8836E-8
^{239}Pu	3.9462E-4
^{240}Pu	3.3206E-5
^{241}Pu	1.5639E-6
^{242}Pu	1.1882E-7
^{234}U	1.2458E-6
^{235}U	1.4886E-4
^{236}U	2.0936E-9
^{238}U	2.0611E-2
^{241}Am	1.5396E-6
O	4.3779E-2

Table 5.125. (continued)

Element/nuclide	Number density
Natural UO_2	
^{234}U	1.1392E-6
^{235}U	1.4913E-4
^{238}U	2.0562E-2
O	4.1424E-2
Zircaloy-2	
Zr	4.2539E-2
Cr	7.5978E-5
Fe	8.8427E-5
Sn	6.6358E-4
N	1.4106E-4
Structural	
Al	6.0041E-2
Pb	3.2171E-2

5.11.2.4 Temperature data

The experiments and experimental temperatures are as follows: PNL-30 (20.98°C), PNL-31 (21.9°C), PNL-32 (22.75°C), PNL-33 (22.66°C), PNL-34 (22.15°C), and PNL-35 (23.4°C).

5.11.2.5 Experimental and benchmark-model k_{eff}

As previously mentioned, a detailed sensitivity study was performed in Ref. 27. The reported experimental k_{eff} values are slightly above 1.0, and the benchmark-model k_{eff} is modified because of PuO_2 particle effects and different experimental temperatures as shown in Table 5.126.

Table 5.126. Experimental and benchmark-model k_{eff}

Parameter case	Experimental k_{eff}[a]	Δk_{eff} PuO_2 particle effect	Δk_{eff} temperature effect	Benchmark-model k_{eff}
PNL-30	1.00018	+0.0008	–0.00006	1.0009
PNL-31	1.00006	+0.0008	–0.00016	1.0007
PNL-32	1.00019	+0.0022	–0.00007	1.0023
PNL-33	1.00022	+0.0022	+0.00011	1.0025
PNL-34	1.00096	+0.0028	+0.00013	1.0039
PNL-35	1.00013	+0.0028	–0.00029	1.0026

[a]Experimental k_{eff} = 1.00 + excess reactivity (cents) × 3.447 × 10^{-5}.

Combining Tables 5.123 and 5.126 data, the benchmark-model k_{eff} values for the models are 1.0009 ± 0.0021 (PNL-30), 1.0007 ± 0.0015 (PNL-31), 1.0023 ± 0.0021 (PNL-32), 1.0025 ± 0.0037 (PNL-33), 1.0039 ± 0.0035 (PNL-34), and 1.0026 ± 0.0052 (PNL-35).

5.11.3 Results

Tables 5.127 and 5.128 contain the calculated neutron multiplication factors, k_{eff}, and associated deviations from KENO-V.a. The calculations were performed using the model descriptions provided previously. The nominal k_{eff} values calculated with the 44-group ENDF/B-V cross section library have

Table 5.127. Calculational results of KENO-V.a

Case	44-group ENDF/B-V	238-group ENDF/B-V
PNL-30	0.9997 ± 0.0016	0.9929 ± 0.0016
PNL-31	0.9977 ± 0.0016	0.9963 ± 0.0015
PNL-32	0.9997 ± 0.0015	1.0017 ± 0.0017
PNL-33	1.0074 ± 0.0015	1.0071 ± 0.0014
PNL-34	1.0050 ± 0.0017	1.0044 ± 0.0017
PNL-35	1.0101 ± 0.0015	1.0054 ± 0.0014

Table 5.128. Reaction rates (1/s)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	PNL-30		
^{241}Am	$1.27486e^{-3}$	$1.6391e^{-5}$	$5.4629e^{-5}$
^{238}Pu	$1.3431e^{-5}$	$1.0184e^{-6}$	$3.0623e^{-6}$
^{239}Pu	$3.9900e^{-1}$	$2.6686e^{-1}$	$7.7146e^{-1}$
^{240}Pu	$3.5027e^{-2}$	$2.2949e^{-4}$	$7.1297e^{-4}$
^{241}Pu	$1.7886e^{-3}$	$1.3183e^{-3}$	$3.8954e^{-3}$
^{242}Pu	$4.2952e^{-5}$	$6.3030e^{-7}$	$1.9918e^{-6}$
^{234}U	$2.8507e^{-4}$	$7.9280e^{-6}$	$2.0806e^{-5}$
^{235}U	$7.2151e^{-2}$	$5.8658e^{-2}$	$1.4311e^{-1}$
^{236}U	$1.9897e^{-7}$	$7.7042e^{-9}$	$1.9776e^{-8}$
^{238}U	$1.9313e^{-1}$	$2.5963e^{-2}$	$7.2846e^{-2}$
O	$4.8312e^{-3}$	–	–
Zr	$4.8556e^{-3}$	–	–
Sn	$3.4856e^{-4}$	–	–
Cr	$5.4602e^{-5}$	–	–
Fe	$5.2065e^{-5}$	–	–
N	$7.6876e^{-5}$	–	–
H	$2.8070e^{-1}$	–	–
B–10	$9.0963e^{-4}$	–	–
B–11	$4.8432e^{-9}$	–	–
Al	$1.1619e^{-3}$	–	–
Pb	$1.6836e^{-4}$	–	–
^{241}Am	$1.3383e^{-3}$	$1.7490e^{-5}$	$5.8337e^{-5}$
^{238}Pu	$1.2907e^{-5}$	$1.0694e^{-6}$	$3.2195e^{-6}$
^{239}Pu	$4.0106e^{-1}$	$2.6618e^{-1}$	$7.6943e^{-1}$
^{240}Pu	$3.8851e^{-2}$	$2.4966e^{-4}$	$7.7507e^{-4}$
^{241}Pu	$1.7656e^{-3}$	$1.2999e^{-3}$	$3.8413e^{-3}$
^{242}Pu	$4.8002e^{-5}$	$6.8406e^{-7}$	$2.1605e^{-6}$
^{234}U	$3.0948e^{-4}$	$8.5701e^{-6}$	$2.2489e^{-5}$
^{235}U	$7.0789e^{-2}$	$5.7079e^{-2}$	$1.3928e^{-1}$
^{236}U	$2.1781e^{-7}$	$8.3766e^{-9}$	$2.1486e^{-8}$
^{238}U	$2.1101e^{-1}$	$2.7946e^{-2}$	$7.8416e^{-2}$
O	$4.8375e^{-3}$	–	–

Table 5.128. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
	PNL-31		
Zr	$5.1649e^{-3}$	–	–
Sn	$3.7826e^{-4}$	–	–
Cr	$5.2573e^{-5}$	–	–
Fe	$5.0065e^{-5}$	–	–
N	$7.5742e^{-5}$	–	–
H	$1.1205e^{-1}$	–	–
B–10	$1.4726e^{-1}$	–	–
B–11	$7.9239e^{-7}$	–	–
Al	$9.5475e^{-4}$	–	–
Pb	$1.2305e^{-4}$	–	–
	PNL-32		
^{241}Am	$1.0862e^{-3}$	$1.1682e^{-5}$	$3.8590e^{-5}$
^{238}Pu	$1.5090e^{-5}$	$7.8873e^{-7}$	$2.3540e^{-6}$
^{239}Pu	$4.0213e^{-1}$	$2.7467e^{-1}$	$7.9413e^{-1}$
^{240}Pu	$2.5449e^{-2}$	$1.3742e^{-4}$	$4.2855e^{-4}$
^{241}Pu	$1.8744e^{-3}$	$1.3827e^{-3}$	$4.0847e^{-3}$
^{242}Pu	$2.5686e^{-5}$	$3.7896e^{-7}$	$1.2023e^{-6}$
^{234}U	$2.0841e^{-4}$	$4.9095e^{-6}$	$1.2888e^{-5}$
^{235}U	$7.6203e^{-2}$	$6.3504e^{-2}$	$1.5485e^{-1}$
^{236}U	$1.1660e^{-7}$	$4.6637e^{-9}$	$1.2019e^{-8}$
^{238}U	$1.3018e^{-1}$	$1.6270e^{-2}$	$4.5736e^{-2}$
O	$4.6614e^{-3}$	–	–
Zr	$3.4789e^{-3}$	–	–
Sn	$2.2158e^{-4}$	–	–
Cr	$5.7108e^{-5}$	–	–
Fe	$5.4693e^{-5}$	–	–
N	$7.3818e^{-5}$	–	–
H	$3.3836e^{-1}$	–	–
B–10	$5.8047e^{-4}$	–	–
B–11	$3.0890e^{-9}$	–	–
Al	$1.1896e^{-3}$	–	–
Pb	$1.3948e^{-4}$	–	–
	PNL-33		
^{241}Am	$1.1841e^{-3}$	$1.3160e^{-5}$	$4.3577e^{-5}$
^{238}Pu	$1.4299e^{-5}$	$8.4121e^{-7}$	$2.5179e^{-6}$
^{239}Pu	$4.1063e^{-1}$	$2.7707e^{-1}$	$8.0092e^{-1}$
^{240}Pu	$3.0689e^{-2}$	$1.6202e^{-4}$	$5.0484e^{-4}$
^{241}Pu	$1.8574e^{-3}$	$1.3688e^{-3}$	$4.0438e^{-3}$
^{242}Pu	$3.1919e^{-5}$	$4.4485e^{-7}$	$1.4106e^{-6}$
^{234}U	$2.3924e^{-4}$	$5.6890e^{-6}$	$1.4949e^{-5}$
^{235}U	$7.4197e^{-2}$	$6.1275e^{-2}$	$1.4944e^{-1}$
^{236}U	$1.4447e^{-7}$	$5.5573e^{-9}$	$1.4298e^{-8}$
^{238}U	$1.5259e^{-1}$	$1.8974e^{-2}$	$5.3348e^{-2}$
O	$4.6440e^{-3}$	–	–
Zr	$3.8132e^{-3}$	–	–
Sn	$2.5677e^{-4}$	–	–
Cr	$5.5036e^{-5}$	–	–
Fe	$5.2654e^{-5}$	–	–
N	$7.3119e^{-5}$	–	–

Table 5.128. (continued)

Element/nuclide	$R(\Sigma_a/\Sigma_t)$	$R(\Sigma_f/\Sigma_t)$	$R(\nu\Sigma_f/\Sigma_t)$
H	$1.0314e^{-1}$	–	–
B–10	$2.1516e^{-1}$	–	–
B–11	$1.1653e^{-6}$	–	–
Al	$9.0686e^{-4}$	–	–
Pb	$1.2486e^{-4}$	–	–
	PNL-34		
^{241}Am	$1.0297e^{-3}$	$1.0277e^{-5}$	$3.3794e^{-5}$
^{238}Pu	$1.5787e^{-5}$	$7.3262e^{-7}$	$2.1785e^{-6}$
^{239}Pu	$4.0183e^{-1}$	$2.7673e^{-1}$	$8.0012e^{-1}$
^{240}Pu	$2.1860e^{-2}$	$1.1054e^{-4}$	$3.4526e^{-4}$
^{241}Pu	$1.9073e^{-3}$	$1.4078e^{-3}$	$4.1585e^{-3}$
^{242}Pu	$1.9604e^{-5}$	$3.0535e^{-7}$	$9.7036e^{-7}$
^{234}U	$1.8319e^{-4}$	$4.0409e^{-6}$	$1.0560e^{-5}$
^{235}U	$7.8307e^{-2}$	$6.5676e^{-2}$	$1.6012e^{-1}$
^{236}U	$8.9190e^{-8}$	$3.7115e^{-9}$	$9.5960e^{-9}$
^{238}U	$1.1254e^{-1}$	$1.3279e^{-2}$	$3.7384e^{-2}$
O	$4.6894e^{-3}$	–	–
Zr	$3.1316e^{-3}$	–	–
Sn	$1.8839e^{-4}$	–	–
Cr	$5.8789e^{-5}$	–	–
Fe	$5.6359e^{-5}$	–	–
N	$7.3871e^{-5}$	–	–
H	$3.6736e^{-1}$	–	–
B–10	$1.1204e^{-3}$	–	–
B–11	$5.9641e^{-9}$	–	–
Al	$1.3653e^{-3}$	–	–
Pb	$2.0214e^{-4}$	–	–
	PNL-35		
^{241}Am	$1.0906e^{-3}$	$1.1302e^{-5}$	$3.7273e^{-5}$
^{238}Pu	$1.5100e^{-5}$	$7.6519e^{-7}$	$2.2816e^{-6}$
^{239}Pu	$4.0729e^{-1}$	$2.7781e^{-1}$	$8.0314e^{-1}$
^{240}Pu	$2.5846e^{-2}$	$1.2823e^{-4}$	$4.0025e^{-4}$
^{241}Pu	$1.8869e^{-3}$	$1.3912e^{-3}$	$4.1098e^{-3}$
^{242}Pu	$2.4747e^{-5}$	$3.5288e^{-7}$	$1.1210e^{-6}$
^{234}U	$2.0268e^{-4}$	$4.5937e^{-6}$	$1.2067e^{-5}$
^{235}U	$7.6236e^{-2}$	$6.3573e^{-2}$	$1.5501e^{-1}$
^{236}U	$1.1089e^{-7}$	$4.3879e^{-9}$	$1.1314e^{-8}$
^{238}U	$1.2759e^{-1}$	$1.5299e^{-2}$	$4.3063e^{-2}$
O	$4.5685e^{-3}$	–	–
Zr	$3.3436e^{-3}$	–	–
Sn	$2.1098e^{-4}$	–	–
Cr	$5.6881e^{-5}$	–	–
Fe	$5.4512e^{-5}$	–	–
N	$7.2974e^{-5}$	–	–
H	$1.4132e^{-1}$	–	–
B–10	$2.0718e^{-1}$	–	–
B–11	$1.1153e^{-6}$	–	–
Al	$1.2408e^{-3}$	–	–
Pb	$1.5346e^{-4}$	–	–

a mean k_{eff} of 1.0033 ± 0.0050, while the nominal k_{eff} values calculated with the 238-group ENDF/B-V cross section library have a mean k_{eff} of 1.0013 ± 0.0056. These statistics are based on the mean k_{eff} values of individual calculations and do not account for the uncertainty associated with each calculation.

Reaction rates, R(x), based on 238-group cross-sections, for all materials of the assembly (compacts and reflector), averaged over energy and volume of the assembly, are shown in Table 5.128 where Σ_a/Σ_t is the normalized absorption cross section, Σ_f/Σ_t is the normalized fission cross-section, and $\nu\Sigma_f/\Sigma_t$ is the normalized fission-product cross section. Table 5.129 lists the leakage from the reflector surface per source neutron and the EALCF and associated deviations.

Table 5.129. Leakage and EALCF

Case	Leakage	EALFC
PNL-30	$4.4321e^{-3} \pm 1.20e^{-4}$	$5.8328e^{-1} \pm 3.67e^{-3}$
PNL-31	$2.8164e^{-3} \pm 1.02e^{-4}$	$7.6863e^{-1} \pm 4.76e^{-3}$
PNL-32	$1.3252e^{-2} \pm 2.51e^{-4}$	$1.9374e^{-1} \pm 9.72e^{-4}$
PNL-33	$2.1826e^{-3} \pm 9.47e^{-5}$	$2.8020e^{-1} \pm 1.36e^{-3}$
PNL-34	$4.2840e^{-3} \pm 1.19e^{-4}$	$1.3616e^{-1} \pm 5.90e^{-4}$
PNL-35	$2.1181e^{-3} \pm 9.18e^{-5}$	$1.8209e^{-1} \pm 8.06e^{-4}$

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6. BIAS AND UNCERTAINTY FROM CRITICAL EXPERIMENTS

(J. J. Lichtenwalter)

For a subcritical configuration, it is desirable to have confidence that the calculation of k_{eff} for a system guarantees sufficient subcriticality; this is especially true in the absence of direct experimental measurements. This assurance of subcriticality requires the determination of an acceptable margin between a calculated value of k_{eff} and a maximum acceptable subcritical value based on known biases and uncertainties associated with the codes and data used to calculate k_{eff}. This section describes two methods for the determination of an upper subcritical limit (USL) from the bias and uncertainty terms associated with the calculation of criticality. American National Standards Institute (ANSI) standards serve as a basis for these approaches and are used in defining uncertainty and bias terms as they relate to criticality experiments and calculations. Descriptions are provided for the two methods, followed by the use of these methods based on calculated results given in the previous sections of this report. USLs are provided for various combinations of results from a set of 102 critical experiments calculated with the SCALE code system.

6.1 ESTABLISHMENT OF USL FOR SUBCRITICALITY

The recommended approach for establishing subcriticality based on the numerical calculation of the neutron multiplication factor is prescribed in Sect. 5.1 of ANSI/ANS-8.17.[1] The following paragraphs describe the recommended approach as set forth in the standard.

The criteria to establish subcriticality require that the calculated multiplication factor for a subcritical system, k_s, be less than or equal to an established maximum allowable multiplication factor based on benchmark calculations and uncertainty terms; that is,

$$k_s \leq k_c - \Delta k_s - \Delta k_c - \Delta k_m \ ,$$

where

k_c = mean value of k_{eff} resulting from the calculation of benchmark criticality experiments using a specific calculational method and data,
Δk_s = uncertainty in the value of k_s,
Δk_c = uncertainty in the value of k_c,
Δk_m = additional margin to assure subcriticality.

Often, Δk_m is assigned an administrative limit of 0.05; however, a value for this margin can also be determined statistically for a given confidence level.

If the calculational bias (β) is defined as $\beta = k_c - 1$, then the uncertainty in the bias is identical to the uncertainty in k_c (i.e., $\Delta k_c = \Delta\beta$). Thus, the subcriticality condition may be rewritten as

$$k_s + \Delta k_s + \Delta k_m - \beta + \Delta\beta \leq 1 \ .$$

The value k_c, and thus the bias β, is not necessarily a constant over the range of a parameter of interest. If trends exist that cause the benchmark values of k_{eff} to vary with one or more parameters (e.g., enrichment and burnup), then β can be determined from a best fit for the calculated k_{eff} values as a function of each of the parameters upon which it is dependent.

The set of critical experiments used as benchmarks in the computation of β should be representative of the composition, configuration, and nuclear characteristics of the system for which k_s is to be determined. However, ANSI/ANS-8.1[2] allows that the range of applicability may be extended beyond the range of conditions represented by the benchmark experiments by extrapolating the trends established for the bias. When the extrapolation is large relative to the range of data ("large" is undefined by the ANSI

standard), the calculational method applied should be supplemented by other methods to better estimate the extrapolated bias.

In addition to the bias, β, determined based on a given computational method, data, and a suite of benchmarks, there is an uncertainty in the bias, $\Delta\beta$. This uncertainty may include uncertainties in the critical experiments, statistical and/or convergence uncertainties in the benchmark calculations, uncertainties due to extrapolation beyond the range of experimental data, and uncertainties due to limitations or weaknesses in the geometrical or nuclear modeling of the critical experiments. Similarly, for a given subcritical system, there is an uncertainty, Δk_s, associated with the calculated k_{eff} value for the system, k_s. This uncertainty includes statistical/convergence and modeling uncertainties, as well as uncertainties in the materials and fabrication of the system components.

Based on the criteria for subcriticality set forth in ANSI/ANS-8.17 and described above, the USL may be determined based on the analysis of a number of critical systems. The USL is determined such that there is a high degree of confidence that a calculated result is subcritical; a system is considered acceptably subcritical if a calculated k_{eff} plus calculational uncertainties lies at or below this limit (i.e., $k_s + \Delta k_s \leq$ USL). Thus, the USL is the magnitude of the sum of the biases, uncertainties, and administrative and/or statistical margins applied to a set of critical benchmarks such that with a high degree of confidence,

$$\text{USL} = 1 - \Delta k_m + \beta - \Delta\beta \ .$$

For a given set of critical experiments, USLs are determined as a function of key system parameters, such as the average energy group causing fission (AEG), fuel enrichment, or fuel/moderator ratio. Because both β and $\Delta\beta$ can vary with a given parameter, the USL is typically expressed as a function of the parameter, within an appropriate range of applicability derived from the parameter bounds.

Two approaches used in calculating the USL are discussed in the following subsection. This discussion is followed by the determination of USLs by both methods for various sets of critical calculations.

6.2 METHODS FOR DETERMINING THE USL

In this subsection, two different methods for determining the USL of a subcritical configuration are presented and discussed. The USLs calculated based on each of these methods and selected sets of critical calculations are presented subsequently.

6.2.1 USL Method 1: Confidence Band with Administrative Margin

One possible statistical approach is a USL determined as the lower bound of a set of two margins applied to a linear fit of calculated data. This approach is illustrated in Fig. 6.1. In this figure, the upper line (solid) represents a linear regression fit to a set of calculations based on critical experiments, $k_c(x)$. The calculational bias $\beta(x)$ is not depicted but is simply $k_c(x) - 1$. The middle line (long dashes) represents the lower confidence limit for a single additional calculation. The width of the band [distance between $k_c(x)$ and the confidence limit], W, is determined statistically based on the existing data and a specified level of confidence; the greater the standard deviation in the data or the larger the confidence desired, the larger the band width will be. This confidence band accounts for uncertainties in the experiments, the calculational approach, and the calculational data (e.g., cross sections), and is therefore a statistical basis for $\Delta\beta$, the uncertainty in the value of β.

$$W = \max\left[w(x_{min}), w(x_{max})\right] \ ,$$

W is defined for a confidence level of $(1 - \gamma_1)$ using the relationship where

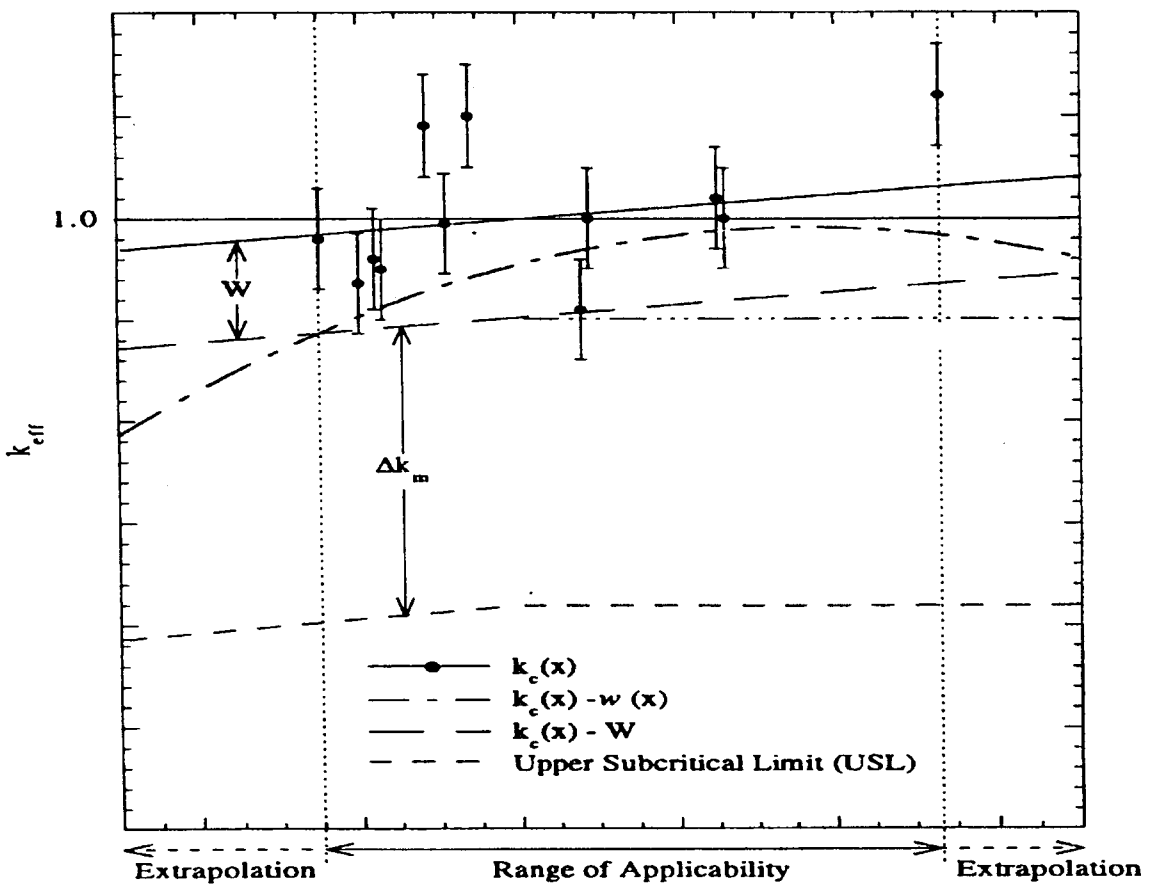

Fig. 6.1. Confidence band and subcritical margin applied to a set of criticality calculations.

$$w(x) = t_{\gamma_1} s_p \left(1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{\sum\limits_{i=1,n} (x_i - \bar{x})^2} \right)^{1/2}$$

and

n = the number of critical calculations used in establishing $k_c(x)$,
t_{γ_1} = the Student-t distribution statistic for γ_1 and n-2 degrees of freedom,
$\bar{x}$ = the mean value of parameter x in the set of calculations,
s_p = the pooled standard deviation for the set of criticality calculations.

The function $w(x)$ is a curvilinear function. For simplicity, it is desirable to obtain a constant width margin. Hence, for conservatism, the confidence band width W is defined as the maximum of $[w(x_{min}), w(x_{max})]$, where x_{min} and x_{max} are the minimum and maximum values of the independent parameter x, respectively. Typically, W is determined at a 95% confidence level. The pooled standard deviation is obtained from the pooled variance $\left(s_p = \sqrt{s_p^2}\right)$, where s_p^2 is given as

$$s_p^2 = s_{k(x)}^2 + s_w^2 \ ,$$

where $s^2_{k(x)}$ is the variance (or mean-square error) of the regression fit and is given by

$$s^2_{k(x)} = \frac{1}{(n-2)} \left\{ \sum_{i=1,n} (k_i - \bar{k})^2 - \frac{\left[\sum_{i=1,n} (x_i - \bar{x})(k_i - \bar{k}) \right]^2}{\sum_{i-1,n} (x_i - \bar{x})^2} \right\} ,$$

and s^2_w is the within-variance of the data

$$s^2_w = \frac{1}{n} \sum_{i=1,n} \sigma_i^2 ,$$

where σ_i is the standard deviation associated with k_i for a Monte Carlo calculation. For deterministic codes that do not have a standard deviation associated with a computed value of k_{eff}, the standard deviation is set to the convergence criteria or residual.

The bottom line (short dashes) in Fig. 6.1 represents the USL, based on an additional margin of subcriticality. This subcritical margin provides further assurance of subcriticality and represents the quantity Δk_m defined earlier. In USL Method 1, Δk_m is given an arbitrary administrative value; as mentioned earlier, a value of 0.05 is often assigned. Using these formulations, the USL Method 1 is defined as

$$USL_1(x) = 1.0 - \Delta k_m - W + \beta(x) .$$

6.2.2 USL Method 2: Single-Sided Uniform Width Closed Interval Approach

In this method, sometimes referred to as a lower tolerance band (LTB) approach, statistical techniques with a more rigorous basis are applied to determine a combined lower confidence band plus subcritical margin. In other words, in the administrative margin approach, $\Delta\beta$ and Δk_m are determined independently; in the LTB method, a combined statistical lower bound is determined in terms of the product $C_{\alpha/\rho} \cdot s_p$, where s_p is the pooled variance of k_c described earlier, and $C_{\alpha/\rho}$ is a statistically determined multiplier. Thus the USL Method 2 is given as

$$USL_2(x) = 1.0 - (C_{\alpha/\rho} \cdot s_p) - \beta(x) .$$

The term $C_{\alpha/\rho} \cdot s_p$ provides a band for which there is a probability ρ that, with an α confidence, an additional calculation of k_{eff} for a critical system will lie within the band. For example, a $C_{95/99.5}$ multiplier produces a USL for which there is a 95% confidence that 995 out of 1000 future calculations of critical systems will yield a value of k_{eff} above the USL. Calculation of the multiplier $C_{\alpha/\rho}$ is somewhat complicated and beyond the scope of this report.[3] In essence, this approach provides a more statistically based subcritical margin, Δk_m, which can be determined as the difference $(C_{\alpha/\rho} \cdot s_p) - W$. In criticality and subcritical applications, such a statistically determined approach generally yields a margin of much less than 0.05, which serves to illustrate the conservatism that may be associated with an administrative margin. Often in the use of Method 1 in the determination of a USL, it is advantageous to apply Method 2 in tandem to demonstrate that the 5% margin is conservative relative to a purely statistical basis; this concurrent application of Method 2 is especially important when a limited number of data points are used in determination of $k_c(x)$ or when the calculated values have a large standard deviation.

6.3 CORRELATION

Before USLs can be applied to calculational results, any trends that cause the benchmark values of k_{eff} to vary with one or more parameters need to be identified. Based on the critical experiments described earlier in this report, it is possible to determine trends in k_{eff} based on various parameters, including temperature, reference number, H/^{239}Pu, energy of the average lethargy causing fission (EALCF), and Ga, B, Gd, Fe, N, O, H, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{235}U, ^{238}U atom densities. The important parameter in trending analysis is the correlation coefficient (Pearson's product moment coefficient) or quantitative measure of the closeness of a linear relationship between two variables given by

$$r_{x,y} = \frac{\sum xy - \frac{1}{n}\sum x \sum y}{(n-1)s_x s_y} ,$$

where $\sum xy$ is the sum of the xy cross-products, each x multiplied by its paired y; n is the sample size or number of data pairs; $\sum x$ and $\sum y$ are the sum of the x and y values; and s_x and s_y are the sample standard deviations of x and y. Note, both x and y must test normal (e.g., verify by using the chi-square test in USLSTATS).

If k_{eff} can be expressed exactly as a function of one of the listed variables above, for example H/^{239}Pu, then the correlation coefficient equals +1/–1, and the k_{eff} – H/^{239}Pu data are directly/inversely related. A correlation coefficient equal to zero implies that H/^{239}Pu has no linear predictability for k_{eff} and vice versa. In addition to direction, the correlation can have strength that is a reflection of the closeness of the data points to a perfect line and is measured by the magnitude of the coefficient (i.e., |r|). To determine the significance, t(%), of the k_{eff} – H/^{239}Pu bivariate relationship, knowing the sample correlation coefficient, r, and the sample size, n, the formula to test the null hypothesis that the population correlation equals zero is applied.

$$t = r\,(n-2)^{1/2}(1-r^2)^{-1/2} .$$

Finally, the coefficient of determination or the square of the correlation coefficient, r^2, can be used to measure the proportion of the variability that two variables share. For example, an $r^2 = 0.8$ means that 80% of the variability of each variable is explained by the other.

The CORR procedure of the Statistical Analysis System[4] was used to calculate the correlation coefficients between calculated k_{eff} values for the critical experiments and each of the parameters listed earlier in this section. From this calculation, N, Gd, Fe, H, Pu, and H/Pu were the only parameters for which a correlation with k_{eff} is noted (see Table 6.1). Parameters are ranked in the table from highest correlation to k_{eff} down to those that exceed the arbitrary cutoff values of $r = \pm 0.3$, considered a very weak correlation, for both cross section libraries used in the calculations. The table also provides the number of observations (calculations), n, parameter-k_{eff} pairs, and the significance probability of the correlation. The coefficient of determination is easily calculated by squaring the correlation coefficient and thus is not shown in Table 6.1.

6.4 CALCULATION OF USLs

Following the determination of correlation coefficients, USLs should be calculated for each parameter with a correlation coefficient exceeding a selected cutoff value. The following section demonstrates the calculation of the USL as a function of each correlated parameter using both methods described in the previous sections and the KENO V.a k_{eff} values for the set of 102 critical calculations of this report. The results of a simple statistical analysis performed on the 102 calculated k_{eff} values are listed in Table 6.2 and provide the range of k_{eff} values and the average bias associated with each cross section library. The

Table 6.1. Largest correlation coefficients

Library	Parameter	Observations	Correlation coefficient	Significance
238	N	73	0.503	99.99
238	Gd	19	–0.493	96.68
238	Fe	22	–0.404	94.41
238	H/^{239}Pu	101	0.375	99.99
238	H	101	0.373	99.99
44	Gd	19	–0.601	99.35
44	N	73	0.520	99.99
44	^{242}Pu	63	0.316	98.84

Table 6.2. Simple statistics of k_{eff}

Statistics	44-group ENDF/B-V	238-group ENDF/B-V
Observations	102	102
Mean	1.0069	1.0048
Average bias	0.69%	0.48%
Standard deviation	0.0077	0.0084
Maximum	1.0276	1.0266
Minimum	0.9890	0.9807

statistical program USLSTATS[3] version 1.3.2, developed at ORNL, was used to compute the USLs. USLSTATS was run with the following options: (1) the proportion of population of critical experiments that will lie above the line representing one tolerance level below the linear regression fit was chosen to be 99.5%, (2) the confidence level to be assigned to the linear regression fit of k_{eff} values was set to 95%, (3) the confidence of the proportion was chosen to be 95%, and (4) the administrative margin of was set to 0.05. The resulting output USLs are given in Figs. 6.2–6.9 as determined as a function of the parameters in Table 6.1. (Note, "unacceptable" experiments are believed to not be included in the USL calculations.)

The figures show the k_{eff} results for each subset, together with lines representing the regression fit $k_c(x)$ to the k_{eff} results; the regression fit minus the confidence band W defined for a confidence level of 95%, $k_c(x)$-W; the USL based on Method 1, ($USL_1 = k_c(x) - W - 0.05$); and the USL based on Method 2, [$USL_2 = k_c(x) - (C_{95/99.5} \cdot s_p)$]. The bias is not depicted but is the difference between $k_c(x)$ and one. The $k_c(x)$-W and USL_1 may be interpreted as follows: for a critical system similar to those validated, one would expect to calculate above $k_c(x)$-W, and similarly USL_1, for a single future estimate of k_{eff} at 95% confidence. USL_2 may be interpreted as follows: for a critical system similar to those validated, one would expect to calculate above USL_2 for 99.5% of the future estimates of k_{eff} at 95% confidence. Any calculated k_{eff} below USL_2 is considered subcritical.

In comparing the two USLs of the figures, note the substantial conservatism of Method 1 relative to Method 2. This can be seen more explicitly in Table 6.3. Table 6.3 gives the linear equations for the USL as a function of each parameter for Methods 1 and 2. Because the y-intercept term of this equation can be misleading, especially when the slope is large, USLs are also reported as evaluated at the minimum and maximum parameter bounds, or within the range of applicability.

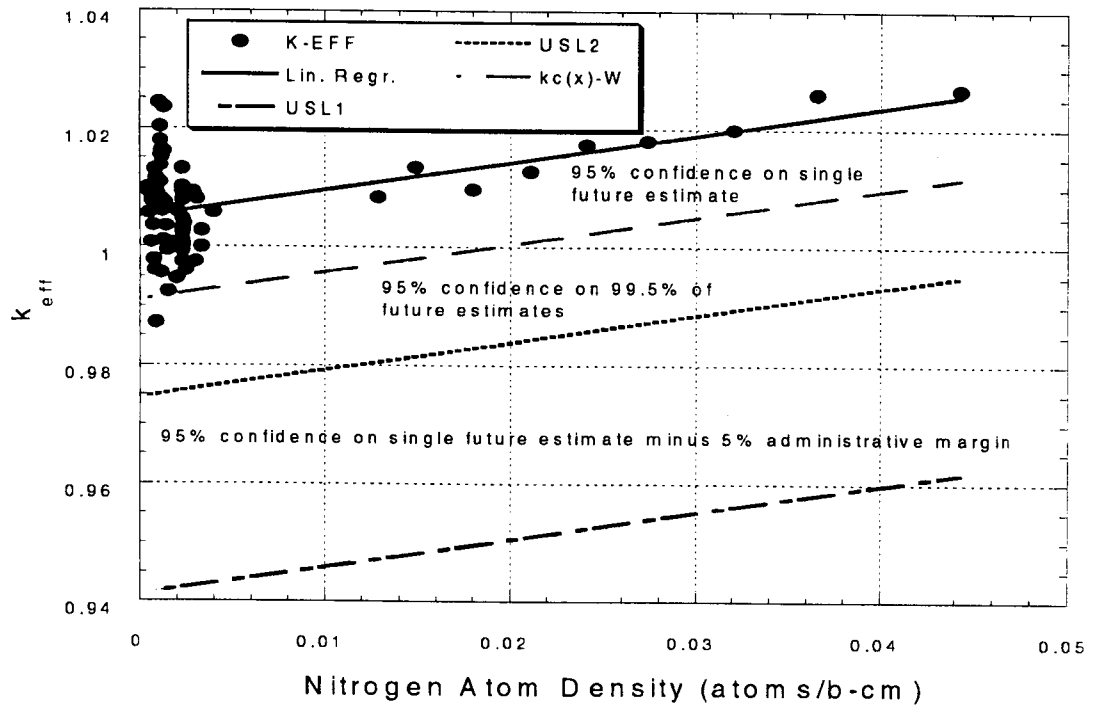

Fig. 6.2. USLs for 73 calculations with 238-group; k_{eff} vs nitrogen content.

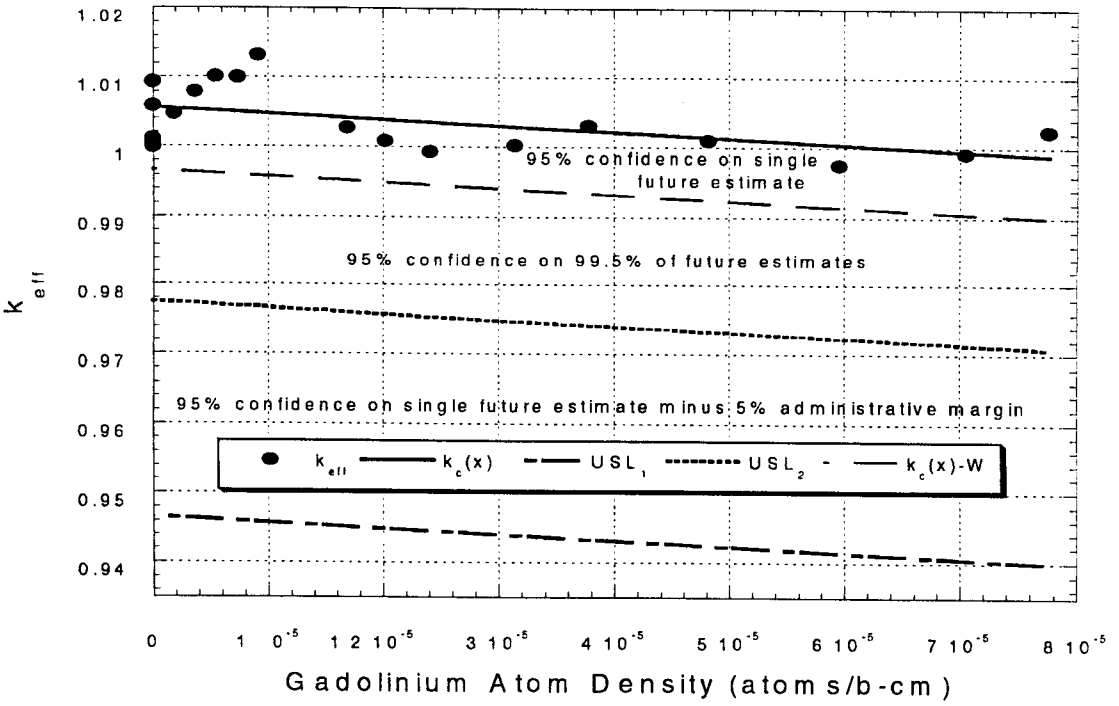

Fig. 6.3. USLs for 19 calculations with 238-group; k_{eff} vs gadolinium content.

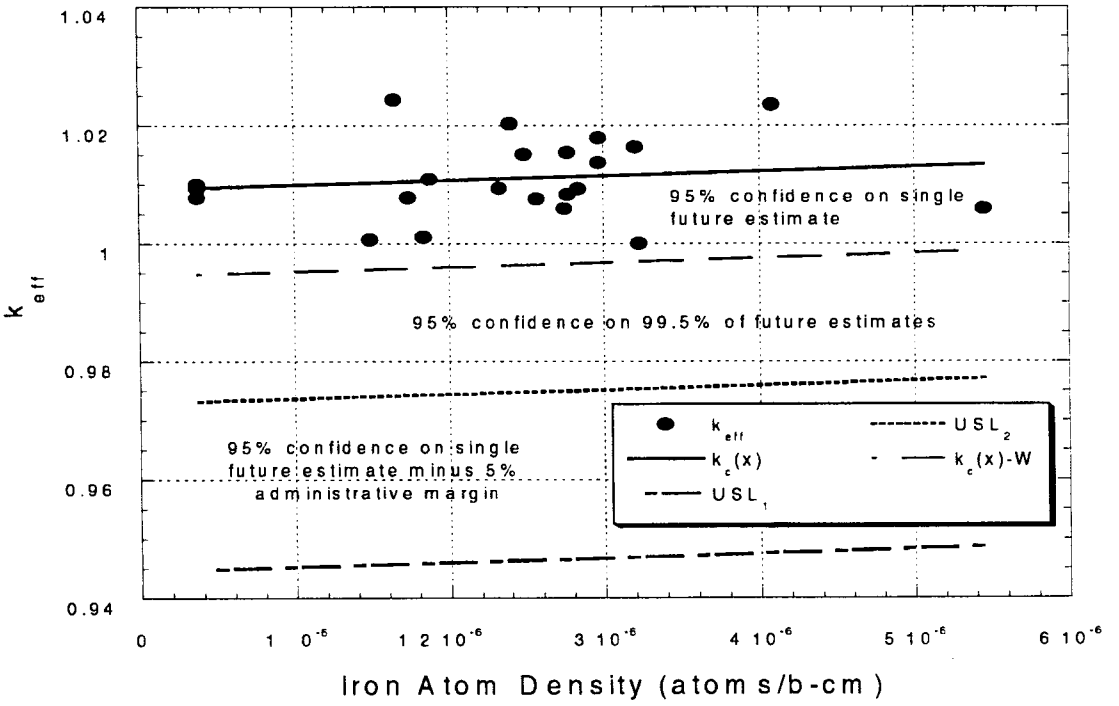

Fig. 6.4. USLs for 22 calculations with 238-group; k_{eff} vs iron content.

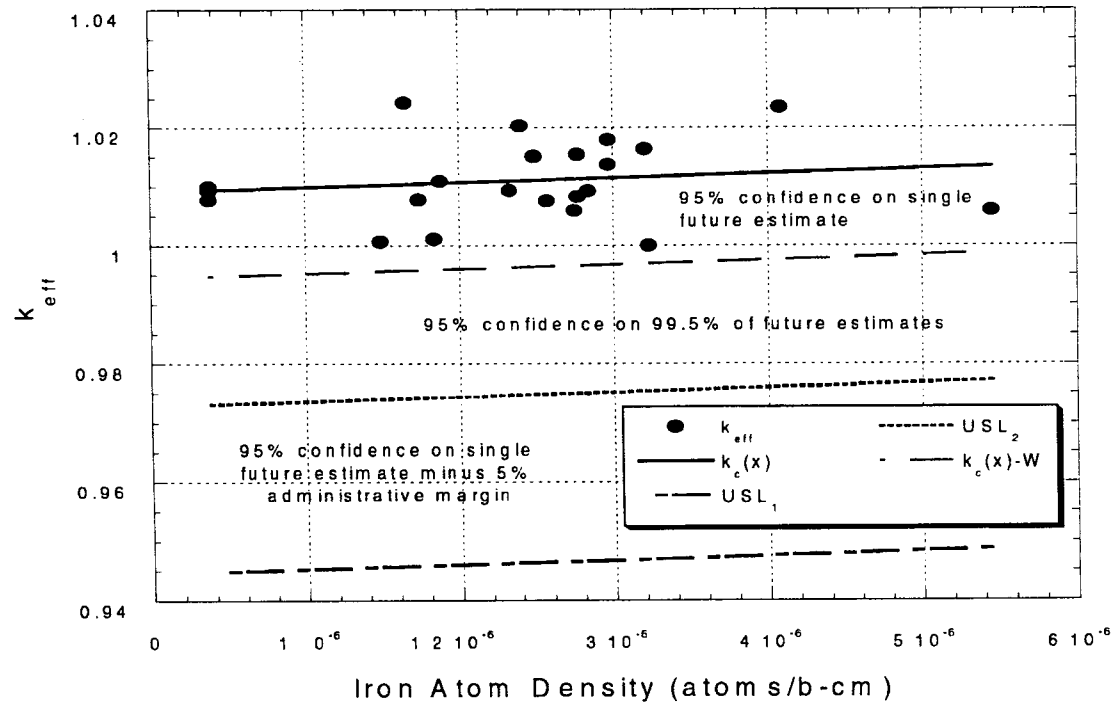

Fig. 6.5. USLs for 101 calculations with 238-group; k_{eff} vs H/^{239}Pu.

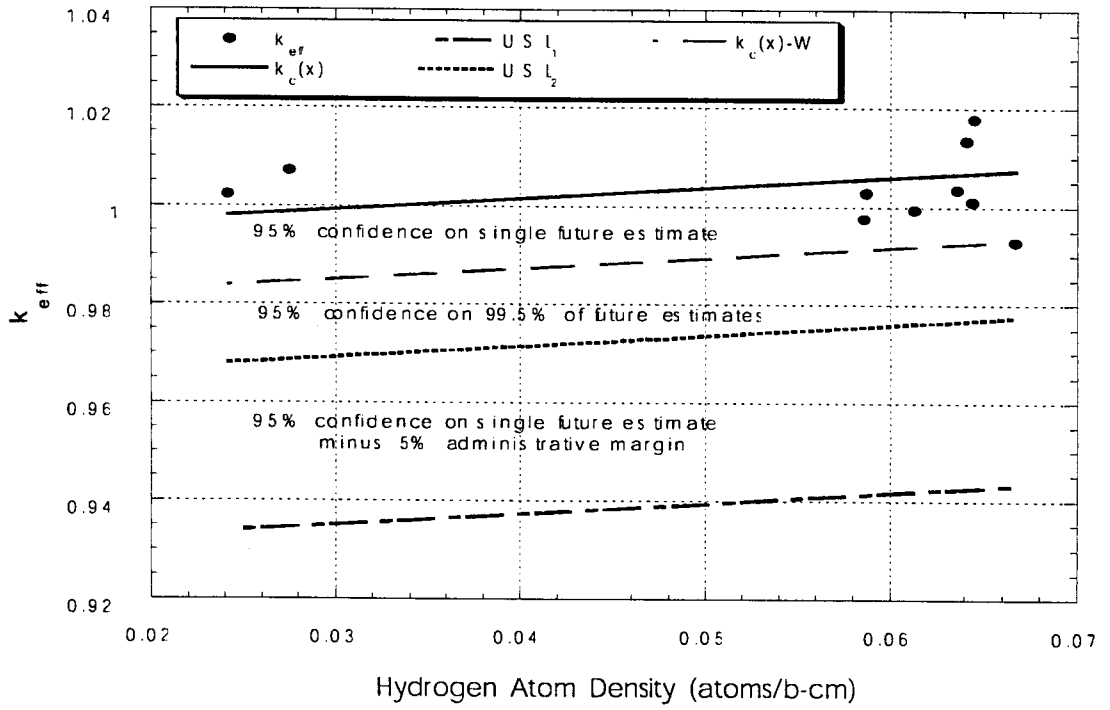

Fig. 6.6. USLs for 101 calculations with 238-group; k_{eff} vs hydrogen content.

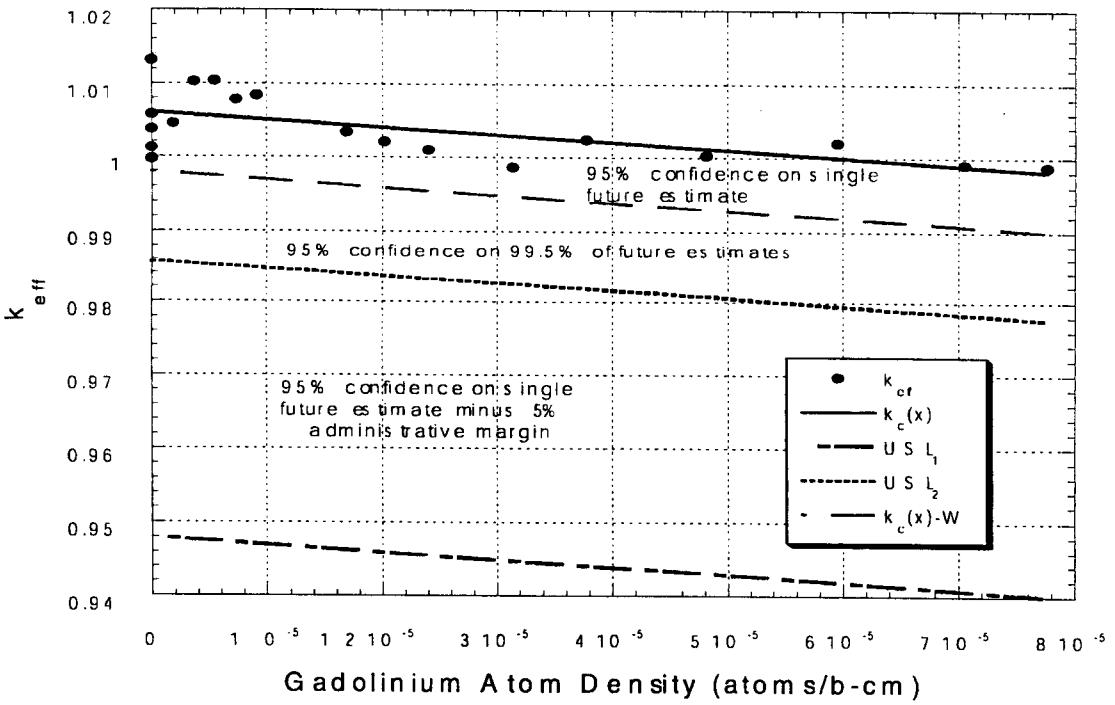

Fig. 6.7. USLs for 19 calculations with 44-group; k_{eff} vs gadolinium content.

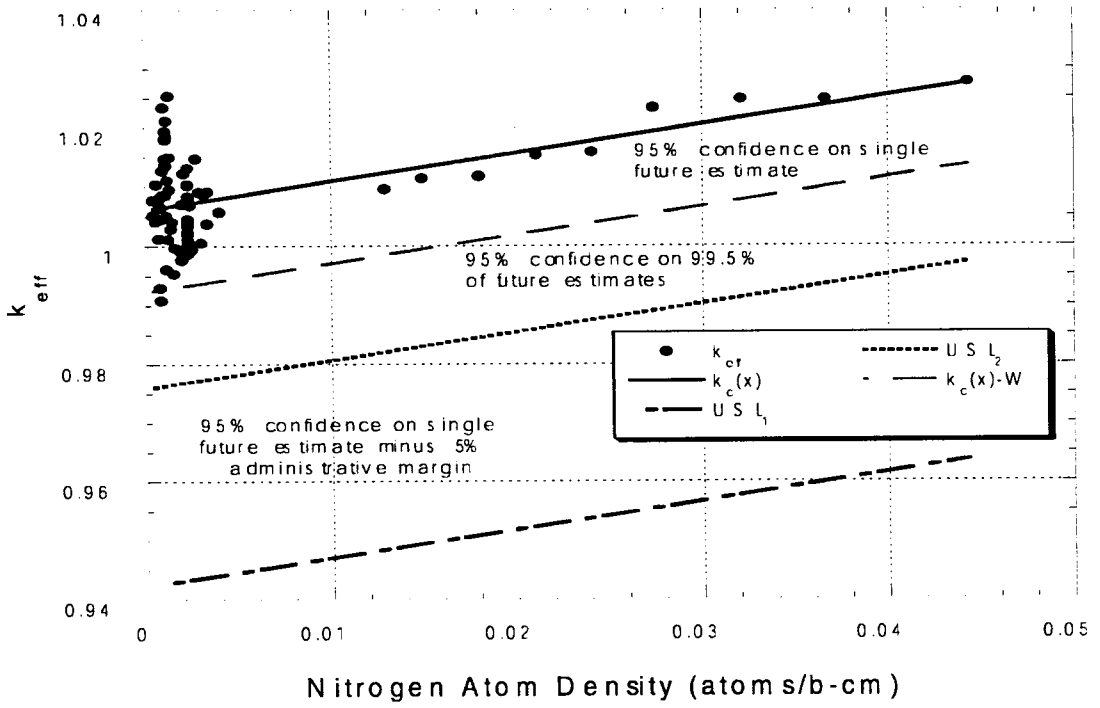

Fig. 6.8. USLs for 73 calculations with 44-group; k_{eff} vs nitrogen content.

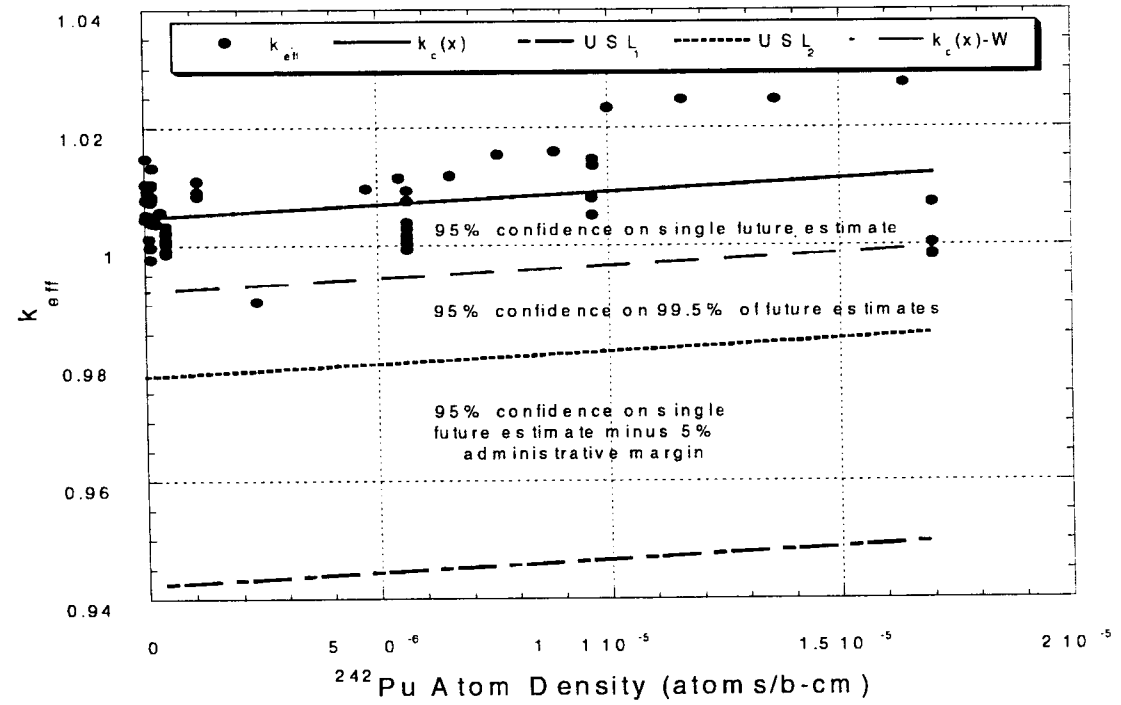

Fig. 6.9. USLs for 63 calculations with 44-group; k_{eff} vs ^{242}Pu content.

Further examination of the figures reveals that the deviation of the individual values with respect to $k_c(x)$ is not especially large; this indicates that the SCALE results have a relatively small uncertainty in the bias, which gives a reasonably high lower tolerance band (USL_2). This results in values for Δk_m in Table 6.3 around 0.02 based on a 95%/99.5% confidence level in the calculation of $C_{\alpha/\rho}$, compared with the assumed administrative margin of 0.05 used in the determination of USL_1.

Several conclusions can be drawn from the data. (1) In most cases, USL_1 and USL_2 are highest with a large number of critical experiments. (2) A visual inspection of the figures provides no reason to suspect that higher polynomial equations would generate better fits to k_{eff} values than linear equations, with the exception of Fig. 6.4. (3) A slight positive trend exists with hydrogen atom density and $H/^{239}Pu$ for the 238-group library, but, in general, no strong trends exist. (4) The recommended minimum of 25 experiments needed to have a significant amount of data (see significance in Table 6.1) for statistical normality was not reached for experiments with gadolinium and iron.

6.5 AREAS OF APPLICABILITY AND EXTRAPOLATION BEYOND

To use these USL methods in an application, it is necessary for the expected parameter value (design or calculational) to lie within the range of applicability of that parameter. This assures that the experiments consisted of the same, or very nearly the same, geometry configurations, materials of construction, and neutron energy spectrum of the safety evaluation for the design of interest. To achieve this, one should first determine the values of the parameters from Table 6.3 that characterize the desired application. Next, the class(es) of experiments in Table 6.3 should be checked to determine which class(es) share similar geometry, neutron energy spectrum, and materials of construction, to the application of concern. It is suggested that the parameter with the strongest correlation to k_{eff} values be used to generate the USLs, using the same code and cross section library. The range of values of this key parameter defines the range of applicability for the USLs. The value of the key parameter for the application of concern must lie within this range to apply the USL.

Table 6.3. Summary of USL calculations for various sets of data

Parameter, x	Bounds	Δkm[a]	USL1(x)	USL2(x)
238-Group				
N	4.68E–4 – 4.43E–2	1.65E–2	0.9412 + 4.6354E–1*x	0.9746 + 4.6354E–1*x
Gd	1.98E–9 – 7.76E–5	1.36E–2	0.9466–8.6419E+1*x	0.9830–8.6419E+1*x
Fe	3.76E–7 – 5.45E–6	2.16E–2	0.9445 + 7.77924E+2*x	0.9729 + 7.7792E+2*x
$H/^{239}Pu$	0–2437	1.64E–2	0.9378 + 6.6039E–6*x	0.9714 + 6.6039E–6*x
H	0–6.67E–2	1.57E–2	0.9285 + 2.1975E–1*x	0.9627 + 2.1975E–1*x
44-Group				
Gd	1.98E–9 – 7.76E–5	1.24E–2	0.9480 + 1.0245E+2*x	0.9856–1.0245E+2*x
N	4.68E–4 – 4.43E–2	1.64E–2	0.9423 + 4.822E–1*x	0.9745 + 4.8223E–1*x
^{242}Pu	1.63E–8 – 9.68E–6	1.44E–2	0.9423 + 4.3130E+2*x	0.9778 + 4.3130E+2*x

[a]Minimum margin of subcriticality.

For a given parameter, either of the methods for determining the USL is generally considered applicable over the range of that parameter in the set of calculations. However, ANSI/ANS-8.1 allows the range of applicability to be extended beyond this range by extrapolating the trends established for the bias. No precise guidelines are specified for the limits of extrapolation. Thus, engineering judgment and additional uncertainty should be applied when extrapolating more than a few percent beyond the range of the parameter bounds. For the parameters of this study, no significant trends were observed in the bias. This instilled confidence that an extrapolation of a few percent beyond the parameter bounds should not present a safety concern as long as the extrapolation uses the curvilinear function, $w(x)$, for the width of the confidence band beyond the range of applicability.

The reader should be aware that studies conducted by M. E. Dunn, ORNL, showed that subsets of these experiments (especially the highly moderated group) yield biases as a function of material properties and these biases can be obscured by the entire suite. The reader is cautioned to examine subsets that resemble specific applications.

6.6 REFERENCES

1. "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors," ANSI/ANS-8.17-1984, R1997, American Nuclear Society, 1997.
2. "Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors," ANSI/ANS-8.1-1984, R1998, American Nuclear Society, 1998.
3. S. M. Bowman, M. D. DeHart and C. V. Parks, "USLSTATS: Computerized Statistical Methods for Determination of Bias and Subcritical Limits," *Trans. American Nuclear Society*, **76**, 238–239, June 1997.
4. *SAS Users Guide: Basics*, 1982 Ed., SAS Institute, Inc., Cary, North Carolina.

Appendix A

DUSKVVER Output

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	1.0617	1.2602	.0015	u-235	8.7370E-04
				u-236	0.0000E+00
				pu-238	0.0000E+00
				pu-239	0.0000E+00
				pu-240	0.0000E+00
				pu-241	0.0000E+00
				pu-242	0.0000E+00
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08
2.00	1.0475	1.2418	.0013	u-235	8.2595E-04
				u-236	9.1428E-06
				pu-238	1.5184E-09
				pu-239	1.8349E-05
				pu-240	6.1047E-07
				pu-241	5.5302E-08
				pu-242	6.3621E-10
				xe-135	1.0234E-08
				sm-149	7.7138E-08
				Total FP	4.1570E-05
4.00	1.0335	1.2211	.0014	u-235	7.8088E-04
				u-236	1.7719E-05
				pu-238	8.4565E-09
				pu-239	3.3910E-05
				pu-240	2.0841E-06
				pu-241	3.8142E-07
				pu-242	9.1521E-09
				xe-135	1.0319E-08
				sm-149	8.3376E-08
				Total FP	8.2089E-05
6.00	1.0128	1.2013	.0013	u-235	7.3813E-04
				u-236	2.5791E-05
				pu-238	2.3358E-08
				pu-239	4.7235E-05
				pu-240	4.0614E-06
				pu-241	1.0777E-06
				pu-242	3.9954E-08
				xe-135	1.0350E-08
				sm-149	8.8929E-08
				Total FP	1.2183E-04
8.00	.9944	1.1792	.0016	u-235	6.9746E-04
				u-236	3.3404E-05
				pu-238	4.8498E-08
				pu-239	5.8729E-05
				pu-240	6.3381E-06
				pu-241	2.1375E-06
				pu-242	1.0860E-07
				xe-135	1.0346E-08
				sm-149	9.3701E-08
				Total FP	1.6094E-04

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
10.00	.9764	1.1585	.0012	u-235	6.5868E-04
				u-236	4.0589E-05
				pu-238	8.5944E-08
				pu-239	6.8690E-05
				pu-240	8.7942E-06
				pu-241	3.5103E-06
				pu-242	2.2879E-07
				xe-135	1.0315E-08
				sm-149	9.7759E-08
				Total FP	1.9948E-04
12.00	.9643	1.1409	.0013	u-235	6.2167E-04
				u-236	4.7370E-05
				pu-238	1.3758E-07
				pu-239	7.7347E-05
				pu-240	1.1355E-05
				pu-241	5.1330E-06
				pu-242	4.1135E-07
				xe-135	1.0265E-08
				sm-149	1.0118E-07
				Total FP	2.3754E-04
14.00	.9505	1.1227	.0013	u-235	5.8631E-04
				u-236	5.3768E-05
				pu-238	2.0513E-07
				pu-239	8.4881E-05
				pu-240	1.3970E-05
				pu-241	6.9437E-06
				pu-242	6.6421E-07
				xe-135	1.0197E-08
				sm-149	1.0403E-07
				Total FP	2.7513E-04
16.00	.9328	1.1064	.0012	u-235	5.5252E-04
				u-236	5.9798E-05
				pu-238	2.9017E-07
				pu-239	9.1441E-05
				pu-240	1.6604E-05
				pu-241	8.8865E-06
				pu-242	9.9270E-07
				xe-135	1.0116E-08
				sm-149	1.0635E-07
				Total FP	3.1230E-04
18.00	.9217	1.0913	.0012	u-235	5.2023E-04
				u-236	6.5476E-05
				pu-238	3.9413E-07
				pu-239	9.7149E-05
				pu-240	1.9232E-05
				pu-241	1.0913E-05
				pu-242	1.3999E-06
				xe-135	1.0024E-08
				sm-149	1.0822E-07
				Total FP	3.4905E-04

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
20.00	.9098	1.0769	.0013	u-235	4.8937E-04
				u-236	7.0814E-05
				pu-238	5.1826E-07
				pu-239	1.0211E-04
				pu-240	2.1833E-05
				pu-241	1.2984E-05
				pu-242	1.8872E-06
				xe-135	9.9225E-09
				sm-149	1.0966E-07
				Total FP	3.8542E-04
22.00	.8961	1.0608	.0013	u-235	4.5988E-04
				u-236	7.5823E-05
				pu-238	6.6366E-07
				pu-239	1.0641E-04
				pu-240	2.4392E-05
				pu-241	1.5064E-05
				pu-242	2.4544E-06
				xe-135	9.8130E-09
				sm-149	1.1073E-07
				Total FP	4.2139E-04
24.00	.8823	1.0463	.0012	u-235	4.3171E-04
				u-236	8.0514E-05
				pu-238	8.3125E-07
				pu-239	1.1013E-04
				pu-240	2.6898E-05
				pu-241	1.7127E-05
				pu-242	3.1001E-06
				xe-135	9.6967E-09
				sm-149	1.1146E-07
				Total FP	4.5699E-04
26.00	.8689	1.0321	.0012	u-235	4.0483E-04
				u-236	8.4897E-05
				pu-238	1.0218E-06
				pu-239	1.1333E-04
				pu-240	2.9340E-05
				pu-241	1.9150E-05
				pu-242	3.8221E-06
				xe-135	9.5750E-09
				sm-149	1.1189E-07
				Total FP	4.9221E-04
28.00	.8611	1.0195	.0012	u-235	3.7918E-04
				u-236	8.8981E-05
				pu-238	1.2358E-06
				pu-239	1.1608E-04
				pu-240	3.1710E-05
				pu-241	2.1116E-05
				pu-242	4.6174E-06
				xe-135	9.4489E-09
				sm-149	1.1205E-07
				Total FP	5.2705E-04

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
30.00	.8484	1.0075	.0013	u-235	3.5474E-04
				u-236	9.2775E-05
				pu-238	1.4735E-06
				pu-239	1.1842E-04
				pu-240	3.4003E-05
				pu-241	2.3011E-05
				pu-242	5.4825E-06
				xe-135	9.3198E-09
				sm-149	1.1198E-07
				Total FP	5.6153E-04
32.00	.8380	.9934	.0013	u-235	3.3146E-04
				u-236	9.6287E-05
				pu-238	1.7351E-06
				pu-239	1.2040E-04
				pu-240	3.6213E-05
				pu-241	2.4823E-05
				pu-242	6.4135E-06
				xe-135	9.1877E-09
				sm-149	1.1169E-07
				Total FP	5.9565E-04
34.00	.8279	.9803	.0013	u-235	3.0932E-04
				u-236	9.9524E-05
				pu-238	2.0205E-06
				pu-239	1.2206E-04
				pu-240	3.8337E-05
				pu-241	2.6545E-05
				pu-242	7.4061E-06
				xe-135	9.0538E-09
				sm-149	1.1123E-07
				Total FP	6.2939E-04
36.00	.8170	.9685	.0011	u-235	2.8828E-04
				u-236	1.0250E-04
				pu-238	2.3294E-06
				pu-239	1.2344E-04
				pu-240	4.0372E-05
				pu-241	2.8171E-05
				pu-242	8.4559E-06
				xe-135	8.9185E-09
				sm-149	1.1060E-07
				Total FP	6.6278E-04
38.00	.8069	.9568	.0012	u-235	2.6831E-04
				u-236	1.0521E-04
				pu-238	2.6612E-06
				pu-239	1.2457E-04
				pu-240	4.2317E-05
				pu-241	2.9698E-05
				pu-242	9.5582E-06
				xe-135	8.7831E-09
				sm-149	1.0983E-07
				Total FP	6.9580E-04

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
40.00	.7986	.9456	.0011	u-235	2.4939E-04
				u-236	1.0767E-04
				pu-238	3.0152E-06
				pu-239	1.2548E-04
				pu-240	4.4170E-05
				pu-241	3.1125E-05
				pu-242	1.0708E-05
				xe-135	8.6484E-09
				sm-149	1.0896E-07
				Total FP	7.2846E-04
42.00	.7877	.9335	.0013	u-235	2.3148E-04
				u-236	1.0989E-04
				pu-238	3.3904E-06
				pu-239	1.2620E-04
				pu-240	4.5931E-05
				pu-241	3.2451E-05
				pu-242	1.1901E-05
				xe-135	8.5145E-09
				sm-149	1.0799E-07
				Total FP	7.6077E-04
44.00	.7776	.9221	.0011	u-235	2.1455E-04
				u-236	1.1187E-04
				pu-238	3.7856E-06
				pu-239	1.2674E-04
				pu-240	4.7600E-05
				pu-241	3.3677E-05
				pu-242	1.3133E-05
				xe-135	8.3821E-09
				sm-149	1.0695E-07
				Total FP	7.9271E-04
46.00	.7692	.9129	.0012	u-235	1.9858E-04
				u-236	1.1363E-04
				pu-238	4.1995E-06
				pu-239	1.2714E-04
				pu-240	4.9177E-05
				pu-241	3.4804E-05
				pu-242	1.4398E-05
				xe-135	8.2515E-09
				sm-149	1.0584E-07
				Total FP	8.2430E-04
48.00	.7605	.9014	.0013	u-235	1.8353E-04
				u-236	1.1517E-04
				pu-238	4.6306E-06
				pu-239	1.2741E-04
				pu-240	5.0664E-05
				pu-241	3.5836E-05
				pu-242	1.5692E-05
				xe-135	8.1235E-09
				sm-149	1.0469E-07
				Total FP	8.5554E-04

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
50.00	.7505	.8912	.0013	u-235	1.6938E-04
				u-236	1.1650E-04
				pu-238	5.0773E-06
				pu-239	1.2756E-04
				pu-240	5.2062E-05
				pu-241	3.6776E-05
				pu-242	1.7011E-05
				xe-135	7.9988E-09
				sm-149	1.0351E-07
				Total FP	8.8642E-04
52.00	.7424	.8810	.0011	u-235	1.5610E-04
				u-236	1.1762E-04
				pu-238	5.5377E-06
				pu-239	1.2762E-04
				pu-240	5.3372E-05
				pu-241	3.7628E-05
				pu-242	1.8350E-05
				xe-135	7.8768E-09
				sm-149	1.0230E-07
				Total FP	9.1695E-04
54.00	.7346	.8725	.0011	u-235	1.4365E-04
				u-236	1.1855E-04
				pu-238	6.0100E-06
				pu-239	1.2760E-04
				pu-240	5.4598E-05
				pu-241	3.8397E-05
				pu-242	1.9704E-05
				xe-135	7.7586E-09
				sm-149	1.0108E-07
				Total FP	9.4714E-04
56.00	.7258	.8613	.0012	u-235	1.3201E-04
				u-236	1.1929E-04
				pu-238	6.4920E-06
				pu-239	1.2751E-04
				pu-240	5.5742E-05
				pu-241	3.9087E-05
				pu-242	2.1070E-05
				xe-135	7.6443E-09
				sm-149	9.9871E-08
				Total FP	9.7698E-04
58.00	.7195	.8535	.0011	u-235	1.2114E-04
				u-236	1.1985E-04
				pu-238	6.9818E-06
				pu-239	1.2736E-04
				pu-240	5.6806E-05
				pu-241	3.9704E-05
				pu-242	2.2443E-05
				xe-135	7.5343E-09
				sm-149	9.8669E-08
				Total FP	1.0065E-03

Variant 1
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
60.00	.7097	.8446	.0011	u-235	1.1101E-04
				u-236	1.2025E-04
				pu-238	7.4772E-06
				pu-239	1.2717E-04
				pu-240	5.7794E-05
				pu-241	4.0252E-05
				pu-242	2.3819E-05
				xe-135	7.4285E-09
				sm-149	9.7482E-08
				Total FP	1.0357E-03

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.1137E+01	3.3352E-01	1.3594E-01	5.3054E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.6839E-02	3.1429E-02	7.7373E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	4.18348E+01	5.01486E-01	8.23403E+01	9.87037E-01
U-236	8.70397E+00	0.00000E+00	8.08304E-01	0.00000E+00
Pu-238	2.68864E+01	0.00000E+00	6.66436E+00	0.00000E+00
Pu-239	1.44055E+02	0.00000E+00	2.62464E+02	0.00000E+00
Pu-240	2.14113E+02	0.00000E+00	1.89320E+00	0.00000E+00
Pu-241	1.27244E+02	0.00000E+00	2.73592E+02	0.00000E+00
Pu-242	3.24856E+01	0.00000E+00	1.41541E+00	0.00000E+00
Xe-135	1.41913E+05	1.84156E-02	0.00000E+00	0.00000E+00
Sm-149	4.49487E+03	4.54306E-03	0.00000E+00	0.00000E+00
Total FP	2.01305E+04	2.29586E-02	0.00000E+00	0.00000E+00

Variant 1
State 1

Burnup = 10 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0652E+01	3.3341E-01	1.3597E-01	5.3062E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.7868E-02	2.8137E-02	7.1922E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.87486E+01	3.45934E-01	7.58909E+01	6.77529E-01
U-236	7.65018E+00	4.20866E-03	7.91661E-01	4.35523E-04
Pu-238	2.49664E+01	2.90827E-05	6.57779E+00	7.66229E-06
Pu-239	1.23315E+02	1.14808E-01	2.25746E+02	2.10173E-01
Pu-240	1.63042E+02	1.94339E-02	1.90185E+00	2.26692E-04
Pu-241	1.13246E+02	5.38803E-03	2.44086E+02	1.16132E-02
Pu-242	3.24418E+01	1.00602E-04	1.44367E+00	4.47680E-06
Xe-135	1.28920E+05	1.80241E-02	0.00000E+00	0.00000E+00
Sm-149	4.07040E+03	5.39334E-03	0.00000E+00	0.00000E+00
Total FP	1.57987E+01	4.27165E-02	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0551E+01	3.3329E-01	1.3602E-01	5.3069E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.8407E-02	2.5733E-02	6.7471E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.83769E+01	2.53826E-01	7.50752E+01	4.96550E-01
U-236	7.06479E+00	6.76157E-03	7.82178E-01	7.48607E-04
Pu-238	2.48805E+01	1.74276E-04	6.60111E+00	4.62374E-05
Pu-239	1.17171E+02	1.61703E-01	2.15200E+02	2.96988E-01
Pu-240	1.26296E+02	3.72678E-02	1.89803E+00	5.60074E-04
Pu-241	1.09779E+02	1.92645E-02	2.36896E+02	4.15714E-02
Pu-242	3.23323E+01	8.24678E-04	1.45597E+00	3.71364E-05
Xe-135	1.28121E+05	1.71819E-02	0.00000E+00	0.00000E+00
Sm-149	4.01544E+03	5.95128E-03	0.00000E+00	0.00000E+00
Total FP	1.12564E+01	5.86353E-02	0.00000E+00	0.00000E+00

Variant 1
State 1

Burnup = 30 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0582E+01	3.3345E-01	1.3591E-01	5.3064E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.8099E-02	2.3443E-02	6.2779E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.84206E+01	1.84434E-01	7.51349E+01	3.60676E-01
U-236	6.71354E+00	8.42847E-03	7.76252E-01	9.74541E-04
Pu-238	2.49795E+01	4.98081E-04	6.62366E+00	1.32073E-04
Pu-239	1.14628E+02	1.83688E-01	2.10949E+02	3.38041E-01
Pu-240	1.06384E+02	4.89506E-02	1.89754E+00	8.73119E-04
Pu-241	1.08654E+02	3.38334E-02	2.34645E+02	7.30657E-02
Pu-242	3.06288E+01	2.27235E-03	1.46468E+00	1.08665E-04
Xe-135	1.29063E+05	1.62770E-02	0.00000E+00	0.00000E+00
Sm-149	4.02892E+03	6.10513E-03	0.00000E+00	0.00000E+00
Total FP	9.52070E+00	7.23452E-02	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0687E+01	3.3339E-01	1.3600E-01	5.3061E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.8065E-02	2.1589E-02	5.8870E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.92675E+01	1.32836E-01	7.68181E+01	2.59864E-01
U-236	6.47956E+00	9.46334E-03	7.68192E-01	1.12194E-03
Pu-238	2.56373E+01	1.04856E-03	6.68107E+00	2.73254E-04
Pu-239	1.14699E+02	1.95226E-01	2.11527E+02	3.60035E-01
Pu-240	9.65721E+01	5.78606E-02	1.88662E+00	1.13036E-03
Pu-241	1.10025E+02	4.64523E-02	2.37747E+02	1.00376E-01
Pu-242	2.92277E+01	4.24529E-03	1.45943E+00	2.11981E-04
Xe-135	1.33387E+05	1.56478E-02	0.00000E+00	0.00000E+00
Sm-149	4.14643E+03	6.12837E-03	0.00000E+00	0.00000E+00
Total FP	8.64773E+00	8.54501E-02	0.00000E+00	0.00000E+00

Variant 1
State 1

Burnup = 50 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0727E+01	3.3321E-01	1.3609E-01	5.3070E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.7795E-02	1.9963E-02	5.5305E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	4.01267E+01	9.22328E-02	7.85578E+01	1.80568E-01
U-236	6.34869E+00	1.00369E-02	7.64557E-01	1.20872E-03
Pu-238	2.62920E+01	1.81154E-03	6.73029E+00	4.63721E-04
Pu-239	1.15899E+02	2.00625E-01	2.14052E+02	3.70530E-01
Pu-240	8.99858E+01	6.35748E-02	1.88313E+00	1.33043E-03
Pu-241	1.11930E+02	5.58600E-02	2.41956E+02	1.20751E-01
Pu-242	2.73705E+01	6.31833E-03	1.45922E+00	3.36854E-04
Xe-135	1.38028E+05	1.49825E-02	0.00000E+00	0.00000E+00
Sm-149	4.27144E+03	5.99994E-03	0.00000E+00	0.00000E+00
Total FP	8.03426E+00	9.66442E-02	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0826E+01	3.3338E-01	1.3604E-01	5.3058E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.7448E-02	1.8593E-02	5.2202E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	4.09205E+01	6.18272E-02	8.01910E+01	1.21161E-01
U-236	6.28404E+00	1.02849E-02	7.64751E-01	1.25164E-03
Pu-238	2.69079E+01	2.73838E-03	6.78269E+00	6.90267E-04
Pu-239	1.17222E+02	2.02894E-01	2.16757E+02	3.75174E-01
Pu-240	8.53665E+01	6.71500E-02	1.88314E+00	1.48130E-03
Pu-241	1.13771E+02	6.23299E-02	2.46019E+02	1.34782E-01
Pu-242	2.58464E+01	8.37915E-03	1.46222E+00	4.74037E-04
Xe-135	1.42271E+05	1.43845E-02	0.00000E+00	0.00000E+00
Sm-149	4.38793E+03	5.82184E-03	0.00000E+00	0.00000E+00
Total FP	7.54090E+00	1.06297E-01	0.00000E+00	0.00000E+00

VARIANT 01, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1094	1.3168	.0015
10.00	1.0186	1.2064	.0014
20.00	.9442	1.1199	.0014
30.00	.8828	1.0477	.0013
40.00	.8300	.9842	.0012
50.00	.7845	.9306	.0012
60.00	.7436	.8831	.0012

VARIANT 01, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1021	1.3075	.0014
10.00	.9764	1.1585	.0012
20.00	.9098	1.0769	.0013
30.00	.8484	1.0075	.0013
40.00	.7986	.9456	.0011
50.00	.7505	.8912	.0013
60.00	.7097	.8446	.0011

VARIANT 01, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1156	1.3241	.0016
10.00	.9909	1.1756	.0013
20.00	.9217	1.0924	.0015
30.00	.8598	1.0215	.0012
40.00	.8102	.9604	.0012
50.00	.7633	.9055	.0011
60.00	.7249	.8597	.0010

VARIANT 01, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.2166	1.3671	.0015
10.00	1.0840	1.2167	.0013
20.00	1.0102	1.1338	.0014
30.00	.9433	1.0606	.0013
40.00	.8824	.9930	.0013
50.00	.8286	.9314	.0012
60.00	.7809	.8787	.0010

Variant 2
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	1.0259	1.2119	.0013	u-235	3.8393E-05
				u-236	0.0000E+00
				pu-238	0.0000E+00
				pu-239	6.5875E-04
				pu-240	4.2323E-05
				pu-241	7.0246E-06
				pu-242	0.0000E+00
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08
2.00	.9875	1.1665	.0013	u-235	3.6998E-05
				u-236	3.1914E-07
				pu-238	2.6157E-09
				pu-239	6.2491E-04
				pu-240	5.5437E-05
				pu-241	1.2862E-05
				pu-242	2.3399E-07
				xe-135	1.7320E-08
				sm-149	1.6340E-07
				Total FP	4.2196E-05
4.00	.9668	1.1422	.0015	u-235	3.5616E-05
				u-236	6.3212E-07
				pu-238	9.7352E-09
				pu-239	5.9276E-04
				pu-240	6.7156E-05
				pu-241	1.9159E-05
				pu-242	6.1310E-07
				xe-135	1.7096E-08
				sm-149	1.7581E-07
				Total FP	8.3284E-05
6.00	.9499	1.1215	.0012	u-235	3.4248E-05
				u-236	9.3670E-07
				pu-238	2.2245E-08
				pu-239	5.6199E-04
				pu-240	7.7682E-05
				pu-241	2.5609E-05
				pu-242	1.1476E-06
				xe-135	1.6710E-08
				sm-149	1.7931E-07
				Total FP	1.2354E-04
8.00	.9352	1.1033	.0012	u-235	3.2897E-05
				u-236	1.2322E-06
				pu-238	4.1182E-08
				pu-239	5.3260E-04
				pu-240	8.7113E-05
				pu-241	3.2052E-05
				pu-242	1.8417E-06
				xe-135	1.6325E-08
				sm-149	1.8136E-07
				Total FP	1.6307E-04

Variant 2
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
10.00	.9231	1.0873	.0012	u-235	3.1564E-05
				u-236	1.5182E-06
				pu-238	6.7700E-08
				pu-239	5.0459E-04
				pu-240	9.5524E-05
				pu-241	3.8369E-05
				pu-242	2.6961E-06
				xe-135	1.5948E-08
				sm-149	1.8248E-07
				Total FP	2.0197E-04
12.00	.9055	1.0705	.0013	u-235	3.0252E-05
				u-236	1.7943E-06
				pu-238	1.0302E-07
				pu-239	4.7797E-04
				pu-240	1.0298E-04
				pu-241	4.4470E-05
				pu-242	3.7089E-06
				xe-135	1.5579E-08
				sm-149	1.8284E-07
				Total FP	2.4027E-04
14.00	.8927	1.0556	.0012	u-235	2.8962E-05
				u-236	2.0603E-06
				pu-238	1.4837E-07
				pu-239	4.5273E-04
				pu-240	1.0953E-04
				pu-241	5.0283E-05
				pu-242	4.8762E-06
				xe-135	1.5217E-08
				sm-149	1.8255E-07
				Total FP	2.7804E-04
16.00	.8820	1.0406	.0013	u-235	2.7695E-05
				u-236	2.3159E-06
				pu-238	2.0496E-07
				pu-239	4.2886E-04
				pu-240	1.1522E-04
				pu-241	5.5755E-05
				pu-242	6.1924E-06
				xe-135	1.4864E-08
				sm-149	1.8173E-07
				Total FP	3.1529E-04
18.00	.8706	1.0285	.0011	u-235	2.6453E-05
				u-236	2.5609E-06
				pu-238	2.7391E-07
				pu-239	4.0634E-04
				pu-240	1.2011E-04
				pu-241	6.0842E-05
				pu-242	7.6505E-06
				xe-135	1.4518E-08
				sm-149	1.8043E-07
				Total FP	3.5206E-04

Variant 2
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
20.00	.8615	1.0173	.0013	u-235	2.5237E-05
				u-236	2.7952E-06
				pu-238	3.5622E-07
				pu-239	3.8515E-04
				pu-240	1.2424E-04
				pu-241	6.5515E-05
				pu-242	9.2425E-06
				xe-135	1.4179E-08
				sm-149	1.7876E-07
				Total FP	3.8835E-04
22.00	.8497	1.0028	.0012	u-235	2.4049E-05
				u-236	3.0186E-06
				pu-238	4.5275E-07
				pu-239	3.6527E-04
				pu-240	1.2766E-04
				pu-241	6.9753E-05
				pu-242	1.0959E-05
				xe-135	1.3849E-08
				sm-149	1.7678E-07
				Total FP	4.2418E-04
24.00	.8395	.9918	.0014	u-235	2.2889E-05
				u-236	3.2311E-06
				pu-238	5.6418E-07
				pu-239	3.4666E-04
				pu-240	1.3041E-04
				pu-241	7.3544E-05
				pu-242	1.2791E-05
				xe-135	1.3528E-08
				sm-149	1.7455E-07
				Total FP	4.5957E-04
26.00	.8332	.9825	.0012	u-235	2.1758E-05
				u-236	3.4327E-06
				pu-238	6.9097E-07
				pu-239	3.2929E-04
				pu-240	1.3254E-04
				pu-241	7.6880E-05
				pu-242	1.4727E-05
				xe-135	1.3213E-08
				sm-149	1.7209E-07
				Total FP	4.9453E-04
28.00	.8233	.9716	.0011	u-235	2.0657E-05
				u-236	3.6233E-06
				pu-238	8.3339E-07
				pu-239	3.1312E-04
				pu-240	1.3409E-04
				pu-241	7.9765E-05
				pu-242	1.6757E-05
				xe-135	1.2907E-08
				sm-149	1.6948E-07
				Total FP	5.2906E-04

Variant 2
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
30.00		.8124	.9608	.0011	u-235 1.9587E-05
					u-236 3.8029E-06
					pu-238 9.9145E-07
					pu-239 2.9810E-04
					pu-240 1.3511E-04
					pu-241 8.2206E-05
					pu-242 1.8869E-05
					xe-135 1.2609E-08
					sm-149 1.6674E-07
					Total FP 5.6318E-04
32.00		.8056	.9510	.0011	u-235 1.8549E-05
					u-236 3.9716E-06
					pu-238 1.1649E-06
					pu-239 2.8418E-04
					pu-240 1.3564E-04
					pu-241 8.4216E-05
					pu-242 2.1051E-05
					xe-135 1.2321E-08
					sm-149 1.6393E-07
					Total FP 5.9689E-04
34.00		.7964	.9408	.0012	u-235 1.7543E-05
					u-236 4.1294E-06
					pu-238 1.3534E-06
					pu-239 2.7131E-04
					pu-240 1.3573E-04
					pu-241 8.5811E-05
					pu-242 2.3292E-05
					xe-135 1.2040E-08
					sm-149 1.6104E-07
					Total FP 6.3019E-04
36.00		.7872	.9312	.0013	u-235 1.6570E-05
					u-236 4.2764E-06
					pu-238 1.5562E-06
					pu-239 2.5943E-04
					pu-240 1.3542E-04
					pu-241 8.7012E-05
					pu-242 2.5579E-05
					xe-135 1.1768E-08
					sm-149 1.5810E-07
					Total FP 6.6310E-04
38.00		.7816	.9220	.0012	u-235 1.5630E-05
					u-236 4.4127E-06
					pu-238 1.7724E-06
					pu-239 2.4849E-04
					pu-240 1.3475E-04
					pu-241 8.7841E-05
					pu-242 2.7900E-05
					xe-135 1.1504E-08
					sm-149 1.5514E-07
					Total FP 6.9562E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
40.00		.7721	.9124	.0011	u-235 1.4724E-05
					u-236 4.5384E-06
					pu-238 2.0009E-06
					pu-239 2.3843E-04
					pu-240 1.3377E-04
					pu-241 8.8323E-05
					pu-242 3.0244E-05
					xe-135 1.1248E-08
					sm-149 1.5218E-07
					Total FP 7.2776E-04
42.00		.7665	.9059	.0013	u-235 1.3852E-05
					u-236 4.6536E-06
					pu-238 2.2404E-06
					pu-239 2.2920E-04
					pu-240 1.3251E-04

Variant 2
State 1

				pu-241	8.8487E-05
				pu-242	3.2599E-05
				xe-135	1.1001E-08
				sm-149	1.4923E-07
				Total FP	7.5951E-04
44.00	.7612	.8975	.0013	u-235	1.3014E-05
				u-236	4.7586E-06
				pu-238	2.4895E-06
				pu-239	2.2074E-04
				pu-240	1.3102E-04
				pu-241	8.8360E-05
				pu-242	3.4953E-05
				xe-135	1.0762E-08
				sm-149	1.4630E-07
				Total FP	7.9090E-04
46.00	.7537	.8894	.0011	u-235	1.2210E-05
				u-236	4.8535E-06
				pu-238	2.7466E-06
				pu-239	2.1299E-04
				pu-240	1.2933E-04
				pu-241	8.7971E-05
				pu-242	3.7296E-05
				xe-135	1.0530E-08
				sm-149	1.4340E-07
				Total FP	8.2191E-04
48.00	.7469	.8819	.0012	u-235	1.1440E-05
				u-236	4.9386E-06
				pu-238	3.0100E-06
				pu-239	2.0590E-04
				pu-240	1.2747E-04
				pu-241	8.7349E-05
				pu-242	3.9618E-05
				xe-135	1.0307E-08
				sm-149	1.4055E-07
				Total FP	8.5257E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
50.00	.7386	.8736	.0012	u-235	1.0704E-05
				u-236	5.0141E-06
				pu-238	3.2779E-06
				pu-239	1.9941E-04
				pu-240	1.2548E-04
				pu-241	8.6522E-05
				pu-242	4.1909E-05
				xe-135	1.0091E-08
				sm-149	1.3775E-07
				Total FP	8.8286E-04
52.00	.7332	.8671	.0011	u-235	1.0002E-05
				u-236	5.0803E-06
				pu-238	3.5485E-06
				pu-239	1.9348E-04
				pu-240	1.2339E-04
				pu-241	8.5518E-05
				pu-242	4.4160E-05
				xe-135	9.8834E-09
				sm-149	1.3500E-07
				Total FP	9.1281E-04
54.00	.7270	.8599	.0012	u-235	9.3328E-06
				u-236	5.1374E-06
				pu-238	3.8200E-06
				pu-239	1.8805E-04
				pu-240	1.2122E-04
				pu-241	8.4365E-05
				pu-242	4.6364E-05
				xe-135	9.6832E-09
				sm-149	1.3232E-07
				Total FP	9.4241E-04
56.00	.7211	.8537	.0013	u-235	8.6965E-06

Variant 2
State 1

				u-236	5.1857E-06
				pu-238	4.0905E-06
				pu-239	1.8308E-04
				pu-240	1.1900E-04
				pu-241	8.3087E-05
				pu-242	4.8513E-05
				xe-135	9.4903E-09
				sm-149	1.2970E-07
				Total FP	9.7167E-04
58.00	.7154	.8457	.0011	u-235	8.0925E-06
				u-236	5.2256E-06
				pu-238	4.3583E-06
				pu-239	1.7852E-04
				pu-240	1.1676E-04
				pu-241	8.1709E-05
				pu-242	5.0601E-05
				xe-135	9.3046E-09
				sm-149	1.2715E-07
				Total FP	1.0006E-03

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
60.00	.7091	.8395	.0011	u-235	7.5203E-06
				u-236	5.2573E-06
				pu-238	4.6216E-06
				pu-239	1.7434E-04
				pu-240	1.1451E-04
				pu-241	8.0254E-05
				pu-242	5.2622E-05
				xe-135	9.1258E-09
				sm-149	1.2468E-07
				Total FP	1.0292E-03

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.8837E+01	3.3286E-01	1.3616E-01	5.3098E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.2534E-02	2.7644E-02	7.9412E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.49302E+01	1.23730E-02	4.69371E+01	2.32952E-02
U-236	9.18012E+00	0.00000E+00	8.84929E-01	0.00000E+00
Pu-238	1.52784E+01	0.00000E+00	6.01229E+00	0.00000E+00
Pu-239	5.76124E+01	4.90608E-01	1.06908E+02	9.10394E-01
Pu-240	9.72022E+01	5.31802E-02	1.99704E+00	1.09260E-03
Pu-241	6.14932E+01	5.58401E-03	1.33760E+02	1.21463E-02
Pu-242	3.43076E+01	0.00000E+00	1.54962E+00	0.00000E+00
Xe-135	6.25951E+04	7.65317E-03	0.00000E+00	0.00000E+00
Sm-149	2.00598E+03	1.91028E-03	0.00000E+00	0.00000E+00
Total FP	8.89990E+03	9.56345E-03	0.00000E+00	0.00000E+00

Variant 2
State 1

Burnup = 10 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.8881E+01	3.3304E-01	1.3603E-01	5.3093E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.2516E-02	2.4723E-02	7.1126E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.58058E+01	1.05472E-02	4.87306E+01	1.99168E-02
U-236	8.87411E+00	1.74453E-04	8.72244E-01	1.71472E-05
Pu-238	1.59454E+01	1.39781E-05	6.06988E+00	5.32101E-06
Pu-239	6.20268E+01	4.05269E-01	1.14794E+02	7.50039E-01
Pu-240	6.66607E+01	8.24533E-02	1.97217E+00	2.43940E-03
Pu-241	6.46655E+01	3.21276E-02	1.40554E+02	6.98310E-02
Pu-242	3.30006E+01	1.15208E-03	1.54198E+00	5.38320E-05
Xe-135	6.70327E+04	1.38426E-02	0.00000E+00	0.00000E+00
Sm-149	2.13435E+03	5.04320E-03	0.00000E+00	0.00000E+00
Total FP	1.51781E+01	3.96934E-02	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9038E+01	3.3321E-01	1.3605E-01	5.3074E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.1968E-02	2.2937E-02	6.6130E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.73289E+01	8.97128E-03	5.18947E+01	1.70355E-02
U-236	8.59924E+00	3.12657E-04	8.59438E-01	3.12480E-05
Pu-238	1.70748E+01	7.91170E-05	6.14771E+00	2.84857E-05
Pu-239	6.83114E+01	3.42230E-01	1.26259E+02	6.32539E-01
Pu-240	5.84976E+01	9.45354E-02	1.95427E+00	3.15821E-03
Pu-241	6.97466E+01	5.94372E-02	1.51475E+02	1.29086E-01
Pu-242	3.01309E+01	3.62240E-03	1.53102E+00	1.84062E-04
Xe-135	7.48118E+04	1.37978E-02	0.00000E+00	0.00000E+00
Sm-149	2.36523E+03	5.49971E-03	0.00000E+00	0.00000E+00
Total FP	1.12295E+01	5.67249E-02	0.00000E+00	0.00000E+00

Variant 2
State 1

Burnup = 30 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9134E+01	3.3326E-01	1.3612E-01	5.3063E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.1488E-02	2.1509E-02	6.2167E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.90261E+01	7.41458E-03	5.53981E+01	1.41512E-02
U-236	8.26113E+00	4.09718E-04	8.47530E-01	4.20340E-05
Pu-238	1.82861E+01	2.36441E-04	6.22981E+00	8.05520E-05
Pu-239	7.51117E+01	2.92012E-01	1.38681E+02	5.39151E-01
Pu-240	5.62710E+01	9.91523E-02	1.94364E+00	3.42479E-03
Pu-241	7.54303E+01	8.08686E-02	1.63671E+02	1.75471E-01
Pu-242	2.74947E+01	6.76595E-03	1.52354E+00	3.74915E-04
Xe-135	8.32033E+04	1.36821E-02	0.00000E+00	0.00000E+00
Sm-149	2.61566E+03	5.68790E-03	0.00000E+00	0.00000E+00
Total FP	9.72107E+00	7.13991E-02	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9344E+01	3.3325E-01	1.3611E-01	5.3064E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.1098E-02	2.0359E-02	5.8968E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.09933E+01	5.98335E-03	5.94855E+01	1.14839E-02
U-236	8.23521E+00	4.90036E-04	8.42371E-01	5.01253E-05
Pu-238	1.97064E+01	5.16992E-04	6.32546E+00	1.65947E-04
Pu-239	8.21971E+01	2.56961E-01	1.51780E+02	4.74488E-01
Pu-240	5.69203E+01	9.98335E-02	1.93226E+00	3.38902E-03
Pu-241	8.16677E+01	9.45747E-02	1.77077E+02	2.05062E-01
Pu-242	2.48194E+01	9.84193E-03	1.51403E+00	6.00379E-04
Xe-135	9.29721E+04	1.37113E-02	0.00000E+00	0.00000E+00
Sm-149	2.90538E+03	5.79711E-03	0.00000E+00	0.00000E+00
Total FP	8.95022E+00	8.54029E-02	0.00000E+00	0.00000E+00

Variant 2
State 1

Burnup = 50 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9656E+01	3.3345E-01	1.3599E-01	5.3056E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.0322E-02	1.9236E-02	5.5811E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.26508E+01	4.62149E-03	6.29290E+01	8.90716E-03
U-236	8.01478E+00	5.31406E-04	8.32817E-01	5.52185E-05
Pu-238	2.08825E+01	9.05151E-04	6.40497E+00	2.77623E-04
Pu-239	8.85137E+01	2.33399E-01	1.63388E+02	4.30833E-01
Pu-240	5.86361E+01	9.72931E-02	1.92273E+00	3.19033E-03
Pu-241	8.70681E+01	9.96157E-02	1.88607E+02	2.15787E-01
Pu-242	2.27987E+01	1.26345E-02	1.50536E+00	8.34236E-04
Xe-135	1.00923E+05	1.34668E-02	0.00000E+00	0.00000E+00
Sm-149	3.13613E+03	5.71253E-03	0.00000E+00	0.00000E+00
Total FP	8.31388E+00	9.70598E-02	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9812E+01	3.3347E-01	1.3604E-01	5.3049E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.9887E-02	1.8402E-02	5.3446E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.46126E+01	3.45574E-03	6.70064E+01	6.68996E-03
U-236	7.99409E+00	5.57961E-04	8.26605E-01	5.76942E-05
Pu-238	2.23125E+01	1.36903E-03	6.49669E+00	3.98617E-04
Pu-239	9.49530E+01	2.19775E-01	1.75410E+02	4.05997E-01
Pu-240	6.11891E+01	9.30228E-02	1.90978E+00	2.90334E-03
Pu-241	9.31511E+01	9.92490E-02	2.01732E+02	2.14938E-01
Pu-242	2.11470E+01	1.47736E-02	1.49329E+00	1.04324E-03
Xe-135	1.10933E+05	1.34401E-02	0.00000E+00	0.00000E+00
Sm-149	3.43870E+03	5.69197E-03	0.00000E+00	0.00000E+00
Total FP	7.89663E+00	1.07900E-01	0.00000E+00	0.00000E+00

VARIANT 02, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0482	1.2397	.0013
10.00	.9407	1.1122	.0014
20.00	.8845	1.0437	.0012
30.00	.8374	.9879	.0011
40.00	.7995	.9432	.0011
50.00	.7636	.9038	.0013
60.00	.7362	.8702	.0012

VARIANT 02, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0437	1.2325	.0015
10.00	.9231	1.0873	.0012
20.00	.8615	1.0173	.0013
30.00	.8124	.9608	.0011
40.00	.7721	.9124	.0011
50.00	.7386	.8736	.0012
60.00	.7091	.8395	.0011

VARIANT 02, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0606	1.2515	.0013
10.00	.9373	1.1040	.0012
20.00	.8744	1.0339	.0012
30.00	.8248	.9750	.0012
40.00	.7847	.9283	.0016
50.00	.7508	.8890	.0012
60.00	.7238	.8549	.0012

VARIANT 02, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1849	1.3283	.0014
10.00	1.0330	1.1587	.0013
20.00	.9658	1.0819	.0011
30.00	.9102	1.0202	.0013
40.00	.8612	.9676	.0012
50.00	.8192	.9199	.0011
60.00	.7845	.8802	.0010

Variant 3
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	.9140	1.0833	.0013	u-235	3.7843E-04
				u-236	8.6365E-05
				pu-238	6.7254E-06
				pu-239	1.3111E-04
				pu-240	3.6233E-05
				pu-241	2.1701E-05
				pu-242	4.7576E-06
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0736E+01	3.3341E-01	1.3606E-01	5.3053E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.8006E-02	2.5236E-02	6.7555E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.89725E+01	2.00310E-01	7.62045E+01	3.91676E-01
U-236	7.28419E+00	8.54436E-03	7.84551E-01	9.20279E-04
Pu-238	2.53363E+01	2.31431E-03	6.63288E+00	6.05872E-04
Pu-239	1.15206E+02	2.05151E-01	2.12197E+02	3.77864E-01
Pu-240	1.08090E+02	5.31927E-02	1.87973E+00	9.25039E-04
Pu-241	1.10065E+02	3.24407E-02	2.37780E+02	7.00834E-02
Pu-242	3.19018E+01	2.06141E-03	1.44875E+00	9.36141E-05
Xe-135	1.31148E+05	1.68472E-02	0.00000E+00	0.00000E+00
Sm-149	4.09539E+03	4.09760E-03	0.00000E+00	0.00000E+00
Total FP	1.85517E+04	2.09448E-02	0.00000E+00	0.00000E+00

Variant 3
States 3-6

VARIANT 03, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9519	1.1266	.0013

VARIANT 03, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9491	1.1241	.0015

VARIANT 03, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9615	1.1413	.0013

VARIANT 03, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0572	1.1887	.0013

Variant 4
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	.8570	1.0139	.0014	u-235	3.7843E-04
				u-236	8.6365E-05
				pu-238	6.7254E-06
				pu-239	1.3111E-04
				pu-240	3.6233E-05
				pu-241	2.1701E-05
				pu-242	4.7576E-06
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	2.2848E-04

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.0212E+01	3.3335E-01	1.3608E-01	5.3057E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.9057E-02	2.3876E-02	6.3951E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	3.66171E+01	1.85746E-01	7.14417E+01	3.62399E-01
U-236	6.57975E+00	7.61722E-03	7.72609E-01	8.94431E-04
Pu-238	2.37407E+01	2.14023E-03	6.55346E+00	5.90796E-04
Pu-239	1.08972E+02	1.91514E-01	2.00424E+02	3.52237E-01
Pu-240	1.02153E+02	4.96138E-02	1.89298E+00	9.19388E-04
Pu-241	1.03012E+02	2.99652E-02	2.22524E+02	6.47302E-02
Pu-242	3.09316E+01	1.97260E-03	1.46631E+00	9.35108E-05
Xe-135	1.20616E+05	1.52917E-02	0.00000E+00	0.00000E+00
Sm-149	3.78942E+03	3.74193E-03	0.00000E+00	0.00000E+00
Total FP	2.03529E+01	6.23351E-02	0.00000E+00	0.00000E+00

Variant 4
States 3-6

VARIANT 04, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.8897	1.0537	.0014

VARIANT 04, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.8849	1.0488	.0014

VARIANT 04, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9013	1.0681	.0015

VARIANT 04, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9939	1.1178	.0014

Variant 7
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	1.0983	1.3001	.0016	u-235	3.8393E-05
				u-236	0.0000E+00
				pu-238	0.0000E+00
				pu-239	6.5875E-04
				pu-240	0.0000E+00
				pu-241	0.0000E+00
				pu-242	0.0000E+00
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.9276E+01	3.3306E-01	1.3611E-01	5.3083E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.1539E-02	2.9274E-02	8.4066E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.63080E+01	1.32127E-02	4.99726E+01	2.50979E-02
U-236	8.91666E+00	0.00000E+00	8.71356E-01	0.00000E+00
Pu-238	1.61349E+01	0.00000E+00	6.05447E+00	0.00000E+00
Pu-239	6.22183E+01	5.36157E-01	1.15447E+02	9.94851E-01
Pu-240	2.20278E+02	0.00000E+00	2.03539E+00	0.00000E+00
Pu-241	6.49799E+01	0.00000E+00	1.41193E+02	0.00000E+00
Pu-242	3.45443E+01	0.00000E+00	1.53447E+00	0.00000E+00
Xe-135	6.84263E+04	8.46604E-03	0.00000E+00	0.00000E+00
Sm-149	2.19932E+03	2.11940E-03	0.00000E+00	0.00000E+00
Total FP	9.73472E+03	1.05854E-02	0.00000E+00	0.00000E+00

Variant 7
States 3-6

VARIANT 07, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1254	1.3351	.0014

VARIANT 07, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1169	1.3242	.0017

VARIANT 07, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1339	1.3427	.0014

VARIANT 07, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.2544	1.4089	.0014

Variant 8
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	.9178	1.0883	.0012	u-235	6.9714E-04
				u-236	0.0000E+00
				pu-238	0.0000E+00
				pu-239	0.0000E+00
				pu-240	4.2323E-05
				pu-241	0.0000E+00
				pu-242	0.0000E+00
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
4.1384E+01	3.3326E-01	1.3603E-01	5.3072E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
5.6481E-02	2.7051E-02	6.6703E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	4.44720E+01	4.27577E-01	8.77623E+01	8.43793E-01
U-236	8.66236E+00	0.00000E+00	8.03851E-01	0.00000E+00
Pu-238	2.90500E+01	0.00000E+00	6.85176E+00	0.00000E+00
Pu-239	1.51400E+02	0.00000E+00	2.76397E+02	0.00000E+00
Pu-240	1.02562E+02	5.98645E-02	1.81766E+00	1.06095E-03
Pu-241	1.35556E+02	0.00000E+00	2.91637E+02	0.00000E+00
Pu-242	3.31714E+01	0.00000E+00	1.40555E+00	0.00000E+00
Xe-135	1.56183E+05	2.03726E-02	0.00000E+00	0.00000E+00
Sm-149	4.91314E+03	4.99161E-03	0.00000E+00	0.00000E+00
Total FP	2.21249E+04	2.53642E-02	0.00000E+00	0.00000E+00

VARIANT 08, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9620	1.1418	.0013

VARIANT 08, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9579	1.1360	.0016

VARIANT 08, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9755	1.1561	.0013

VARIANT 08, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0746	1.2088	.0014

Variant 9
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	1.2918	1.5231	.0017	u-235	3.8393E-05
				u-236	0.0000E+00
				pu-238	0.0000E+00
				pu-239	0.0000E+00
				pu-240	0.0000E+00
				pu-241	6.6577E-04
				pu-242	0.0000E+00
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.8614E+01	3.3301E-01	1.3610E-01	5.3089E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
6.2913E-02	3.4257E-02	1.0057E-01

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	2.57161E+01	1.26961E-02	4.87425E+01	2.40643E-02
U-236	8.00837E+00	0.00000E+00	8.31206E-01	0.00000E+00
Pu-238	1.53202E+01	0.00000E+00	5.96408E+00	0.00000E+00
Pu-239	7.53880E+01	0.00000E+00	1.37062E+02	0.00000E+00
Pu-240	2.07469E+02	0.00000E+00	1.99607E+00	0.00000E+00
Pu-241	6.42386E+01	5.49963E-01	1.39391E+02	1.19337E+00
Pu-242	3.20292E+01	0.00000E+00	1.50522E+00	0.00000E+00
Xe-135	6.20281E+04	7.54408E-03	0.00000E+00	0.00000E+00
Sm-149	2.02079E+03	1.91429E-03	0.00000E+00	0.00000E+00
Total FP	8.84851E+03	9.45837E-03	0.00000E+00	0.00000E+00

VARIANT 09, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.3220	1.5598	.0020

VARIANT 09, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.3134	1.5478	.0015

VARIANT 09, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.3313	1.5665	.0019

VARIANT 09, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.4396	1.6137	.0018

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
.00	.9540	1.1051	.0013	u-235	5.0000E-05
				u-236	0.0000E+00
				pu-238	3.0000E-05
				pu-239	1.1600E-03
				pu-240	4.9000E-04
				pu-241	1.9000E-04
				pu-242	1.0500E-04
				xe-135	9.4581E-09
				sm-149	7.3667E-08
				Total FP	8.3125E-08
2.00	.9418	1.0893	.0011	u-235	4.8933E-05
				u-236	2.9778E-07
				pu-238	2.9672E-05
				pu-239	1.1373E-03
				pu-240	4.8951E-04
				pu-241	1.9618E-04
				pu-242	1.0519E-04
				xe-135	2.6920E-08
				sm-149	3.3892E-07
				Total FP	4.1459E-05
4.00	.9357	1.0826	.0011	u-235	4.7882E-05
				u-236	5.8887E-07
				pu-238	2.9489E-05
				pu-239	1.1154E-03
				pu-240	4.8874E-04
				pu-241	2.0213E-04
				pu-242	1.0546E-04
				xe-135	2.7021E-08
				sm-149	4.6501E-07
				Total FP	8.1935E-05
6.00	.9299	1.0739	.0013	u-235	4.6848E-05
				u-236	8.7200E-07
				pu-238	2.9425E-05
				pu-239	1.0941E-03
				pu-240	4.8780E-04
				pu-241	2.0774E-04
				pu-242	1.0580E-04
				xe-135	2.6954E-08
				sm-149	5.2162E-07
				Total FP	1.2170E-04
8.00	.9220	1.0687	.0012	u-235	4.5830E-05
				u-236	1.1472E-06
				pu-238	2.9459E-05
				pu-239	1.0733E-03
				pu-240	4.8671E-04
				pu-241	2.1301E-04
				pu-242	1.0621E-04
				xe-135	2.6869E-08
				sm-149	5.5043E-07
				Total FP	1.6086E-04

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
10.00	.9181	1.0628	.0012	u-235	4.4829E-05
				u-236	1.4146E-06
				pu-238	2.9574E-05
				pu-239	1.0529E-03
				pu-240	4.8548E-04
				pu-241	2.1796E-04
				pu-242	1.0669E-04
				xe-135	2.6775E-08
				sm-149	5.6736E-07
				Total FP	1.9950E-04
12.00	.9149	1.0582	.0012	u-235	4.3844E-05
				u-236	1.6743E-06
				pu-238	2.9755E-05
				pu-239	1.0330E-03
				pu-240	4.8411E-04
				pu-241	2.2259E-04
				pu-242	1.0724E-04
				xe-135	2.6676E-08
				sm-149	5.7866E-07
				Total FP	2.3768E-04
14.00	.9118	1.0538	.0013	u-235	4.2876E-05
				u-236	1.9264E-06
				pu-238	2.9992E-05
				pu-239	1.0136E-03
				pu-240	4.8261E-04
				pu-241	2.2691E-04
				pu-242	1.0785E-04
				xe-135	2.6574E-08
				sm-149	5.8686E-07
				Total FP	2.7544E-04
16.00	.9034	1.0466	.0011	u-235	4.1923E-05
				u-236	2.1711E-06
				pu-238	3.0275E-05
				pu-239	9.9460E-04
				pu-240	4.8098E-04
				pu-241	2.3094E-04
				pu-242	1.0852E-04
				xe-135	2.6470E-08
				sm-149	5.9304E-07
				Total FP	3.1280E-04
18.00	.8992	1.0431	.0014	u-235	4.0986E-05
				u-236	2.4085E-06
				pu-238	3.0596E-05
				pu-239	9.7604E-04
				pu-240	4.7923E-04
				pu-241	2.3468E-04
				pu-242	1.0924E-04
				xe-135	2.6363E-08
				sm-149	5.9769E-07
				Total FP	3.4980E-04

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
20.00	.8980	1.0397	.0012	u-235	4.0065E-05
				u-236	2.6388E-06
				pu-238	3.0949E-05
				pu-239	9.5790E-04
				pu-240	4.7736E-04
				pu-241	2.3815E-04
				pu-242	1.1002E-04
				xe-135	2.6255E-08
				sm-149	6.0108E-07
				Total FP	3.8645E-04
22.00	.8932	1.0337	.0013	u-235	3.9159E-05
				u-236	2.8621E-06
				pu-238	3.1328E-05
				pu-239	9.4018E-04
				pu-240	4.7537E-04
				pu-241	2.4136E-04
				pu-242	1.1085E-04
				xe-135	2.6145E-08
				sm-149	6.0341E-07
				Total FP	4.2277E-04
24.00	.8913	1.0300	.0012	u-235	3.8268E-05
				u-236	3.0785E-06
				pu-238	3.1730E-05
				pu-239	9.2286E-04
				pu-240	4.7326E-04
				pu-241	2.4431E-04
				pu-242	1.1173E-04
				xe-135	2.6033E-08
				sm-149	6.0481E-07
				Total FP	4.5877E-04
26.00	.8840	1.0248	.0012	u-235	3.7392E-05
				u-236	3.2882E-06
				pu-238	3.2151E-05
				pu-239	9.0594E-04
				pu-240	4.7104E-04
				pu-241	2.4702E-04
				pu-242	1.1265E-04
				xe-135	2.5920E-08
				sm-149	6.0538E-07
				Total FP	4.9447E-04
28.00	.8819	1.0205	.0012	u-235	3.6531E-05
				u-236	3.4913E-06
				pu-238	3.2589E-05
				pu-239	8.8941E-04
				pu-240	4.6871E-04
				pu-241	2.4949E-04
				pu-242	1.1361E-04
				xe-135	2.5805E-08
				sm-149	6.0524E-07
				Total FP	5.2988E-04

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
30.00	.8785	1.0161	.0011	u-235	3.5685E-05
				u-236	3.6879E-06
				pu-238	3.3041E-05
				pu-239	8.7326E-04
				pu-240	4.6628E-04
				pu-241	2.5173E-04
				pu-242	1.1461E-04
				xe-135	2.5689E-08
				sm-149	6.0445E-07
				Total FP	5.6501E-04
32.00	.8737	1.0105	.0011	u-235	3.4853E-05
				u-236	3.8781E-06
				pu-238	3.3505E-05
				pu-239	8.5749E-04
				pu-240	4.6374E-04
				pu-241	2.5375E-04
				pu-242	1.1565E-04
				xe-135	2.5571E-08
				sm-149	6.0307E-07
				Total FP	5.9986E-04
34.00	.8695	1.0068	.0012	u-235	3.4036E-05
				u-236	4.0620E-06
				pu-238	3.3979E-05
				pu-239	8.4208E-04
				pu-240	4.6111E-04
				pu-241	2.5556E-04
				pu-242	1.1673E-04
				xe-135	2.5452E-08
				sm-149	6.0120E-07
				Total FP	6.3444E-04
36.00	.8659	1.0027	.0012	u-235	3.3233E-05
				u-236	4.2397E-06
				pu-238	3.4462E-05
				pu-239	8.2703E-04
				pu-240	4.5838E-04
				pu-241	2.5717E-04
				pu-242	1.1784E-04
				xe-135	2.5332E-08
				sm-149	5.9885E-07
				Total FP	6.6876E-04
38.00	.8610	.9977	.0011	u-235	3.2444E-05
				u-236	4.4114E-06
				pu-238	3.4953E-05
				pu-239	8.1234E-04
				pu-240	4.5556E-04
				pu-241	2.5858E-04
				pu-242	1.1898E-04
				xe-135	2.5210E-08
				sm-149	5.9609E-07
				Total FP	7.0283E-04

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
40.00	.8569	.9934	.0012	u-235	3.1669E-05
				u-236	4.5771E-06
				pu-238	3.5451E-05
				pu-239	7.9799E-04
				pu-240	4.5265E-04
				pu-241	2.5980E-04
				pu-242	1.2015E-04
				xe-135	2.5088E-08
				sm-149	5.9300E-07
				Total FP	7.3665E-04
42.00	.8531	.9897	.0012	u-235	3.0907E-05
				u-236	4.7369E-06
				pu-238	3.5955E-05
				pu-239	7.8398E-04
				pu-240	4.4966E-04
				pu-241	2.6084E-04
				pu-242	1.2134E-04
				xe-135	2.4964E-08
				sm-149	5.8958E-07
				Total FP	7.7023E-04
44.00	.8499	.9862	.0012	u-235	3.0159E-05
				u-236	4.8910E-06
				pu-238	3.6464E-05
				pu-239	7.7030E-04
				pu-240	4.4659E-04
				pu-241	2.6171E-04
				pu-242	1.2256E-04
				xe-135	2.4839E-08
				sm-149	5.8588E-07
				Total FP	8.0357E-04
46.00	.8483	.9825	.0011	u-235	2.9424E-05
				u-236	5.0394E-06
				pu-238	3.6977E-05
				pu-239	7.5695E-04
				pu-240	4.4344E-04
				pu-241	2.6241E-04
				pu-242	1.2380E-04
				xe-135	2.4714E-08
				sm-149	5.8195E-07
				Total FP	8.3668E-04
48.00	.8441	.9776	.0012	u-235	2.8703E-05
				u-236	5.1823E-06
				pu-238	3.7494E-05
				pu-239	7.4392E-04
				pu-240	4.4022E-04
				pu-241	2.6294E-04
				pu-242	1.2506E-04
				xe-135	2.4588E-08
				sm-149	5.7779E-07
				Total FP	8.6955E-04

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
50.00	.8406	.9728	.0013	u-235	2.7995E-05
				u-236	5.3197E-06
				pu-238	3.8014E-05
				pu-239	7.3120E-04
				pu-240	4.3692E-04
				pu-241	2.6332E-04
				pu-242	1.2634E-04
				xe-135	2.4460E-08
				sm-149	5.7343E-07
				Total FP	9.0220E-04
52.00	.8368	.9697	.0010	u-235	2.7300E-05
				u-236	5.4517E-06
				pu-238	3.8537E-05
				pu-239	7.1878E-04
				pu-240	4.3356E-04
				pu-241	2.6355E-04
				pu-242	1.2763E-04
				xe-135	2.4332E-08
				sm-149	5.6890E-07
				Total FP	9.3463E-04
54.00	.8346	.9654	.0012	u-235	2.6618E-05
				u-236	5.5784E-06
				pu-238	3.9062E-05
				pu-239	7.0666E-04
				pu-240	4.3013E-04
				pu-241	2.6363E-04
				pu-242	1.2894E-04
				xe-135	2.4203E-08
				sm-149	5.6422E-07
				Total FP	9.6683E-04
56.00	.8307	.9614	.0012	u-235	2.5948E-05
				u-236	5.7000E-06
				pu-238	3.9588E-05
				pu-239	6.9484E-04
				pu-240	4.2664E-04
				pu-241	2.6357E-04
				pu-242	1.3026E-04
				xe-135	2.4073E-08
				sm-149	5.5941E-07
				Total FP	9.9882E-04
58.00	.8275	.9580	.0013	u-235	2.5291E-05
				u-236	5.8165E-06
				pu-238	4.0115E-05
				pu-239	6.8330E-04
				pu-240	4.2310E-04
				pu-241	2.6338E-04
				pu-242	1.3159E-04
				xe-135	2.3942E-08
				sm-149	5.5449E-07
				Total FP	1.0306E-03

Variant 10
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2)
60.00	.8245	.9544	.0012	u-235	2.4646E-05
				u-236	5.9279E-06
				pu-238	4.0642E-05
				pu-239	6.7204E-04
				pu-240	4.1950E-04
				pu-241	2.6306E-04
				pu-242	1.3293E-04
				xe-135	2.3811E-08
				sm-149	5.4949E-07
				Total FP	1.0622E-03

Additional data

Burnup = 0 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5269E+01	3.3282E-01	1.3613E-01	5.3104E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1555E-02	2.8100E-02	8.1287E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.50729E+01	8.84648E-03	2.68641E+01	1.57669E-02
U-236	8.31418E+00	0.00000E+00	8.82027E-01	0.00000E+00
Pu-238	8.67092E+00	3.05344E-03	5.63695E+00	1.98504E-03
Pu-239	2.68568E+01	3.65692E-01	4.96825E+01	6.76495E-01
Pu-240	2.33988E+01	1.34584E-01	2.03340E+00	1.16956E-02
Pu-241	3.22801E+01	7.19933E-02	7.10940E+01	1.58559E-01
Pu-242	1.49298E+01	1.84012E-02	1.61187E+00	1.98666E-03
Xe-135	2.08889E+04	2.31911E-03	0.00000E+00	0.00000E+00
Sm-149	7.10365E+02	6.14267E-04	0.00000E+00	0.00000E+00
Total FP	3.00630E+03	2.93338E-03	0.00000E+00	0.00000E+00

Variant 10
State 1

Burnup = 10 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5316E+01	3.3292E-01	1.3617E-01	5.3091E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1571E-02	2.6969E-02	7.8168E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.49812E+01	7.89636E-03	2.66793E+01	1.40623E-02
U-236	7.98771E+00	1.32855E-04	8.72988E-01	1.45199E-05
Pu-238	8.60676E+00	2.99275E-03	5.63452E+00	1.95924E-03
Pu-239	2.71309E+01	3.35870E-01	5.00648E+01	6.19784E-01
Pu-240	2.30116E+01	1.31353E-01	2.03236E+00	1.16009E-02
Pu-241	3.20337E+01	8.20926E-02	7.05427E+01	1.80780E-01
Pu-242	1.47055E+01	1.84469E-02	1.61076E+00	2.02057E-03
Xe-135	2.03171E+04	6.39605E-03	0.00000E+00	0.00000E+00
Sm-149	6.90265E+02	4.60464E-03	0.00000E+00	0.00000E+00
Total FP	1.07561E+01	2.52301E-02	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5270E+01	3.3258E-01	1.3610E-01	5.3132E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1582E-02	2.6370E-02	7.6501E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.51180E+01	7.10495E-03	2.69748E+01	1.26772E-02
U-236	7.69360E+00	2.38142E-04	8.63497E-01	2.67281E-05
Pu-238	8.69463E+00	3.15645E-03	5.64115E+00	2.04793E-03
Pu-239	2.80643E+01	3.15337E-01	5.16996E+01	5.80909E-01
Pu-240	2.28789E+01	1.28110E-01	2.03047E+00	1.13696E-02
Pu-241	3.25237E+01	9.08555E-02	7.15603E+01	1.99905E-01
Pu-242	1.43288E+01	1.84920E-02	1.60913E+00	2.07665E-03
Xe-135	2.10605E+04	6.48605E-03	0.00000E+00	0.00000E+00
Sm-149	7.13608E+02	5.03144E-03	0.00000E+00	0.00000E+00
Total FP	8.26333E+00	3.74581E-02	0.00000E+00	0.00000E+00

Variant 10
State 1

Burnup = 30 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5368E+01	3.3286E-01	1.3612E-01	5.3101E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1409E-02	2.5653E-02	7.4480E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.52782E+01	6.41849E-03	2.73081E+01	1.14724E-02
U-236	7.54906E+00	3.27754E-04	8.57859E-01	3.72452E-05
Pu-238	8.79011E+00	3.41919E-03	5.64894E+00	2.19733E-03
Pu-239	2.88843E+01	2.96948E-01	5.31445E+01	5.46358E-01
Pu-240	2.30760E+01	1.26672E-01	2.02714E+00	1.11277E-02
Pu-241	3.29814E+01	9.77416E-02	7.25462E+01	2.14993E-01
Pu-242	1.38586E+01	1.86989E-02	1.60570E+00	2.16651E-03
Xe-135	2.17606E+04	6.58103E-03	0.00000E+00	0.00000E+00
Sm-149	7.34910E+02	5.22962E-03	0.00000E+00	0.00000E+00
Total FP	7.25865E+00	4.82819E-02	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5414E+01	3.3294E-01	1.3617E-01	5.3089E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1109E-02	2.4999E-02	7.2639E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.54589E+01	5.77239E-03	2.76942E+01	1.03411E-02
U-236	7.41284E+00	4.00053E-04	8.56321E-01	4.62136E-05
Pu-238	8.93119E+00	3.73320E-03	5.66284E+00	2.36704E-03
Pu-239	2.97949E+01	2.80338E-01	5.47789E+01	5.15411E-01
Pu-240	2.32292E+01	1.23977E-01	2.03043E+00	1.08366E-02
Pu-241	3.35842E+01	1.02877E-01	7.38058E+01	2.26086E-01
Pu-242	1.36549E+01	1.93444E-02	1.60828E+00	2.27839E-03
Xe-135	2.27956E+04	6.74310E-03	0.00000E+00	0.00000E+00
Sm-149	7.66433E+02	5.35886E-03	0.00000E+00	0.00000E+00
Total FP	6.67728E+00	5.79970E-02	0.00000E+00	0.00000E+00

Variant 10
State 1

Burnup = 50 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5541E+01	3.3273E-01	1.3616E-01	5.3111E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.1057E-02	2.4463E-02	7.1129E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.57134E+01	5.20207E-03	2.82234E+01	9.34363E-03
U-236	7.32247E+00	4.60650E-04	8.50158E-01	5.34827E-05
Pu-238	9.10352E+00	4.09242E-03	5.66856E+00	2.54826E-03
Pu-239	3.09862E+01	2.67936E-01	5.69243E+01	4.92221E-01
Pu-240	2.35784E+01	1.21827E-01	2.02394E+00	1.04575E-02
Pu-241	3.44120E+01	1.07157E-01	7.55801E+01	2.35352E-01
Pu-242	1.33573E+01	1.99567E-02	1.60234E+00	2.39400E-03
Xe-135	2.39611E+04	6.93089E-03	0.00000E+00	0.00000E+00
Sm-149	8.03250E+02	5.44700E-03	0.00000E+00	0.00000E+00
Total FP	6.29824E+00	6.71968E-02	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
3.5572E+01	3.3289E-01	1.3616E-01	5.3095E-01

One-group cell-averaged macroscopic cross-sections:

Absorption	Fission	Nu*Fission
7.0975E-02	2.3950E-02	6.9687E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Isotope	Absorption		Nu*Fission	
	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
U-235	1.60172E+01	4.67466E-03	2.88315E+01	8.41454E-03
U-236	7.24082E+00	5.08283E-04	8.48749E-01	5.95796E-05
Pu-238	9.29208E+00	4.47204E-03	5.68111E+00	2.73417E-03
Pu-239	3.22377E+01	2.56553E-01	5.91734E+01	4.70911E-01
Pu-240	2.39852E+01	1.19150E-01	2.02334E+00	1.00512E-02
Pu-241	3.53265E+01	1.10045E-01	7.75108E+01	2.41454E-01
Pu-242	1.30324E+01	2.05146E-02	1.60203E+00	2.52180E-03
Xe-135	2.51831E+04	7.10076E-03	0.00000E+00	0.00000E+00
Sm-149	8.40657E+02	5.47011E-03	0.00000E+00	0.00000E+00
Total FP	6.01959E+00	7.57132E-02	0.00000E+00	0.00000E+00

Variant 10
States 3-6

VARIANT 10, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9656	1.1184	.0013
10.00	.9288	1.0754	.0011
20.00	.9078	1.0500	.0010
30.00	.8871	1.0285	.0011
40.00	.8707	1.0060	.0012
50.00	.8496	.9847	.0011
60.00	.8324	.9655	.0011

VARIANT 10, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9591	1.1095	.0012
10.00	.9181	1.0628	.0012
20.00	.8980	1.0397	.0012
30.00	.8785	1.0161	.0011
40.00	.8569	.9934	.0012
50.00	.8406	.9728	.0013
60.00	.8245	.9544	.0012

VARIANT 10, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.9754	1.1294	.0013
10.00	.9332	1.0799	.0012
20.00	.9117	1.0552	.0014
30.00	.8918	1.0321	.0012
40.00	.8727	1.0097	.0012
50.00	.8512	.9881	.0011
60.00	.8372	.9704	.0012

VARIANT 10, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0819	1.1987	.0013
10.00	1.0265	1.1392	.0013
20.00	1.0074	1.1149	.0012
30.00	.9847	1.0892	.0011
40.00	.9658	1.0690	.0013
50.00	.9453	1.0464	.0013
60.00	.9272	1.0267	.0011

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
.00	1.0685	1.2646	.0007	u-235	8.7370E-04	8.7370E-04	8.7370E-04
				u-236	0.0000E+00	0.0000E+00	0.0000E+00
				pu-238	0.0000E+00	0.0000E+00	0.0000E+00
				pu-239	0.0000E+00	0.0000E+00	0.0000E+00
				pu-240	0.0000E+00	0.0000E+00	0.0000E+00
				pu-241	0.0000E+00	0.0000E+00	0.0000E+00
				pu-242	0.0000E+00	0.0000E+00	0.0000E+00
				xe-135	9.4581E-09	9.4581E-09	9.4581E-09
				sm-149	7.3667E-08	7.3667E-08	7.3667E-08
				Total FP	8.3125E-08	8.3125E-08	8.3125E-08
2.00	1.0568	1.2491	.0017	u-235	8.2411E-04	8.2746E-04	8.2518E-04
				u-236	9.0626E-06	8.8553E-06	8.9885E-06
				pu-238	1.2088E-09	1.4134E-09	1.2483E-09
				pu-239	1.5816E-05	1.7805E-05	1.6378E-05
				pu-240	5.2804E-07	5.7422E-07	5.4062E-07
				pu-241	4.1350E-08	5.0351E-08	4.4009E-08
				pu-242	4.9148E-10	5.6006E-10	5.1272E-10
				xe-135	9.5355E-09	1.0132E-08	9.6893E-09
				sm-149	6.9751E-08	7.7015E-08	7.1527E-08
				Total FP	4.2937E-05	4.0226E-05	4.2048E-05
4.00	1.0404	1.2278	.0013	u-235	7.7722E-04	7.8363E-04	7.7884E-04
				u-236	1.7563E-05	1.7199E-05	1.7507E-05
				pu-238	6.6405E-09	7.8619E-09	6.9686E-09
				pu-239	2.9015E-05	3.3014E-05	3.0250E-05
				pu-240	1.8392E-06	1.9740E-06	1.8905E-06
				pu-241	2.8838E-07	3.5060E-07	3.1003E-07
				pu-242	7.2205E-09	8.1398E-09	7.6301E-09
				xe-135	9.4757E-09	1.0223E-08	9.6906E-09
				sm-149	7.3476E-08	8.3029E-08	7.5823E-08
				Total FP	8.4509E-05	7.9547E-05	8.3267E-05
6.00	1.0205	1.2079	.0016	u-235	7.3243E-04	7.4186E-04	7.3503E-04
				u-236	2.5614E-05	2.5092E-05	2.5492E-05
				pu-238	1.8232E-08	2.1739E-08	1.9128E-08
				pu-239	4.0170E-05	4.6132E-05	4.1916E-05
				pu-240	3.6435E-06	3.8702E-06	3.7216E-06
				pu-241	8.2599E-07	1.0001E-06	8.8145E-07
				pu-242	3.2249E-08	3.5901E-08	3.3698E-08
				xe-135	9.3948E-09	1.0266E-08	9.6144E-09
				sm-149	7.6701E-08	8.8421E-08	7.9553E-08
				Total FP	1.2529E-04	1.1826E-04	1.2334E-04
8.00	1.0051	1.1884	.0013	u-235	6.8969E-04	7.0197E-04	6.9318E-04
				u-236	3.3222E-05	3.2565E-05	3.3048E-05
				pu-238	3.7670E-08	4.5217E-08	3.9573E-08
				pu-239	4.9589E-05	5.7513E-05	5.1848E-05
				pu-240	5.7537E-06	6.0689E-06	5.8577E-06
				pu-241	1.6547E-06	1.9997E-06	1.7599E-06
				pu-242	8.9303E-08	9.8461E-08	9.2750E-08
				xe-135	9.2776E-09	1.0272E-08	9.5295E-09
				sm-149	7.9271E-08	9.3091E-08	8.2606E-08
				Total FP	1.6525E-04	1.5645E-04	1.6272E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
10.00	.9876	1.1679	.0006	u-235	6.4904E-04	6.6376E-04	6.5298E-04
				u-236	4.0385E-05	3.9653E-05	4.0233E-05
				pu-238	6.6328E-08	8.0366E-08	7.0107E-08
				pu-239	5.7512E-05	6.7441E-05	6.0350E-05
				pu-240	8.0435E-06	8.4580E-06	8.1948E-06
				pu-241	2.7316E-06	3.3092E-06	2.9122E-06
				pu-242	1.9057E-07	2.0927E-07	1.9833E-07
				xe-135	9.1291E-09	1.0258E-08	9.4323E-09
				sm-149	8.1230E-08	9.7109E-08	8.5078E-08
				Total FP	2.0429E-04	1.9425E-04	2.0167E-04
12.00	.9722	1.1491	.0015	u-235	6.1010E-04	6.2717E-04	6.1457E-04
				u-236	4.7169E-05	4.6369E-05	4.7019E-05
				pu-238	1.0572E-07	1.2906E-07	1.1213E-07
				pu-239	6.4211E-05	7.6113E-05	6.7576E-05
				pu-240	1.0450E-05	1.0962E-05	1.0643E-05
				pu-241	4.0117E-06	4.8711E-06	4.2790E-06
				pu-242	3.4711E-07	3.7922E-07	3.6090E-07
				xe-135	8.9786E-09	1.0219E-08	9.3014E-09
				sm-149	8.2701E-08	1.0053E-07	8.6983E-08
				Total FP	2.4273E-04	2.3168E-04	2.3998E-04
14.00	.9561	1.1305	.0012	u-235	5.7269E-04	5.9202E-04	5.7790E-04
				u-236	5.3609E-05	5.2743E-05	5.3419E-05
				pu-238	1.5731E-07	1.9323E-07	1.6693E-07
				pu-239	6.9872E-05	8.3713E-05	7.3701E-05
				pu-240	1.2928E-05	1.3538E-05	1.3148E-05
				pu-241	5.4483E-06	6.6324E-06	5.8030E-06
				pu-242	5.6828E-07	6.1735E-07	5.8833E-07
				xe-135	8.8210E-09	1.0170E-08	9.1540E-09
				sm-149	8.3752E-08	1.0343E-07	8.8392E-08
				Total FP	2.8071E-04	2.6885E-04	2.7763E-04
16.00	.9400	1.1118	.0014	u-235	5.3701E-04	5.5830E-04	5.4263E-04
				u-236	5.9672E-05	5.8775E-05	5.9494E-05
				pu-238	2.2191E-07	2.7449E-07	2.3621E-07
				pu-239	7.4596E-05	9.0362E-05	7.8915E-05
				pu-240	1.5422E-05	1.6145E-05	1.5689E-05
				pu-241	6.9824E-06	8.5374E-06	7.4462E-06
				pu-242	8.5879E-07	9.2959E-07	8.8871E-07
				xe-135	8.6372E-09	1.0102E-08	9.0120E-09
				sm-149	8.4356E-08	1.0582E-07	8.9431E-08
				Total FP	3.1796E-04	3.0573E-04	3.1495E-04
18.00	.9258	1.0957	.0014	u-235	5.0279E-04	5.2598E-04	5.0895E-04
				u-236	6.5405E-05	6.4473E-05	6.5211E-05
				pu-238	3.0091E-07	3.7436E-07	3.2069E-07
				pu-239	7.8535E-05	9.6171E-05	8.3297E-05
				pu-240	1.7916E-05	1.8757E-05	1.8220E-05
				pu-241	8.5806E-06	1.0538E-05	9.1523E-06
				pu-242	1.2245E-06	1.3198E-06	1.2642E-06
				xe-135	8.4573E-09	1.0021E-08	8.8441E-09
				sm-149	8.4652E-08	1.0777E-07	9.0037E-08
				Total FP	3.5472E-04	3.4230E-04	3.5166E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
20.00	.9126	1.0792	.0007	u-235	4.7005E-04	4.9500E-04	4.7662E-04
				u-236	7.0807E-05	6.9848E-05	7.0614E-05
				pu-238	3.9513E-07	4.9425E-07	4.2187E-07
				pu-239	8.1783E-05	1.0124E-04	8.6977E-05
				pu-240	2.0383E-05	2.1353E-05	2.0734E-05
				pu-241	1.0203E-05	1.2594E-05	1.0894E-05
				pu-242	1.6676E-06	1.7902E-06	1.7195E-06
				xe-135	8.2662E-09	9.9290E-09	8.6805E-09
				sm-149	8.4619E-08	1.0930E-07	9.0348E-08
				Total FP	3.9092E-04	3.7857E-04	3.8799E-04
22.00	.8979	1.0633	.0012	u-235	4.3882E-04	4.6525E-04	4.4574E-04
				u-236	7.5876E-05	7.4919E-05	7.5689E-05
				pu-238	5.0511E-07	6.3573E-07	5.4032E-07
				pu-239	8.4424E-05	1.0566E-04	9.0029E-05
				pu-240	2.2799E-05	2.3922E-05	2.3202E-05
				pu-241	1.1816E-05	1.4676E-05	1.2632E-05
				pu-242	2.1879E-06	2.3427E-06	2.2540E-06
				xe-135	8.0659E-09	9.8343E-09	8.5019E-09
				sm-149	8.4290E-08	1.1049E-07	9.0322E-08
				Total FP	4.2647E-04	4.1465E-04	4.2379E-04
24.00	.8877	1.0489	.0013	u-235	4.0904E-04	4.3671E-04	4.1619E-04
				u-236	8.0625E-05	7.9690E-05	8.0458E-05
				pu-238	6.3150E-07	7.9999E-07	6.7705E-07
				pu-239	8.6542E-05	1.0950E-04	9.2537E-05
				pu-240	2.5151E-05	2.6450E-05	2.5616E-05
				pu-241	1.3395E-05	1.6755E-05	1.4345E-05
				pu-242	2.7853E-06	2.9771E-06	2.8687E-06
				xe-135	7.8639E-09	9.7307E-09	8.3233E-09
				sm-149	8.3727E-08	1.1135E-07	9.0052E-08
				Total FP	4.6141E-04	4.5051E-04	4.5915E-04
26.00	.8740	1.0331	.0013	u-235	3.8043E-04	4.0931E-04	3.8811E-04
				u-236	8.5100E-05	8.4174E-05	8.4901E-05
				pu-238	7.7588E-07	9.8835E-07	8.3178E-07
				pu-239	8.8219E-05	1.1283E-04	9.4556E-05
				pu-240	2.7447E-05	2.8930E-05	2.7951E-05
				pu-241	1.4934E-05	1.8810E-05	1.6000E-05
				pu-242	3.4644E-06	3.6935E-06	3.5582E-06
				xe-135	7.6726E-09	9.6240E-09	8.1299E-09
				sm-149	8.3022E-08	1.1193E-07	8.9490E-08
				Total FP	4.9604E-04	4.8622E-04	4.9384E-04
28.00	.8602	1.0170	.0012	u-235	3.5327E-04	3.8303E-04	3.6133E-04
				u-236	8.9261E-05	8.8376E-05	8.9047E-05
				pu-238	9.3730E-07	1.2019E-06	1.0054E-06
				pu-239	8.9495E-05	1.1570E-04	9.6160E-05
				pu-240	2.9653E-05	3.1353E-05	3.0207E-05
				pu-241	1.6400E-05	2.0823E-05	1.7590E-05
				pu-242	4.2166E-06	4.4906E-06	4.3228E-06
				xe-135	7.4627E-09	9.5121E-09	7.9430E-09
				sm-149	8.2050E-08	1.1224E-07	8.8764E-08
				Total FP	5.2997E-04	5.2179E-04	5.2803E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
30.00	.8465	1.0025	.0006	u-235	3.2754E-04	3.5801E-04	3.3566E-04
				u-236	9.3114E-05	9.2274E-05	9.2928E-05
				pu-238	1.1156E-06	1.4398E-06	1.1993E-06
				pu-239	9.0426E-05	1.1814E-04	9.7409E-05
				pu-240	3.1761E-05	3.3695E-05	3.2392E-05
				pu-241	1.7780E-05	2.2763E-05	1.9112E-05
				pu-242	5.0376E-06	5.3601E-06	5.1654E-06
				xe-135	7.2526E-09	9.3794E-09	7.7650E-09
				sm-149	8.0918E-08	1.1223E-07	8.7921E-08
				Total FP	5.6317E-04	5.5694E-04	5.6196E-04
32.00	.8355	.9891	.0012	u-235	3.0300E-04	3.3405E-04	3.1131E-04
				u-236	9.6698E-05	9.5902E-05	9.6516E-05
				pu-238	1.3119E-06	1.7038E-06	1.4121E-06
				pu-239	9.1068E-05	1.2021E-04	9.8336E-05
				pu-240	3.3783E-05	3.5967E-05	3.4480E-05
				pu-241	1.9078E-05	2.4632E-05	2.0542E-05
				pu-242	5.9308E-06	6.3044E-06	6.0758E-06
				xe-135	7.0554E-09	9.2584E-09	7.5717E-09
				sm-149	7.9724E-08	1.1207E-07	8.6850E-08
				Total FP	5.9593E-04	5.9195E-04	5.9530E-04
34.00	.8216	.9732	.0010	u-235	2.7987E-04	3.1119E-04	2.8801E-04
				u-236	9.9985E-05	9.9255E-05	9.9851E-05
				pu-238	1.5243E-06	1.9938E-06	1.6456E-06
				pu-239	9.1455E-05	1.2195E-04	9.8992E-05
				pu-240	3.5694E-05	3.8158E-05	3.6486E-05
				pu-241	2.0274E-05	2.6415E-05	2.1888E-05
				pu-242	6.8835E-06	7.3182E-06	7.0598E-06
				xe-135	6.8467E-09	9.1297E-09	7.3940E-09
				sm-149	7.8345E-08	1.1170E-07	8.5740E-08
				Total FP	6.2791E-04	6.2673E-04	6.2841E-04
36.00	.8116	.9608	.0011	u-235	2.5785E-04	2.8937E-04	2.6599E-04
				u-236	1.0302E-04	1.0234E-04	1.0290E-04
				pu-238	1.7544E-06	2.3101E-06	1.8974E-06
				pu-239	9.1633E-05	1.2340E-04	9.9406E-05
				pu-240	3.7514E-05	4.0267E-05	3.8387E-05
				pu-241	2.1380E-05	2.8108E-05	2.3129E-05
				pu-242	7.9028E-06	8.3994E-06	8.1038E-06
				xe-135	6.6556E-09	9.0016E-09	7.2008E-09
				sm-149	7.6968E-08	1.1117E-07	8.4421E-08
				Total FP	6.5951E-04	6.6135E-04	6.6091E-04
38.00	.7997	.9467	.0012	u-235	2.3698E-04	2.6869E-04	2.4516E-04
				u-236	1.0580E-04	1.0515E-04	1.0569E-04
				pu-238	2.0013E-06	2.6510E-06	2.1673E-06
				pu-239	9.1631E-05	1.2458E-04	9.9614E-05
				pu-240	3.9234E-05	4.2281E-05	4.0184E-05
				pu-241	2.2391E-05	2.9696E-05	2.4267E-05
				pu-242	8.9825E-06	9.5379E-06	9.2051E-06
				xe-135	6.4638E-09	8.8615E-09	7.0137E-09
				sm-149	7.5504E-08	1.1044E-07	8.3041E-08
				Total FP	6.9063E-04	6.9560E-04	6.9288E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
40.00	.7867	.9323	.0006	u-235	2.1746E-04	2.4902E-04	2.2541E-04
				u-236	1.0830E-04	1.0771E-04	1.0823E-04
				pu-238	2.2619E-06	3.0172E-06	2.4556E-06
				pu-239	9.1476E-05	1.2553E-04	9.9648E-05
				pu-240	4.0837E-05	4.4206E-05	4.1884E-05
				pu-241	2.3295E-05	3.1185E-05	2.5308E-05
				pu-242	1.0106E-05	1.0734E-05	1.0365E-05
				xe-135	6.2646E-09	8.7305E-09	6.8361E-09
				sm-149	7.3919E-08	1.0963E-07	8.1636E-08
				Total FP	7.2092E-04	7.2965E-04	7.2451E-04
42.00	.7776	.9201	.0012	u-235	1.9896E-04	2.3034E-04	2.0686E-04
				u-236	1.1057E-04	1.1002E-04	1.1051E-04
				pu-238	2.5383E-06	3.4080E-06	2.7595E-06
				pu-239	9.1197E-05	1.2628E-04	9.9533E-05
				pu-240	4.2346E-05	4.6042E-05	4.3474E-05
				pu-241	2.4111E-05	3.2572E-05	2.6244E-05
				pu-242	1.1286E-05	1.1984E-05	1.1570E-05
				xe-135	6.0871E-09	8.5996E-09	6.6521E-09
				sm-149	7.2410E-08	1.0872E-07	8.0118E-08
				Total FP	7.5089E-04	7.6352E-04	7.5550E-04
44.00	.7661	.9076	.0012	u-235	1.8167E-04	2.1260E-04	1.8949E-04
				u-236	1.1259E-04	1.1209E-04	1.1253E-04
				pu-238	2.8270E-06	3.8234E-06	3.0774E-06
				pu-239	9.0818E-05	1.2685E-04	9.9297E-05
				pu-240	4.3745E-05	4.7791E-05	4.4954E-05
				pu-241	2.4831E-05	3.3861E-05	2.7077E-05
				pu-242	1.2505E-05	1.3286E-05	1.2813E-05
				xe-135	5.9034E-09	8.4739E-09	6.4728E-09
				sm-149	7.0808E-08	1.0774E-07	7.8566E-08
				Total FP	7.8016E-04	7.9730E-04	7.8586E-04
46.00	.7551	.8942	.0011	u-235	1.6539E-04	1.9594E-04	1.7303E-04
				u-236	1.1439E-04	1.1390E-04	1.1434E-04
				pu-238	3.1291E-06	4.2586E-06	3.4118E-06
				pu-239	9.0357E-05	1.2726E-04	9.8960E-05
				pu-240	4.5049E-05	4.9436E-05	4.6345E-05
				pu-241	2.5467E-05	3.5039E-05	2.7826E-05
				pu-242	1.3770E-05	1.4623E-05	1.4108E-05
				xe-135	5.7355E-09	8.3319E-09	6.3146E-09
				sm-149	6.9271E-08	1.0660E-07	7.7105E-08
				Total FP	8.0909E-04	8.3061E-04	8.1607E-04
48.00	.7449	.8829	.0012	u-235	1.5029E-04	1.8015E-04	1.5770E-04
				u-236	1.1595E-04	1.1549E-04	1.1591E-04
				pu-238	3.4399E-06	4.7161E-06	3.7575E-06
				pu-239	8.9836E-05	1.2753E-04	9.8542E-05
				pu-240	4.6244E-05	5.0997E-05	4.7629E-05
				pu-241	2.6015E-05	3.6123E-05	2.8480E-05
				pu-242	1.5060E-05	1.6005E-05	1.5432E-05
				xe-135	5.5628E-09	8.2114E-09	6.1459E-09
				sm-149	6.7665E-08	1.0551E-07	7.5534E-08
				Total FP	8.3725E-04	8.6389E-04	8.4565E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
50.00	.7342	.8701	.0005	u-235	1.3623E-04	1.6534E-04	1.4333E-04
				u-236	1.1729E-04	1.1684E-04	1.1726E-04
				pu-238	3.7594E-06	5.1913E-06	4.1151E-06
				pu-239	8.9271E-05	1.2768E-04	9.8059E-05
				pu-240	4.7341E-05	5.2460E-05	4.8819E-05
				pu-241	2.6485E-05	3.7107E-05	2.9053E-05
				pu-242	1.6379E-05	1.7416E-05	1.6791E-05
				xe-135	5.4037E-09	8.0800E-09	5.9923E-09
				sm-149	6.6125E-08	1.0431E-07	7.4034E-08
				Total FP	8.6489E-04	8.9683E-04	8.7490E-04
52.00	.7224	.8585	.0011	u-235	1.2317E-04	1.5146E-04	1.2997E-04
				u-236	1.1842E-04	1.1797E-04	1.1839E-04
				pu-238	4.0861E-06	5.6825E-06	4.4813E-06
				pu-239	8.8675E-05	1.2772E-04	9.7530E-05
				pu-240	4.8344E-05	5.3830E-05	4.9911E-05
				pu-241	2.6884E-05	3.7995E-05	2.9545E-05
				pu-242	1.7723E-05	1.8853E-05	1.8174E-05
				xe-135	5.2528E-09	7.9539E-09	5.8396E-09
				sm-149	6.4620E-08	1.0308E-07	7.2514E-08
				Total FP	8.9203E-04	9.2949E-04	9.0364E-04
54.00	.7161	.8475	.0010	u-235	1.1100E-04	1.3846E-04	1.1762E-04
				u-236	1.1935E-04	1.1888E-04	1.1931E-04
				pu-238	4.4199E-06	6.1882E-06	4.8532E-06
				pu-239	8.8060E-05	1.2768E-04	9.6968E-05
				pu-240	4.9261E-05	5.5110E-05	5.0906E-05
				pu-241	2.7221E-05	3.8793E-05	2.9961E-05
				pu-242	1.9096E-05	2.0313E-05	1.9570E-05
				xe-135	5.1140E-09	7.8336E-09	5.6913E-09
				sm-149	6.3189E-08	1.0186E-07	7.1006E-08
				Total FP	9.1887E-04	9.6191E-04	9.3178E-04
56.00	.7075	.8381	.0010	u-235	9.9783E-05	1.2630E-04	1.0624E-04
				u-236	1.2009E-04	1.1959E-04	1.2003E-04
				pu-238	4.7571E-06	6.7066E-06	5.2286E-06
				pu-239	8.7439E-05	1.2756E-04	9.6388E-05
				pu-240	5.0090E-05	5.6304E-05	5.1807E-05
				pu-241	2.7497E-05	3.9508E-05	3.0308E-05
				pu-242	2.0483E-05	2.1793E-05	2.0975E-05
				xe-135	4.9769E-09	7.7191E-09	5.5507E-09
				sm-149	6.1761E-08	1.0065E-07	6.9536E-08
				Total FP	9.4519E-04	9.9416E-04	9.5935E-04
58.00	.6951	.8256	.0010	u-235	8.9575E-05	1.1500E-04	9.5628E-05
				u-236	1.2064E-04	1.2010E-04	1.2057E-04
				pu-238	5.0933E-06	7.2334E-06	5.6098E-06
				pu-239	8.6825E-05	1.2738E-04	9.5795E-05
				pu-240	5.0829E-05	5.7409E-05	5.2632E-05
				pu-241	2.7716E-05	4.0141E-05	3.0600E-05
				pu-242	2.1866E-05	2.3282E-05	2.2405E-05
				xe-135	4.8419E-09	7.6025E-09	5.4303E-09
				sm-149	6.0339E-08	9.9402E-08	6.8205E-08
				Total FP	9.7073E-04	1.0261E-03	9.8681E-04

Variant 11
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
60.00	.6807	.8074	.0005	u-235	8.0198E-05	1.0451E-04	8.5898E-05
				u-236	1.2102E-04	1.2041E-04	1.2093E-04
				pu-238	5.4297E-06	7.7668E-06	5.9911E-06
				pu-239	8.6220E-05	1.2715E-04	9.5201E-05
				pu-240	5.1492E-05	5.8430E-05	5.3373E-05
				pu-241	2.7889E-05	4.0699E-05	3.0836E-05
				pu-242	2.3257E-05	2.4777E-05	2.3836E-05
				xe-135	4.7244E-09	7.4932E-09	5.3056E-09
				sm-149	5.9045E-08	9.8190E-08	6.6842E-08
				Total FP	9.9588E-04	1.0577E-03	1.0138E-03

Additional data

Burnup = 0 MWd/kgU

Power distribution by pin

1	1.0556E+00	2	1.0373E+00	3	1.0241E+00	4	1.0227E+00	5	1.0297E+00	6	1.0279E+00
7	1.0221E+00	8	1.0262E+00	9	1.0247E+00	10	1.0352E+00	11	1.0556E+00	12	1.0352E+00
13	9.8879E-01	14	9.8004E-01	15	9.6807E-01	16	9.7449E-01	17	9.7536E-01	18	9.6690E-01
19	9.8062E-01	20	9.7157E-01	21	9.7770E-01	22	9.8879E-01	23	1.0373E+00	24	1.0247E+00
25	9.7770E-01	26	9.6223E-01	27	9.5989E-01	28	9.5318E-01	29	9.6194E-01	30	9.7069E-01
31	9.5931E-01	32	9.5435E-01	33	9.4705E-01	34	9.6223E-01	35	9.8004E-01	36	1.0241E+00
37	1.0262E+00	38	9.7157E-01	39	9.4705E-01	40	9.5493E-01	41	9.6427E-01	42	9.7069E-01
43	9.9492E-01	44	9.8383E-01	45	9.7595E-01	46	9.6661E-01	47	9.5493E-01	48	9.5989E-01
49	9.6807E-01	50	1.0227E+00	51	1.0221E+00	52	9.8062E-01	53	9.5435E-01	54	9.6661E-01
55	9.8763E-01	56	1.0069E+00	57	1.0133E+00	58	0.0000E+00	59	9.9726E-01	60	1.0008E+00
61	9.8763E-01	62	9.6427E-01	63	9.5318E-01	64	9.7449E-01	65	1.0297E+00	66	1.0279E+00
67	9.6690E-01	68	9.5931E-01	69	9.7595E-01	70	1.0008E+00	71	0.0000E+00	72	1.0256E+00
73	1.0279E+00	74	1.0294E+00	75	1.0238E+00	76	0.0000E+00	77	1.0069E+00	78	9.7069E-01
79	9.6194E-01	80	9.7536E-01	81	1.0279E+00	82	1.0297E+00	83	9.7536E-01	84	9.7069E-01
85	9.8383E-01	86	9.9726E-01	87	1.0238E+00	88	1.0265E+00	89	1.0349E+00	90	1.0311E+00
91	1.0060E+00	92	1.0265E+00	93	1.0256E+00	94	1.0133E+00	95	9.9492E-01	96	9.7069E-01
97	9.6690E-01	98	1.0221E+00	99	1.0227E+00	100	9.7449E-01	101	9.6194E-01	102	9.9492E-01
103	0.0000E+00	104	1.0294E+00	105	1.0060E+00	106	1.0370E+00	107	0.0000E+00	108	1.0367E+00
109	1.0370E+00	110	1.0349E+00	111	1.0279E+00	112	0.0000E+00	113	9.8383E-01	114	9.5931E-01
115	9.8062E-01	116	1.0262E+00	117	1.0241E+00	118	9.6807E-01	119	9.5318E-01	120	9.7069E-01
121	1.0133E+00	122	1.0279E+00	123	1.0311E+00	124	1.0367E+00	125	1.0428E+00	126	1.0516E+00
127	1.0428E+00	128	0.0000E+00	129	1.0311E+00	130	1.0294E+00	131	9.9726E-01	132	9.7595E-01
133	9.5435E-01	134	9.7157E-01	135	1.0247E+00	136	1.0373E+00	137	9.8004E-01	138	9.5989E-01
139	9.6427E-01	140	1.0069E+00	141	1.0256E+00	142	1.0349E+00	143	0.0000E+00	144	1.0516E+00
145	1.0521E+00	146	1.0521E+00	147	1.0516E+00	148	1.0367E+00	149	1.0060E+00	150	1.0238E+00
151	1.0008E+00	152	9.6661E-01	153	9.4705E-01	154	9.7770E-01	155	1.0352E+00	156	1.0556E+00
157	9.8879E-01	158	9.6223E-01	159	9.5493E-01	160	9.8763E-01	161	0.0000E+00	162	1.0265E+00
163	1.0370E+00	164	1.0428E+00	165	1.0521E+00	166	0.0000E+00	167	1.0521E+00	168	1.0428E+00
169	1.0370E+00	170	1.0265E+00	171	0.0000E+00	172	9.8763E-01	173	9.5493E-01	174	9.6223E-01
175	9.8879E-01	176	1.0556E+00	177	1.0352E+00	178	9.7770E-01	179	9.4705E-01	180	9.6661E-01
181	1.0008E+00	182	1.0238E+00	183	1.0060E+00	184	1.0367E+00	185	1.0516E+00	186	1.0521E+00
187	1.0521E+00	188	1.0516E+00	189	0.0000E+00	190	1.0349E+00	191	1.0256E+00	192	1.0069E+00
193	9.6427E-01	194	9.5989E-01	195	9.8004E-01	196	1.0373E+00	197	1.0247E+00	198	9.7157E-01
199	9.5435E-01	200	9.7595E-01	201	9.9726E-01	202	1.0294E+00	203	1.0311E+00	204	0.0000E+00
205	1.0428E+00	206	1.0516E+00	207	1.0428E+00	208	1.0367E+00	209	1.0311E+00	210	1.0279E+00
211	1.0133E+00	212	9.7069E-01	213	9.5318E-01	214	9.6807E-01	215	1.0241E+00	216	1.0262E+00
217	9.8062E-01	218	9.5931E-01	219	9.8383E-01	220	0.0000E+00	221	1.0279E+00	222	1.0349E+00
223	1.0370E+00	224	1.0367E+00	225	0.0000E+00	226	1.0370E+00	227	1.0060E+00	228	1.0294E+00
229	0.0000E+00	230	9.9492E-01	231	9.6194E-01	232	9.7449E-01	233	1.0227E+00	234	1.0221E+00
235	9.6690E-01	236	9.7069E-01	237	9.9492E-01	238	1.0133E+00	239	1.0256E+00	240	1.0265E+00
241	1.0060E+00	242	1.0311E+00	243	1.0349E+00	244	1.0265E+00	245	1.0238E+00	246	9.9726E-01
247	9.8383E-01	248	9.7069E-01	249	9.7536E-01	250	1.0297E+00	251	1.0279E+00	252	9.7536E-01
253	9.6194E-01	254	9.7069E-01	255	1.0069E+00	256	0.0000E+00	257	1.0238E+00	258	1.0294E+00
259	1.0279E+00	260	1.0256E+00	261	0.0000E+00	262	1.0008E+00	263	9.7595E-01	264	9.5931E-01
265	9.6690E-01	266	1.0279E+00	267	1.0297E+00	268	9.7449E-01	269	9.5318E-01	270	9.6427E-01
271	9.8763E-01	272	1.0008E+00	273	9.9726E-01	274	0.0000E+00	275	1.0133E+00	276	1.0069E+00
277	9.8763E-01	278	9.6661E-01	279	9.5435E-01	280	9.8062E-01	281	1.0221E+00	282	1.0227E+00
283	9.6807E-01	284	9.5989E-01	285	9.5493E-01	286	9.6661E-01	287	9.7595E-01	288	9.8383E-01
289	9.9492E-01	290	9.7069E-01	291	9.6427E-01	292	9.5493E-01	293	9.4705E-01	294	9.7157E-01
295	1.0262E+00	296	1.0241E+00	297	9.8004E-01	298	9.6223E-01	299	9.4705E-01	300	9.5435E-01
301	9.5931E-01	302	9.7069E-01	303	9.6194E-01	304	9.5318E-01	305	9.5989E-01	306	9.6223E-01
307	9.7770E-01	308	1.0247E+00	309	1.0373E+00	310	9.8879E-01	311	9.7770E-01	312	9.7157E-01
313	9.8062E-01	314	9.6690E-01	315	9.7536E-01	316	9.7449E-01	317	9.6807E-01	318	9.8004E-01

319 9.8879E-01 320 1.0352E+00 321 1.0556E+00 322 1.0352E+00 323 1.0247E+00 324 1.0262E+00
325 1.0221E+00 326 1.0279E+00 327 1.0297E+00 328 1.0227E+00 329 1.0241E+00 330 1.0373E+00
331 1.0556E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3878E-01	3.2298E-01	1.3608E-01	5.4095E-01
29	1.3754E-01	3.2266E-01	1.3684E-01	5.4050E-01
72	1.3873E-01	3.2314E-01	1.3636E-01	5.4051E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.3795E-02	3.9257E-02	9.6425E-02
29	6.8771E-02	3.5955E-02	8.8381E-02
72	7.1748E-02	3.7886E-02	9.3073E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.25759E+01	2.05888E-03	1.04384E+02	4.08768E-03
	U-236	8.88278E+00	0.00000E+00	7.91339E-01	0.00000E+00
	Pu-238	3.47666E+01	0.00000E+00	7.21417E+00	0.00000E+00
	Pu-239	1.75822E+02	0.00000E+00	3.22219E+02	0.00000E+00
	Pu-240	2.16966E+02	0.00000E+00	1.82080E+00	0.00000E+00
	Pu-241	1.58866E+02	0.00000E+00	3.41986E+02	0.00000E+00
	Pu-242	3.27395E+01	0.00000E+00	1.35620E+00	0.00000E+00
	Xe-135	1.93701E+05	8.21141E-05	0.00000E+00	0.00000E+00
	Sm-149	6.00212E+03	1.98180E-05	0.00000E+00	0.00000E+00
	Total FP	2.73588E+04	1.01932E-04	0.00000E+00	0.00000E+00
29	U-235	4.80796E+01	1.86425E-03	9.51085E+01	3.68776E-03
	U-236	8.60861E+00	0.00000E+00	7.91008E-01	0.00000E+00
	Pu-238	3.13724E+01	0.00000E+00	6.96684E+00	0.00000E+00
	Pu-239	1.62664E+02	0.00000E+00	2.97380E+02	0.00000E+00
	Pu-240	2.20553E+02	0.00000E+00	1.84924E+00	0.00000E+00
	Pu-241	1.45565E+02	0.00000E+00	3.13173E+02	0.00000E+00
	Pu-242	3.30164E+01	0.00000E+00	1.37697E+00	0.00000E+00
	Xe-135	1.71087E+05	7.18128E-05	0.00000E+00	0.00000E+00
	Sm-149	5.34956E+03	1.74893E-05	0.00000E+00	0.00000E+00
	Total FP	2.42074E+04	8.93021E-05	0.00000E+00	0.00000E+00
72	U-235	5.07347E+01	1.98712E-03	1.00585E+02	3.93959E-03
	U-236	8.94701E+00	0.00000E+00	7.91480E-01	0.00000E+00
	Pu-238	3.33305E+01	0.00000E+00	7.10955E+00	0.00000E+00
	Pu-239	1.70830E+02	0.00000E+00	3.12690E+02	0.00000E+00
	Pu-240	2.26672E+02	0.00000E+00	1.82790E+00	0.00000E+00
	Pu-241	1.53303E+02	0.00000E+00	3.29969E+02	0.00000E+00
	Pu-242	3.28150E+01	0.00000E+00	1.35675E+00	0.00000E+00
	Xe-135	1.84062E+05	7.80410E-05	0.00000E+00	0.00000E+00
	Sm-149	5.70877E+03	1.88526E-05	0.00000E+00	0.00000E+00
	Total FP	2.60020E+04	9.68936E-05	0.00000E+00	0.00000E+00

Burnup = 10 MWd/kgU

Power distribution by pin

1	1.0408E+00	2	1.0231E+00	3	1.0118E+00	4	9.9787E-01	5	9.9819E-01	6	1.0032E+00
7	9.9377E-01	8	9.8903E-01	9	9.9882E-01	10	1.0134E+00	11	1.0408E+00	12	1.0134E+00
13	1.0108E+00	14	9.9282E-01	15	9.8492E-01	16	9.9566E-01	17	9.8682E-01	18	9.8934E-01
19	9.8145E-01	20	9.9156E-01	21	1.0074E+00	22	1.0108E+00	23	1.0231E+00	24	9.9882E-01
25	1.0074E+00	26	9.6850E-01	27	9.6755E-01	28	9.7166E-01	29	9.8619E-01	30	9.7481E-01
31	9.7450E-01	32	9.6123E-01	33	9.6534E-01	34	9.6850E-01	35	9.9282E-01	36	1.0118E+00
37	9.8903E-01	38	9.9156E-01	39	9.6534E-01	40	9.7102E-01	41	9.7829E-01	42	9.8461E-01
43	9.8492E-01	44	9.9156E-01	45	9.9124E-01	46	9.7229E-01	47	9.7102E-01	48	9.6755E-01
49	9.8492E-01	50	9.9787E-01	51	9.9377E-01	52	9.8145E-01	53	9.6123E-01	54	9.7229E-01
55	9.8334E-01	56	9.9250E-01	57	1.0121E+00	58	0.0000E+00	59	1.0077E+00	60	9.9535E-01
61	9.8334E-01	62	9.7829E-01	63	9.7166E-01	64	9.9566E-01	65	9.9819E-01	66	1.0032E+00
67	9.8934E-01	68	9.7450E-01	69	9.9124E-01	70	9.9535E-01	71	0.0000E+00	72	1.0061E+00
73	1.0291E+00	74	1.0178E+00	75	1.0077E+00	76	0.0000E+00	77	9.9250E-01	78	9.8461E-01
79	9.8619E-01	80	9.8682E-01	81	1.0032E+00	82	9.9819E-01	83	9.8682E-01	84	9.7481E-01
85	9.9156E-01	86	1.0077E+00	87	1.0077E+00	88	1.0187E+00	89	1.0291E+00	90	1.0241E+00
91	1.0326E+00	92	1.0187E+00	93	1.0061E+00	94	1.0121E+00	95	9.8492E-01	96	9.7481E-01

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 97 9.8934E-01  98 9.9377E-01  99 9.9787E-01 100 9.9566E-01 101 9.8619E-01 102 9.8492E-01
103 0.0000E+00 104 1.0178E+00 105 1.0326E+00 106 1.0333E+00 107 0.0000E+00 108 1.0304E+00
109 1.0333E+00 110 1.0291E+00 111 1.0291E+00 112 0.0000E+00 113 9.9156E-01 114 9.7450E-01
115 9.8145E-01 116 9.8903E-01 117 1.0118E+00 118 9.8492E-01 119 9.7166E-01 120 9.8461E-01
121 1.0121E+00 122 1.0291E+00 123 1.0241E+00 124 1.0304E+00 125 1.0374E+00 126 1.0418E+00
127 1.0374E+00 128 0.0000E+00 129 1.0241E+00 130 1.0178E+00 131 1.0077E+00 132 9.9124E-01
133 9.6123E-01 134 9.9156E-01 135 9.9882E-01 136 1.0231E+00 137 9.9282E-01 138 9.6755E-01
139 9.7829E-01 140 9.9250E-01 141 1.0061E+00 142 1.0291E+00 143 0.0000E+00 144 1.0418E+00
145 1.0465E+00 146 1.0465E+00 147 1.0418E+00 148 1.0304E+00 149 1.0326E+00 150 1.0077E+00
151 9.9535E-01 152 9.7229E-01 153 9.6534E-01 154 1.0074E+00 155 1.0134E+00 156 1.0408E+00
157 1.0108E+00 158 9.6850E-01 159 9.7102E-01 160 9.8334E-01 161 0.0000E+00 162 1.0187E+00
163 1.0333E+00 164 1.0374E+00 165 1.0465E+00 166 0.0000E+00 167 1.0465E+00 168 1.0374E+00
169 1.0333E+00 170 1.0187E+00 171 0.0000E+00 172 9.8334E-01 173 9.7102E-01 174 9.6850E-01
175 1.0108E+00 176 1.0408E+00 177 1.0134E+00 178 1.0074E+00 179 9.6534E-01 180 9.7229E-01
181 9.9535E-01 182 1.0077E+00 183 1.0326E+00 184 1.0304E+00 185 1.0418E+00 186 1.0465E+00
187 1.0465E+00 188 1.0418E+00 189 0.0000E+00 190 1.0291E+00 191 1.0061E+00 192 9.9250E-01
193 9.7829E-01 194 9.6755E-01 195 9.9282E-01 196 1.0231E+00 197 9.9882E-01 198 9.9156E-01
199 9.6123E-01 200 9.9124E-01 201 1.0077E+00 202 1.0178E+00 203 1.0241E+00 204 0.0000E+00
205 1.0374E+00 206 1.0418E+00 207 1.0374E+00 208 1.0304E+00 209 1.0241E+00 210 1.0291E+00
211 1.0121E+00 212 9.8461E-01 213 9.7166E-01 214 9.8492E-01 215 1.0118E+00 216 9.8903E-01
217 9.8145E-01 218 9.7450E-01 219 9.9156E-01 220 0.0000E+00 221 1.0291E+00 222 1.0291E+00
223 1.0333E+00 224 1.0304E+00 225 0.0000E+00 226 1.0333E+00 227 1.0326E+00 228 1.0178E+00
229 0.0000E+00 230 9.8492E-01 231 9.8619E-01 232 9.9566E-01 233 9.9787E-01 234 9.9377E-01
235 9.8934E-01 236 9.7481E-01 237 9.8492E-01 238 1.0121E+00 239 1.0061E+00 240 1.0187E+00
241 1.0326E+00 242 1.0241E+00 243 1.0291E+00 244 1.0187E+00 245 1.0077E+00 246 1.0077E+00
247 9.9156E-01 248 9.7481E-01 249 9.8682E-01 250 9.9819E-01 251 1.0032E+00 252 9.8682E-01
253 9.8619E-01 254 9.8461E-01 255 9.9250E-01 256 0.0000E+00 257 1.0077E+00 258 1.0178E+00
259 1.0291E+00 260 1.0061E+00 261 0.0000E+00 262 9.9535E-01 263 9.9124E-01 264 9.7450E-01
265 9.8934E-01 266 1.0032E+00 267 9.9819E-01 268 9.9566E-01 269 9.7166E-01 270 9.7829E-01
271 9.8334E-01 272 9.9535E-01 273 1.0077E+00 274 0.0000E+00 275 1.0121E+00 276 9.9250E-01
277 9.8334E-01 278 9.7229E-01 279 9.6123E-01 280 9.8145E-01 281 9.9377E-01 282 9.9787E-01
283 9.8492E-01 284 9.6755E-01 285 9.7102E-01 286 9.7229E-01 287 9.9124E-01 288 9.9156E-01
289 9.8492E-01 290 9.8461E-01 291 9.7829E-01 292 9.7102E-01 293 9.6534E-01 294 9.9156E-01
295 9.8903E-01 296 1.0118E+00 297 9.9282E-01 298 9.6850E-01 299 9.6534E-01 300 9.6123E-01
301 9.7450E-01 302 9.7481E-01 303 9.8619E-01 304 9.7166E-01 305 9.6755E-01 306 9.6850E-01
307 1.0074E+00 308 9.9882E-01 309 1.0231E+00 310 1.0108E+00 311 1.0074E+00 312 9.9156E-01
313 9.8145E-01 314 9.8934E-01 315 9.8682E-01 316 9.9566E-01 317 9.8492E-01 318 9.9282E-01
319 1.0108E+00 320 1.0134E+00 321 1.0408E+00 322 1.0134E+00 323 9.9882E-01 324 9.8903E-01
325 9.9377E-01 326 1.0032E+00 327 9.9819E-01 328 9.9787E-01 329 1.0118E+00 330 1.0231E+00
331 1.0408E+00
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Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3749E-01	3.2342E-01	1.3637E-01	5.4021E-01
29	1.3648E-01	3.2389E-01	1.3647E-01	5.3964E-01
72	1.3723E-01	3.2366E-01	1.3649E-01	5.3986E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.4209E-02	3.4941E-02	8.8723E-02
29	7.0067E-02	3.2747E-02	8.3518E-02
72	7.2109E-02	3.3839E-02	8.6030E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.09068E+01	1.46923E-03	1.00768E+02	2.90827E-03
	U-236	8.43718E+00	1.51516E-05	7.85770E-01	1.41110E-06
	Pu-238	3.36741E+01	9.93197E-08	7.16403E+00	2.11298E-08
	Pu-239	1.61846E+02	4.13906E-04	2.97608E+02	7.61105E-04
	Pu-240	1.81540E+02	6.49320E-05	1.81880E+00	6.50539E-07
	Pu-241	1.50146E+02	1.82379E-05	3.23758E+02	3.93260E-05
	Pu-242	3.35963E+01	2.84700E-07	1.36900E+00	1.16011E-08
	Xe-135	1.86142E+05	7.55640E-05	0.00000E+00	0.00000E+00
	Sm-149	5.74396E+03	2.07477E-05	0.00000E+00	0.00000E+00
	Total FP	1.89592E+01	1.72230E-04	0.00000E+00	0.00000E+00
29	U-235	4.52825E+01	1.32857E-03	8.92920E+01	2.61980E-03
	U-236	8.03665E+00	1.40863E-05	7.85547E-01	1.37687E-06
	Pu-238	2.96190E+01	1.05217E-07	6.88404E+00	2.44546E-08
	Pu-239	1.44572E+02	4.30975E-04	2.65318E+02	7.90926E-04
	Pu-240	1.76124E+02	6.58461E-05	1.85823E+00	6.94725E-07

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	Pu-241	1.33293E+02	1.94973E-05	2.87391E+02	4.20378E-05
	Pu-242	3.27833E+01	3.03252E-07	1.40269E+00	1.29752E-08
	Xe-135	1.59842E+05	7.24766E-05	0.00000E+00	0.00000E+00
	Sm-149	4.99062E+03	2.14219E-05	0.00000E+00	0.00000E+00
	Total FP	1.88059E+01	1.61474E-04	0.00000E+00	0.00000E+00
72	U-235	4.85896E+01	1.40925E-03	9.60865E+01	2.78681E-03
	U-236	8.08904E+00	1.44552E-05	7.80513E-01	1.39479E-06
	Pu-238	3.20776E+01	9.98869E-08	7.05705E+00	2.19751E-08
	Pu-239	1.53608E+02	4.11752E-04	2.82466E+02	7.57161E-04
	Pu-240	1.81028E+02	6.58915E-05	1.83828E+00	6.69107E-07
	Pu-241	1.42836E+02	1.84758E-05	3.08076E+02	3.98497E-05
	Pu-242	3.35684E+01	2.95709E-07	1.38502E+00	1.22009E-08
	Xe-135	1.75675E+05	7.35993E-05	0.00000E+00	0.00000E+00
	Sm-149	5.45114E+03	2.05992E-05	0.00000E+00	0.00000E+00
	Total FP	1.86069E+01	1.66673E-04	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Power distribution by pin

1	1.0241E+00	2	9.9126E-01	3	9.8716E-01	4	9.7349E-01	5	9.7520E-01	6	9.7998E-01
7	9.6973E-01	8	9.7486E-01	9	9.8956E-01	10	9.8921E-01	11	1.0241E+00	12	9.8921E-01
13	1.0306E+00	14	1.0227E+00	15	1.0077E+00	16	9.9400E-01	17	1.0125E+00	18	1.0073E+00
19	1.0148E+00	20	1.0152E+00	21	1.0155E+00	22	1.0306E+00	23	9.9126E-01	24	9.8956E-01
25	1.0155E+00	26	9.9502E-01	27	9.8340E-01	28	9.8306E-01	29	9.8443E-01	30	9.9981E-01
31	9.9092E-01	32	9.8443E-01	33	9.8101E-01	34	9.9502E-01	35	1.0227E+00	36	9.8716E-01
37	9.7486E-01	38	1.0152E+00	39	9.8101E-01	40	9.7828E-01	41	1.0019E+00	42	9.9502E-01
43	9.7417E-01	44	9.7588E-01	45	1.0107E+00	46	9.9878E-01	47	9.7828E-01	48	9.8340E-01
49	1.0077E+00	50	9.7349E-01	51	9.6973E-01	52	1.0148E+00	53	9.8443E-01	54	9.9878E-01
55	9.6084E-01	56	9.8956E-01	57	9.9297E-01	58	0.0000E+00	59	9.8990E-01	60	9.7315E-01
61	9.6084E-01	62	1.0019E+00	63	9.8306E-01	64	9.9400E-01	65	9.7520E-01	66	9.7998E-01
67	1.0073E+00	68	9.9092E-01	69	1.0107E+00	70	9.7315E-01	71	0.0000E+00	72	1.0190E+00
73	1.0094E+00	74	1.0169E+00	75	1.0002E+00	76	0.0000E+00	77	9.8956E-01	78	9.9502E-01
79	9.8443E-01	80	1.0125E+00	81	9.7998E-01	82	9.7520E-01	83	1.0125E+00	84	9.9981E-01
85	9.7588E-01	86	9.8990E-01	87	1.0002E+00	88	1.0060E+00	89	1.0152E+00	90	1.0077E+00
91	1.0589E+00	92	1.0060E+00	93	1.0190E+00	94	9.9297E-01	95	9.7417E-01	96	9.9981E-01
97	1.0073E+00	98	9.6973E-01	99	9.7349E-01	100	9.9400E-01	101	9.8443E-01	102	9.7417E-01
103	0.0000E+00	104	1.0169E+00	105	1.0589E+00	106	1.0186E+00	107	0.0000E+00	108	1.0179E+00
109	1.0186E+00	110	1.0152E+00	111	1.0094E+00	112	0.0000E+00	113	9.7588E-01	114	9.9092E-01
115	1.0148E+00	116	9.7486E-01	117	9.8716E-01	118	1.0077E+00	119	9.8306E-01	120	9.9502E-01
121	9.9297E-01	122	1.0094E+00	123	1.0077E+00	124	1.0179E+00	125	1.0391E+00	126	1.0374E+00
127	1.0391E+00	128	0.0000E+00	129	1.0077E+00	130	1.0169E+00	131	9.8990E-01	132	1.0107E+00
133	9.8443E-01	134	1.0152E+00	135	9.8956E-01	136	9.9126E-01	137	1.0227E+00	138	9.8340E-01
139	1.0019E+00	140	9.8956E-01	141	1.0190E+00	142	1.0152E+00	143	0.0000E+00	144	1.0374E+00
145	1.0357E+00	146	1.0357E+00	147	1.0374E+00	148	1.0179E+00	149	1.0589E+00	150	1.0002E+00
151	9.7315E-01	152	9.9878E-01	153	9.8101E-01	154	1.0155E+00	155	9.8921E-01	156	1.0241E+00
157	1.0306E+00	158	9.9502E-01	159	9.7828E-01	160	9.6084E-01	161	0.0000E+00	162	1.0060E+00
163	1.0186E+00	164	1.0391E+00	165	1.0357E+00	166	0.0000E+00	167	1.0357E+00	168	1.0391E+00
169	1.0186E+00	170	1.0060E+00	171	0.0000E+00	172	9.6084E-01	173	9.7828E-01	174	9.9502E-01
175	1.0306E+00	176	1.0241E+00	177	9.8921E-01	178	1.0155E+00	179	9.8101E-01	180	9.9878E-01
181	9.7315E-01	182	1.0002E+00	183	1.0589E+00	184	1.0179E+00	185	1.0374E+00	186	1.0357E+00
187	1.0357E+00	188	1.0374E+00	189	0.0000E+00	190	1.0152E+00	191	1.0190E+00	192	9.8956E-01
193	1.0019E+00	194	9.8340E-01	195	1.0227E+00	196	9.9126E-01	197	9.8956E-01	198	1.0152E+00
199	9.8443E-01	200	1.0107E+00	201	9.8990E-01	202	1.0169E+00	203	1.0077E+00	204	0.0000E+00
205	1.0391E+00	206	1.0374E+00	207	1.0391E+00	208	1.0179E+00	209	1.0077E+00	210	1.0094E+00
211	9.9297E-01	212	9.9502E-01	213	9.8306E-01	214	1.0077E+00	215	9.8716E-01	216	9.7486E-01
217	1.0148E+00	218	9.9092E-01	219	9.7588E-01	220	0.0000E+00	221	1.0094E+00	222	1.0152E+00
223	1.0186E+00	224	1.0179E+00	225	0.0000E+00	226	1.0186E+00	227	1.0589E+00	228	1.0169E+00
229	0.0000E+00	230	9.7417E-01	231	9.8443E-01	232	9.9400E-01	233	9.7349E-01	234	9.6973E-01
235	1.0073E+00	236	9.9981E-01	237	9.7417E-01	238	9.9297E-01	239	1.0190E+00	240	1.0060E+00
241	1.0589E+00	242	1.0077E+00	243	1.0152E+00	244	1.0060E+00	245	1.0002E+00	246	9.8990E-01
247	9.7588E-01	248	9.9981E-01	249	1.0125E+00	250	9.7520E-01	251	9.7998E-01	252	1.0125E+00
253	9.8443E-01	254	9.9502E-01	255	9.8956E-01	256	0.0000E+00	257	1.0002E+00	258	1.0169E+00
259	1.0094E+00	260	1.0190E+00	261	0.0000E+00	262	9.7315E-01	263	1.0107E+00	264	9.9092E-01
265	1.0073E+00	266	9.7998E-01	267	9.7520E-01	268	9.9400E-01	269	9.8306E-01	270	1.0019E+00
271	9.6084E-01	272	9.7315E-01	273	9.8990E-01	274	0.0000E+00	275	9.9297E-01	276	9.8956E-01
277	9.6084E-01	278	9.9878E-01	279	9.8443E-01	280	1.0148E+00	281	9.6973E-01	282	9.7349E-01
283	1.0077E+00	284	9.8340E-01	285	9.7828E-01	286	9.9878E-01	287	1.0107E+00	288	9.7588E-01
289	9.7417E-01	290	9.9502E-01	291	1.0019E+00	292	9.7828E-01	293	9.8101E-01	294	1.0152E+00
295	9.7486E-01	296	9.8716E-01	297	1.0227E+00	298	9.9502E-01	299	9.8101E-01	300	9.8443E-01
301	9.9092E-01	302	9.9981E-01	303	9.8443E-01	304	9.8306E-01	305	9.8340E-01	306	9.9502E-01
307	1.0155E+00	308	9.8956E-01	309	9.9126E-01	310	1.0306E+00	311	1.0155E+00	312	1.0152E+00
313	1.0148E+00	314	1.0073E+00	315	1.0125E+00	316	9.9400E-01	317	1.0077E+00	318	1.0227E+00
319	1.0306E+00	320	9.8921E-01	321	1.0241E+00	322	9.8921E-01	323	9.8956E-01	324	9.7486E-01
325	9.6973E-01	326	9.7998E-01	327	9.7520E-01	328	9.7349E-01	329	9.8716E-01	330	9.9126E-01

331 1.0241E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3785E-01	3.2324E-01	1.3648E-01	5.4028E-01
29	1.3579E-01	3.2350E-01	1.3669E-01	5.3982E-01
72	1.3688E-01	3.2395E-01	1.3648E-01	5.3957E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.2865E-02	3.0707E-02	7.9867E-02
29	7.1260E-02	3.0146E-02	7.8906E-02
72	7.2223E-02	3.0554E-02	7.9626E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.09586E+01	1.06731E-03	1.00830E+02	2.11184E-03
	U-236	7.68999E+00	2.42622E-05	7.68326E-01	2.42409E-06
	Pu-238	3.38018E+01	5.95123E-07	7.19239E+00	1.26631E-07
	Pu-239	1.58058E+02	5.75981E-04	2.91252E+02	1.06135E-03
	Pu-240	1.46933E+02	1.33449E-04	1.80902E+00	1.64301E-06
	Pu-241	1.48462E+02	6.74950E-05	3.20315E+02	1.45624E-04
	Pu-242	3.27698E+01	2.43497E-06	1.37553E+00	1.02209E-07
	Xe-135	1.86310E+05	6.86229E-05	0.00000E+00	0.00000E+00
	Sm-149	5.70860E+03	2.15241E-05	0.00000E+00	0.00000E+00
	Total FP	1.31139E+01	2.28428E-04	0.00000E+00	0.00000E+00
29	U-235	4.50469E+01	9.79541E-04	8.86727E+01	1.92818E-03
	U-236	7.49527E+00	2.29982E-05	7.75254E-01	2.37876E-06
	Pu-238	2.95790E+01	6.42220E-07	6.90711E+00	1.49967E-07
	Pu-239	1.39511E+02	6.20460E-04	2.56581E+02	1.14111E-03
	Pu-240	1.39481E+02	1.30836E-04	1.84812E+00	1.73358E-06
	Pu-241	1.30786E+02	7.23568E-05	2.82251E+02	1.56154E-04
	Pu-242	3.24378E+01	2.55097E-06	1.41014E+00	1.10896E-07
	Xe-135	1.58960E+05	6.93339E-05	0.00000E+00	0.00000E+00
	Sm-149	4.93131E+03	2.36775E-05	0.00000E+00	0.00000E+00
	Total FP	1.31424E+01	2.18564E-04	0.00000E+00	0.00000E+00
72	U-235	4.91898E+01	1.03963E-03	9.72413E+01	2.05519E-03
	U-236	7.77168E+00	2.43352E-05	7.72341E-01	2.41841E-06
	Pu-238	3.25498E+01	6.08914E-07	7.09803E+00	1.32784E-07
	Pu-239	1.53046E+02	5.90276E-04	2.81849E+02	1.08705E-03
	Pu-240	1.48017E+02	1.36090E-04	1.82175E+00	1.67495E-06
	Pu-241	1.43403E+02	6.92746E-05	3.09374E+02	1.49452E-04
	Pu-242	3.21927E+01	2.45465E-06	1.38517E+00	1.05617E-07
	Xe-135	1.78505E+05	6.87109E-05	0.00000E+00	0.00000E+00
	Sm-149	5.48832E+03	2.19881E-05	0.00000E+00	0.00000E+00
	Total FP	1.31306E+01	2.25908E-04	0.00000E+00	0.00000E+00

Burnup = 30 MWd/kgU

Power distribution by pin

1	1.0047E+00	2	9.5976E-01	3	9.6529E-01	4	9.4133E-01	5	9.5534E-01	6	9.4907E-01
7	9.4944E-01	8	9.5055E-01	9	9.6492E-01	10	9.6418E-01	11	1.0047E+00	12	9.6418E-01
13	1.0755E+00	14	1.0324E+00	15	1.0361E+00	16	1.0206E+00	17	1.0342E+00	18	1.0350E+00
19	1.0302E+00	20	1.0287E+00	21	1.0416E+00	22	1.0755E+00	23	9.5976E-01	24	9.6492E-01
25	1.0416E+00	26	1.0084E+00	27	1.0014E+00	28	1.0014E+00	29	1.0066E+00	30	1.0309E+00
31	1.0195E+00	32	1.0088E+00	33	1.0073E+00	34	1.0084E+00	35	1.0324E+00	36	9.6529E-01
37	9.5055E-01	38	1.0287E+00	39	1.0073E+00	40	1.0062E+00	41	1.0106E+00	42	1.0265E+00
43	9.5571E-01	44	9.5902E-01	45	1.0279E+00	46	1.0169E+00	47	1.0062E+00	48	1.0014E+00
49	1.0361E+00	50	9.4133E-01	51	9.4944E-01	52	1.0302E+00	53	1.0088E+00	54	1.0169E+00
55	9.4576E-01	56	9.7561E-01	57	9.6971E-01	58	0.0000E+00	59	9.8188E-01	60	9.5718E-01
61	9.4576E-01	62	1.0106E+00	63	1.0014E+00	64	1.0206E+00	65	9.5534E-01	66	9.4907E-01
67	1.0350E+00	68	1.0195E+00	69	1.0279E+00	70	9.5718E-01	71	0.0000E+00	72	9.9183E-01
73	9.9809E-01	74	9.9772E-01	75	9.8740E-01	76	0.0000E+00	77	9.7561E-01	78	1.0265E+00
79	1.0066E+00	80	1.0342E+00	81	9.4907E-01	82	9.5534E-01	83	1.0342E+00	84	1.0309E+00
85	9.5902E-01	86	9.8188E-01	87	9.8740E-01	88	9.9662E-01	89	9.9662E-01	90	1.0069E+00
91	1.0766E+00	92	9.9662E-01	93	9.9183E-01	94	9.6971E-01	95	9.5571E-01	96	1.0309E+00
97	1.0350E+00	98	9.4944E-01	99	9.4133E-01	100	1.0206E+00	101	1.0066E+00	102	9.5571E-01
103	0.0000E+00	104	9.9772E-01	105	1.0766E+00	106	1.0125E+00	107	0.0000E+00	108	1.0147E+00

109 1.0125E+00 110 9.9662E-01 111 9.9809E-01 112 0.0000E+00 113 9.5902E-01 114 1.0195E+00
115 1.0302E+00 116 9.5055E-01 117 9.6529E-01 118 1.0361E+00 119 1.0014E+00 120 1.0265E+00
121 9.6971E-01 122 9.9809E-01 123 1.0069E+00 124 1.0147E+00 125 1.0143E+00 126 1.0272E+00
127 1.0143E+00 128 0.0000E+00 129 1.0069E+00 130 9.9772E-01 131 9.8188E-01 132 1.0279E+00
133 1.0088E+00 134 1.0287E+00 135 9.6492E-01 136 9.5976E-01 137 1.0324E+00 138 1.0014E+00
139 1.0106E+00 140 9.7561E-01 141 9.9183E-01 142 9.9662E-01 143 0.0000E+00 144 1.0272E+00
145 1.0235E+00 146 1.0235E+00 147 1.0272E+00 148 1.0147E+00 149 1.0766E+00 150 9.8740E-01
151 9.5718E-01 152 1.0169E+00 153 1.0073E+00 154 1.0416E+00 155 9.6418E-01 156 1.0047E+00
157 1.0755E+00 158 1.0084E+00 159 1.0062E+00 160 9.4576E-01 161 0.0000E+00 162 9.9662E-01
163 1.0125E+00 164 1.0143E+00 165 1.0235E+00 166 0.0000E+00 167 1.0235E+00 168 1.0143E+00
169 1.0125E+00 170 9.9662E-01 171 0.0000E+00 172 9.4576E-01 173 1.0062E+00 174 1.0084E+00
175 1.0755E+00 176 1.0047E+00 177 9.6418E-01 178 1.0416E+00 179 1.0073E+00 180 1.0169E+00
181 9.5718E-01 182 9.8740E-01 183 1.0766E+00 184 1.0147E+00 185 1.0272E+00 186 1.0235E+00
187 1.0235E+00 188 1.0272E+00 189 0.0000E+00 190 9.9662E-01 191 9.9183E-01 192 9.7561E-01
193 1.0106E+00 194 1.0014E+00 195 1.0324E+00 196 9.5976E-01 197 9.6492E-01 198 1.0287E+00
199 1.0088E+00 200 1.0279E+00 201 9.8188E-01 202 9.9772E-01 203 1.0069E+00 204 0.0000E+00
205 1.0143E+00 206 1.0272E+00 207 1.0143E+00 208 1.0147E+00 209 1.0069E+00 210 9.9809E-01
211 9.6971E-01 212 1.0265E+00 213 1.0014E+00 214 1.0361E+00 215 9.6529E-01 216 9.5055E-01
217 1.0302E+00 218 1.0195E+00 219 9.5902E-01 220 0.0000E+00 221 9.9809E-01 222 9.9662E-01
223 1.0125E+00 224 1.0147E+00 225 0.0000E+00 226 1.0125E+00 227 1.0766E+00 228 9.9772E-01
229 0.0000E+00 230 9.5571E-01 231 1.0066E+00 232 1.0206E+00 233 9.4133E-01 234 9.4944E-01
235 1.0350E+00 236 1.0309E+00 237 9.5571E-01 238 9.6971E-01 239 9.9183E-01 240 9.9662E-01
241 1.0766E+00 242 1.0069E+00 243 9.9662E-01 244 9.9662E-01 245 9.8740E-01 246 9.8188E-01
247 9.5902E-01 248 1.0309E+00 249 1.0342E+00 250 9.5534E-01 251 9.4907E-01 252 1.0342E+00
253 1.0066E+00 254 1.0265E+00 255 9.7561E-01 256 0.0000E+00 257 9.8740E-01 258 9.9772E-01
259 9.9809E-01 260 9.9183E-01 261 0.0000E+00 262 9.5718E-01 263 1.0279E+00 264 1.0195E+00
265 1.0350E+00 266 9.4907E-01 267 9.5534E-01 268 1.0206E+00 269 1.0014E+00 270 1.0106E+00
271 9.4576E-01 272 9.5718E-01 273 9.8188E-01 274 0.0000E+00 275 9.6971E-01 276 9.7561E-01
277 9.4576E-01 278 1.0169E+00 279 1.0088E+00 280 1.0302E+00 281 9.4944E-01 282 9.4133E-01
283 1.0361E+00 284 1.0014E+00 285 1.0062E+00 286 1.0169E+00 287 1.0279E+00 288 9.5902E-01
289 9.5571E-01 290 1.0265E+00 291 1.0106E+00 292 1.0062E+00 293 1.0073E+00 294 1.0287E+00
295 9.5055E-01 296 9.6529E-01 297 1.0324E+00 298 1.0084E+00 299 1.0073E+00 300 1.0088E+00
301 1.0195E+00 302 1.0309E+00 303 1.0066E+00 304 1.0014E+00 305 1.0014E+00 306 1.0084E+00
307 1.0416E+00 308 9.6492E-01 309 9.5976E-01 310 1.0755E+00 311 1.0416E+00 312 1.0287E+00
313 1.0302E+00 314 1.0350E+00 315 1.0342E+00 316 1.0206E+00 317 1.0361E+00 318 1.0324E+00
319 1.0755E+00 320 9.6418E-01 321 1.0047E+00 322 9.6418E-01 323 9.6492E-01 324 9.5055E-01
325 9.4944E-01 326 9.4907E-01 327 9.5534E-01 328 9.4133E-01 329 9.6529E-01 330 9.5976E-01
331 1.0047E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3784E-01	3.2320E-01	1.3632E-01	5.4049E-01
29	1.3636E-01	3.2351E-01	1.3662E-01	5.3987E-01
72	1.3740E-01	3.2360E-01	1.3623E-01	5.4018E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.1790E-02	2.7161E-02	7.2142E-02
29	7.1303E-02	2.7729E-02	7.4179E-02
72	7.1036E-02	2.7062E-02	7.2023E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.25919E+01	7.67432E-04	1.04165E+02	1.51999E-03
	U-236	7.29762E+00	3.02728E-05	7.54877E-01	3.13147E-06
	Pu-238	3.50798E+01	1.74350E-06	7.29599E+00	3.62618E-07
	Pu-239	1.60479E+02	6.46501E-04	2.96327E+02	1.19377E-03
	Pu-240	1.29415E+02	1.83120E-04	1.79535E+00	2.54038E-06
	Pu-241	1.51836E+02	1.20271E-04	3.27844E+02	2.59690E-04
	Pu-242	3.09695E+01	6.95047E-06	1.37069E+00	3.07623E-07
	Xe-135	1.95399E+05	6.31354E-05	0.00000E+00	0.00000E+00
	Sm-149	5.96672E+03	2.15099E-05	0.00000E+00	0.00000E+00
	Total FP	1.11548E+01	2.79869E-04	0.00000E+00	0.00000E+00
29	U-235	4.55200E+01	7.18931E-04	8.96547E+01	1.41598E-03
	U-236	7.34047E+00	2.98809E-05	7.74221E-01	3.15162E-06
	Pu-238	2.99820E+01	1.90438E-06	6.95189E+00	4.41565E-07
	Pu-239	1.38269E+02	7.20630E-04	2.54826E+02	1.32810E-03
	Pu-240	1.19452E+02	1.77561E-04	1.84771E+00	2.74656E-06
	Pu-241	1.30658E+02	1.31207E-04	2.82149E+02	2.83333E-04
	Pu-242	3.09469E+01	7.31780E-06	1.41868E+00	3.35464E-07

	Xe-135	1.61982E+05	6.70243E-05	0.00000E+00	0.00000E+00
	Sm-149	5.00227E+03	2.47666E-05	0.00000E+00	0.00000E+00
	Total FP	1.11001E+01	2.72724E-04	0.00000E+00	0.00000E+00
72	U-235	5.01088E+01	7.47858E-04	9.90693E+01	1.47858E-03
	U-236	7.30973E+00	3.02032E-05	7.56727E-01	3.12674E-06
	Pu-238	3.33183E+01	1.77671E-06	7.16267E+00	3.81952E-07
	Pu-239	1.52434E+02	6.60218E-04	2.81335E+02	1.21851E-03
	Pu-240	1.26947E+02	1.82837E-04	1.80350E+00	2.59753E-06
	Pu-241	1.44597E+02	1.22877E-04	3.12162E+02	2.65272E-04
	Pu-242	3.16396E+01	7.26675E-06	1.37828E+00	3.16553E-07
	Xe-135	1.83761E+05	6.34453E-05	0.00000E+00	0.00000E+00
	Sm-149	5.63423E+03	2.20259E-05	0.00000E+00	0.00000E+00
	Total FP	1.10417E+01	2.75897E-04	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Power distribution by pin

1	9.5981E-01	2	9.5068E-01	3	9.3362E-01	4	9.2886E-01	5	9.2847E-01	6	9.2013E-01
7	9.2489E-01	8	9.1339E-01	9	9.3442E-01	10	9.3680E-01	11	9.5981E-01	12	9.3680E-01
13	1.0852E+00	14	1.0749E+00	15	1.0586E+00	16	1.0681E+00	17	1.0610E+00	18	1.0519E+00
19	1.0423E+00	20	1.0535E+00	21	1.0658E+00	22	1.0852E+00	23	9.5068E-01	24	9.3442E-01
25	1.0658E+00	26	1.0281E+00	27	1.0261E+00	28	1.0340E+00	29	1.0467E+00	30	1.0467E+00
31	1.0356E+00	32	1.0253E+00	33	1.0162E+00	34	1.0281E+00	35	1.0749E+00	36	9.3362E-01
37	9.1339E-01	38	1.0535E+00	39	1.0162E+00	40	1.0265E+00	41	1.0384E+00	42	1.0439E+00
43	9.4592E-01	44	9.4473E-01	45	1.0439E+00	46	1.0285E+00	47	1.0265E+00	48	1.0261E+00
49	1.0586E+00	50	9.2886E-01	51	9.2489E-01	52	1.0423E+00	53	1.0253E+00	54	1.0285E+00
55	9.4116E-01	56	9.4672E-01	57	9.6457E-01	58	0.0000E+00	59	9.5822E-01	60	9.4632E-01
61	9.4116E-01	62	1.0384E+00	63	1.0340E+00	64	1.0681E+00	65	9.2847E-01	66	9.2013E-01
67	1.0519E+00	68	1.0356E+00	69	1.0439E+00	70	9.4632E-01	71	0.0000E+00	72	9.8997E-01
73	9.8362E-01	74	9.7449E-01	75	9.7846E-01	76	0.0000E+00	77	9.4672E-01	78	1.0439E+00
79	1.0467E+00	80	1.0610E+00	81	9.2013E-01	82	9.2847E-01	83	1.0610E+00	84	1.0467E+00
85	9.4473E-01	86	9.5822E-01	87	9.7846E-01	88	9.8203E-01	89	9.8124E-01	90	9.9116E-01
91	1.1110E+00	92	9.8203E-01	93	9.8997E-01	94	9.6457E-01	95	9.4592E-01	96	1.0467E+00
97	1.0519E+00	98	9.2489E-01	99	9.2886E-01	100	1.0681E+00	101	1.0467E+00	102	9.4592E-01
103	0.0000E+00	104	9.7449E-01	105	1.1110E+00	106	1.0015E+00	107	0.0000E+00	108	9.9631E-01
109	1.0015E+00	110	9.8124E-01	111	9.8362E-01	112	0.0000E+00	113	9.4473E-01	114	1.0356E+00
115	1.0423E+00	116	9.1339E-01	117	9.3362E-01	118	1.0586E+00	119	1.0340E+00	120	1.0439E+00
121	9.6457E-01	122	9.8362E-01	123	9.9116E-01	124	9.9631E-01	125	1.0086E+00	126	1.0130E+00
127	1.0086E+00	128	0.0000E+00	129	9.9116E-01	130	9.7449E-01	131	9.5822E-01	132	1.0439E+00
133	1.0253E+00	134	1.0535E+00	135	9.3442E-01	136	9.5068E-01	137	1.0749E+00	138	1.0261E+00
139	1.0384E+00	140	9.4672E-01	141	9.8997E-01	142	9.8124E-01	143	0.0000E+00	144	1.0130E+00
145	1.0090E+00	146	1.0090E+00	147	1.0130E+00	148	9.9631E-01	149	1.1110E+00	150	9.7846E-01
151	9.4632E-01	152	1.0285E+00	153	1.0162E+00	154	1.0658E+00	155	9.3680E-01	156	9.5981E-01
157	1.0852E+00	158	1.0281E+00	159	1.0265E+00	160	9.4116E-01	161	0.0000E+00	162	9.8203E-01
163	1.0015E+00	164	1.0086E+00	165	1.0090E+00	166	0.0000E+00	167	1.0090E+00	168	1.0086E+00
169	1.0015E+00	170	9.8203E-01	171	0.0000E+00	172	9.4116E-01	173	1.0265E+00	174	1.0281E+00
175	1.0852E+00	176	9.5981E-01	177	9.3680E-01	178	1.0658E+00	179	1.0162E+00	180	1.0285E+00
181	9.4632E-01	182	9.7846E-01	183	1.1110E+00	184	9.9631E-01	185	1.0130E+00	186	1.0090E+00
187	1.0090E+00	188	1.0130E+00	189	0.0000E+00	190	9.8124E-01	191	9.8997E-01	192	9.4672E-01
193	1.0384E+00	194	1.0261E+00	195	1.0749E+00	196	9.5068E-01	197	9.3442E-01	198	1.0535E+00
199	1.0253E+00	200	1.0439E+00	201	9.5822E-01	202	9.7449E-01	203	9.9116E-01	204	0.0000E+00
205	1.0086E+00	206	1.0130E+00	207	1.0086E+00	208	9.9631E-01	209	9.9116E-01	210	9.8362E-01
211	9.6457E-01	212	1.0439E+00	213	1.0340E+00	214	1.0586E+00	215	9.3362E-01	216	9.1339E-01
217	1.0423E+00	218	1.0356E+00	219	9.4473E-01	220	0.0000E+00	221	9.8362E-01	222	9.8124E-01
223	1.0015E+00	224	9.9631E-01	225	0.0000E+00	226	1.0015E+00	227	1.1110E+00	228	9.7449E-01
229	0.0000E+00	230	9.4592E-01	231	1.0467E+00	232	1.0681E+00	233	9.2886E-01	234	9.2489E-01
235	1.0519E+00	236	1.0467E+00	237	9.4592E-01	238	9.6457E-01	239	9.8997E-01	240	9.8203E-01
241	1.1110E+00	242	9.9116E-01	243	9.8124E-01	244	9.8203E-01	245	9.7846E-01	246	9.5822E-01
247	9.4473E-01	248	1.0467E+00	249	1.0610E+00	250	9.2847E-01	251	9.2013E-01	252	1.0610E+00
253	1.0467E+00	254	1.0439E+00	255	9.4672E-01	256	0.0000E+00	257	9.7846E-01	258	9.7449E-01
259	9.8362E-01	260	9.8997E-01	261	0.0000E+00	262	9.4632E-01	263	1.0439E+00	264	1.0356E+00
265	1.0519E+00	266	9.2013E-01	267	9.2847E-01	268	1.0681E+00	269	1.0340E+00	270	1.0384E+00
271	9.4116E-01	272	9.4632E-01	273	9.5822E-01	274	0.0000E+00	275	9.6457E-01	276	9.4672E-01
277	9.4116E-01	278	1.0285E+00	279	1.0253E+00	280	1.0423E+00	281	9.2489E-01	282	9.2886E-01
283	1.0586E+00	284	1.0261E+00	285	1.0265E+00	286	1.0285E+00	287	1.0439E+00	288	9.4473E-01
289	9.4592E-01	290	1.0439E+00	291	1.0384E+00	292	1.0265E+00	293	1.0162E+00	294	1.0535E+00
295	9.1339E-01	296	9.3362E-01	297	1.0749E+00	298	1.0281E+00	299	1.0162E+00	300	1.0253E+00
301	1.0356E+00	302	1.0467E+00	303	1.0467E+00	304	1.0340E+00	305	1.0261E+00	306	1.0281E+00
307	1.0658E+00	308	9.3442E-01	309	9.5068E-01	310	1.0852E+00	311	1.0658E+00	312	1.0535E+00
313	1.0423E+00	314	1.0519E+00	315	1.0610E+00	316	1.0681E+00	317	1.0586E+00	318	1.0749E+00
319	1.0852E+00	320	9.3680E-01	321	9.5981E-01	322	9.3680E-01	323	9.3442E-01	324	9.1339E-01
325	9.2489E-01	326	9.2013E-01	327	9.2847E-01	328	9.2886E-01	329	9.3362E-01	330	9.5068E-01
331	9.5981E-01										

Variant 11
State 1

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3877E-01	3.2276E-01	1.3631E-01	5.4092E-01
29	1.3731E-01	3.2418E-01	1.3658E-01	5.3924E-01
72	1.3798E-01	3.2274E-01	1.3673E-01	5.4053E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.9635E-02	2.3526E-02	6.3731E-02
29	7.1979E-02	2.5879E-02	7.0565E-02
72	7.0257E-02	2.4304E-02	6.5963E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.37095E+01	5.23140E-04	1.06473E+02	1.03706E-03
	U-236	7.29273E+00	3.53757E-05	7.51118E-01	3.64354E-06
	Pu-238	3.60093E+01	3.64817E-06	7.36352E+00	7.46012E-07
	Pu-239	1.62016E+02	6.63823E-04	2.99611E+02	1.22759E-03
	Pu-240	1.20978E+02	2.21282E-04	1.78155E+00	3.25865E-06
	Pu-241	1.54541E+02	1.61248E-04	3.33779E+02	3.48264E-04
	Pu-242	3.00441E+01	1.35996E-05	1.36424E+00	6.17527E-07
	Xe-135	2.01643E+05	5.65800E-05	0.00000E+00	0.00000E+00
	Sm-149	6.14917E+03	2.03591E-05	0.00000E+00	0.00000E+00
	Total FP	1.00142E+01	3.23365E-04	0.00000E+00	0.00000E+00
29	U-235	4.71739E+01	5.22896E-04	9.30652E+01	1.03157E-03
	U-236	7.02420E+00	3.36769E-05	7.66163E-01	3.67330E-06
	Pu-238	3.12465E+01	4.19648E-06	7.05440E+00	9.47422E-07
	Pu-239	1.41026E+02	7.87999E-04	2.60464E+02	1.45537E-03
	Pu-240	1.09935E+02	2.16320E-04	1.83863E+00	3.61788E-06
	Pu-241	1.34669E+02	1.86936E-04	2.90924E+02	4.03836E-04
	Pu-242	2.93525E+01	1.40244E-05	1.41519E+00	6.76171E-07
	Xe-135	1.71155E+05	6.65131E-05	0.00000E+00	0.00000E+00
	Sm-149	5.27731E+03	2.57526E-05	0.00000E+00	0.00000E+00
	Total FP	1.00809E+01	3.27413E-04	0.00000E+00	0.00000E+00
72	U-235	5.21381E+01	5.23339E-04	1.03299E+02	1.03687E-03
	U-236	7.00764E+00	3.37734E-05	7.49187E-01	3.61071E-06
	Pu-238	3.48647E+01	3.81240E-06	7.28162E+00	7.96233E-07
	Pu-239	1.57658E+02	6.99585E-04	2.91379E+02	1.29295E-03
	Pu-240	1.16347E+02	2.16999E-04	1.79733E+00	3.35220E-06
	Pu-241	1.50075E+02	1.69131E-04	3.24129E+02	3.65283E-04
	Pu-242	3.00050E+01	1.38490E-05	1.37935E+00	6.36648E-07
	Xe-135	1.95142E+05	5.94036E-05	0.00000E+00	0.00000E+00
	Sm-149	5.98162E+03	2.17448E-05	0.00000E+00	0.00000E+00
	Total FP	9.97142E+00	3.21703E-04	0.00000E+00	0.00000E+00

Burnup = 50 MWd/kgU

Power distribution by pin

1	9.3584E-01	2	9.0652E-01	3	9.0609E-01	4	8.9887E-01	5	8.9037E-01	6	8.9802E-01
7	8.9122E-01	8	8.9589E-01	9	8.9504E-01	10	9.1204E-01	11	9.3584E-01	12	9.1204E-01
13	1.0990E+00	14	1.0867E+00	15	1.0706E+00	16	1.0893E+00	17	1.0833E+00	18	1.0795E+00
19	1.0718E+00	20	1.0723E+00	21	1.0897E+00	22	1.0990E+00	23	9.0652E-01	24	8.9504E-01
25	1.0897E+00	26	1.0493E+00	27	1.0476E+00	28	1.0434E+00	29	1.0629E+00	30	1.0697E+00
31	1.0663E+00	32	1.0497E+00	33	1.0383E+00	34	1.0493E+00	35	1.0867E+00	36	9.0609E-01
37	8.9589E-01	38	1.0723E+00	39	1.0383E+00	40	1.0523E+00	41	1.0650E+00	42	1.0850E+00
43	9.3159E-01	44	9.2352E-01	45	1.0740E+00	46	1.0608E+00	47	1.0523E+00	48	1.0476E+00
49	1.0706E+00	50	8.9887E-01	51	8.9122E-01	52	1.0718E+00	53	1.0497E+00	54	1.0608E+00
55	9.1629E-01	56	9.3627E-01	57	9.4817E-01	58	0.0000E+00	59	9.5837E-01	60	9.4859E-01
61	9.1629E-01	62	1.0650E+00	63	1.0434E+00	64	1.0893E+00	65	8.9037E-01	66	8.9802E-01
67	1.0795E+00	68	1.0663E+00	69	1.0740E+00	70	9.4859E-01	71	0.0000E+00	72	9.6517E-01
73	9.7579E-01	74	9.6899E-01	75	9.6559E-01	76	0.0000E+00	77	9.3627E-01	78	1.0850E+00
79	1.0629E+00	80	1.0833E+00	81	8.9802E-01	82	8.9037E-01	83	1.0833E+00	84	1.0697E+00
85	9.2352E-01	86	9.5837E-01	87	9.6559E-01	88	9.7877E-01	89	9.6559E-01	90	9.8004E-01
91	1.1458E+00	92	9.7877E-01	93	9.6517E-01	94	9.4817E-01	95	9.3159E-01	96	1.0697E+00
97	1.0795E+00	98	8.9122E-01	99	8.9887E-01	100	1.0893E+00	101	1.0629E+00	102	9.3159E-01
103	0.0000E+00	104	9.6899E-01	105	1.1458E+00	106	9.8897E-01	107	0.0000E+00	108	9.7749E-01
109	9.8897E-01	110	9.6559E-01	111	9.7579E-01	112	0.0000E+00	113	9.2352E-01	114	1.0663E+00
115	1.0718E+00	116	8.9589E-01	117	9.0609E-01	118	1.0706E+00	119	1.0434E+00	120	1.0850E+00

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121 9.4817E-01 122 9.7579E-01 123 9.8004E-01 124 9.7749E-01 125 1.0017E+00 126 9.9959E-01
127 1.0017E+00 128 0.0000E+00 129 9.8004E-01 130 9.6899E-01 131 9.5837E-01 132 1.0740E+00
133 1.0497E+00 134 1.0723E+00 135 8.9504E-01 136 9.0652E-01 137 1.0867E+00 138 1.0476E+00
139 1.0650E+00 140 9.3627E-01 141 9.6517E-01 142 9.6559E-01 143 0.0000E+00 144 9.9959E-01
145 9.8727E-01 146 9.8727E-01 147 9.9959E-01 148 9.7749E-01 149 1.1458E+00 150 9.6559E-01
151 9.4859E-01 152 1.0608E+00 153 1.0383E+00 154 1.0897E+00 155 9.1204E-01 156 9.3584E-01
157 1.0990E+00 158 1.0493E+00 159 1.0523E+00 160 9.1629E-01 161 0.0000E+00 162 9.7877E-01
163 9.8897E-01 164 1.0017E+00 165 9.8727E-01 166 0.0000E+00 167 9.8727E-01 168 1.0017E+00
169 9.8897E-01 170 9.7877E-01 171 0.0000E+00 172 9.1629E-01 173 1.0523E+00 174 1.0493E+00
175 1.0990E+00 176 9.3584E-01 177 9.1204E-01 178 1.0897E+00 179 1.0383E+00 180 1.0608E+00
181 9.4859E-01 182 9.6559E-01 183 1.1458E+00 184 9.7749E-01 185 9.9959E-01 186 9.8727E-01
187 9.8727E-01 188 9.9959E-01 189 0.0000E+00 190 9.6559E-01 191 9.6517E-01 192 9.3627E-01
193 1.0650E+00 194 1.0476E+00 195 1.0867E+00 196 9.0652E-01 197 8.9504E-01 198 1.0723E+00
199 1.0497E+00 200 1.0740E+00 201 9.5837E-01 202 9.6899E-01 203 9.8004E-01 204 0.0000E+00
205 1.0017E+00 206 9.9959E-01 207 1.0017E+00 208 9.7749E-01 209 9.8004E-01 210 9.7579E-01
211 9.4817E-01 212 1.0850E+00 213 1.0434E+00 214 1.0706E+00 215 9.0609E-01 216 8.9589E-01
217 1.0718E+00 218 1.0663E+00 219 9.2352E-01 220 0.0000E+00 221 9.7579E-01 222 9.6559E-01
223 9.8897E-01 224 9.7749E-01 225 0.0000E+00 226 9.8897E-01 227 1.1458E+00 228 9.6899E-01
229 0.0000E+00 230 9.3159E-01 231 1.0629E+00 232 1.0893E+00 233 8.9887E-01 234 8.9122E-01
235 1.0795E+00 236 1.0697E+00 237 9.3159E-01 238 9.4817E-01 239 9.6517E-01 240 9.7877E-01
241 1.1458E+00 242 9.8004E-01 243 9.6559E-01 244 9.7877E-01 245 9.6559E-01 246 9.5837E-01
247 9.2352E-01 248 1.0697E+00 249 1.0833E+00 250 8.9037E-01 251 8.9802E-01 252 1.0833E+00
253 1.0629E+00 254 1.0850E+00 255 9.3627E-01 256 0.0000E+00 257 9.6559E-01 258 9.6899E-01
259 9.7579E-01 260 9.6517E-01 261 0.0000E+00 262 9.4859E-01 263 1.0740E+00 264 1.0663E+00
265 1.0795E+00 266 8.9802E-01 267 8.9037E-01 268 1.0893E+00 269 1.0434E+00 270 1.0650E+00
271 9.1629E-01 272 9.4859E-01 273 9.5837E-01 274 0.0000E+00 275 9.4817E-01 276 9.3627E-01
277 9.1629E-01 278 1.0608E+00 279 1.0497E+00 280 1.0718E+00 281 8.9122E-01 282 8.9887E-01
283 1.0706E+00 284 1.0476E+00 285 1.0523E+00 286 1.0608E+00 287 1.0740E+00 288 9.2352E-01
289 9.3159E-01 290 1.0850E+00 291 1.0650E+00 292 1.0523E+00 293 1.0383E+00 294 1.0723E+00
295 8.9589E-01 296 9.0609E-01 297 1.0867E+00 298 1.0493E+00 299 1.0383E+00 300 1.0497E+00
301 1.0663E+00 302 1.0697E+00 303 1.0629E+00 304 1.0434E+00 305 1.0476E+00 306 1.0493E+00
307 1.0897E+00 308 8.9504E-01 309 9.0652E-01 310 1.0990E+00 311 1.0897E+00 312 1.0723E+00
313 1.0718E+00 314 1.0795E+00 315 1.0833E+00 316 1.0893E+00 317 1.0706E+00 318 1.0867E+00
319 1.0990E+00 320 9.1204E-01 321 9.3584E-01 322 9.1204E-01 323 8.9504E-01 324 8.9589E-01
325 8.9122E-01 326 8.9802E-01 327 8.9037E-01 328 8.9887E-01 329 9.0609E-01 330 9.0652E-01
331 9.3584E-01
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Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.3911E-01	3.2237E-01	1.3614E-01	5.4148E-01
29	1.3819E-01	3.2335E-01	1.3673E-01	5.3992E-01
72	1.3872E-01	3.2188E-01	1.3612E-01	5.4199E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.8061E-02	2.0640E-02	5.6942E-02
29	7.2069E-02	2.4075E-02	6.6769E-02
72	6.9277E-02	2.1631E-02	5.9751E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.56203E+01	3.39808E-04	1.10324E+02	6.74017E-04
	U-236	7.09803E+00	3.73358E-05	7.42679E-01	3.90651E-06
	Pu-238	3.73871E+01	6.30329E-06	7.46098E+00	1.25789E-06
	Pu-239	1.65744E+02	6.63553E-04	3.06930E+02	1.22879E-03
	Pu-240	1.14066E+02	2.42171E-04	1.76649E+00	3.75038E-06
	Pu-241	1.59339E+02	1.89256E-04	3.44207E+02	4.08834E-04
	Pu-242	2.86482E+01	2.10432E-05	1.35416E+00	9.94683E-07
	Xe-135	2.10696E+05	5.10594E-05	0.00000E+00	0.00000E+00
	Sm-149	6.38808E+03	1.89436E-05	0.00000E+00	0.00000E+00
	Total FP	9.28442E+00	3.60114E-04	0.00000E+00	0.00000E+00
29	U-235	4.85759E+01	3.58875E-04	9.59322E+01	7.08738E-04
	U-236	6.94571E+00	3.62620E-05	7.65248E-01	3.99519E-06
	Pu-238	3.22779E+01	7.48731E-06	7.12570E+00	1.65290E-06
	Pu-239	1.44535E+02	8.24591E-04	2.67179E+02	1.52429E-03
	Pu-240	1.03122E+02	2.41725E-04	1.83580E+00	4.30326E-06
	Pu-241	1.38656E+02	2.29899E-04	2.99621E+02	4.96789E-04
	Pu-242	2.78147E+01	2.16454E-05	1.41648E+00	1.10231E-06
	Xe-135	1.78121E+05	6.43089E-05	0.00000E+00	0.00000E+00
	Sm-149	5.47194E+03	2.55042E-05	0.00000E+00	0.00000E+00

	Total FP	9.33509E+00	3.74088E-04	0.00000E+00	0.00000E+00
72	U-235	5.42448E+01	3.47156E-04	1.07622E+02	6.88764E-04
	U-236	6.94589E+00	3.63670E-05	7.42118E-01	3.88555E-06
	Pu-238	3.64606E+01	6.69938E-06	7.38985E+00	1.35783E-06
	Pu-239	1.60460E+02	7.02561E-04	2.97336E+02	1.30186E-03
	Pu-240	1.13344E+02	2.47070E-04	1.77858E+00	3.87697E-06
	Pu-241	1.55076E+02	2.01172E-04	3.35099E+02	4.34705E-04
	Pu-242	2.87686E+01	2.15687E-05	1.36439E+00	1.02293E-06
	Xe-135	2.05771E+05	5.50564E-05	0.00000E+00	0.00000E+00
	Sm-149	6.25970E+03	2.06926E-05	0.00000E+00	0.00000E+00
	Total FP	9.31723E+00	3.63977E-04	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Power distribution by pin

1	9.1897E-01	2	8.7451E-01	3	8.7680E-01	4	8.7864E-01	5	8.6168E-01	6	8.6901E-01
7	8.6397E-01	8	8.7497E-01	9	8.6993E-01	10	8.9193E-01	11	9.1897E-01	12	8.9193E-01
13	1.1339E+00	14	1.1087E+00	15	1.1073E+00	16	1.0977E+00	17	1.1028E+00	18	1.1119E+00
19	1.1005E+00	20	1.0927E+00	21	1.1170E+00	22	1.1339E+00	23	8.7451E-01	24	8.6993E-01
25	1.1170E+00	26	1.0734E+00	27	1.0734E+00	28	1.0679E+00	29	1.0817E+00	30	1.0876E+00
31	1.0840E+00	32	1.0808E+00	33	1.0730E+00	34	1.0734E+00	35	1.1087E+00	36	8.7680E-01
37	8.7497E-01	38	1.0927E+00	39	1.0730E+00	40	1.0725E+00	41	1.0913E+00	42	1.0886E+00
43	9.2722E-01	44	9.1760E-01	45	1.1023E+00	46	1.0794E+00	47	1.0725E+00	48	1.0734E+00
49	1.1073E+00	50	8.7864E-01	51	8.6397E-01	52	1.1005E+00	53	1.0808E+00	54	1.0794E+00
55	9.0660E-01	56	9.2172E-01	57	9.3501E-01	58	0.0000E+00	59	9.4922E-01	60	9.3043E-01
61	9.0660E-01	62	1.0913E+00	63	1.0679E+00	64	1.0977E+00	65	8.6168E-01	66	8.6901E-01
67	1.1119E+00	68	1.0840E+00	69	1.1023E+00	70	9.3043E-01	71	0.0000E+00	72	9.5014E-01
73	9.5930E-01	74	9.6068E-01	75	9.4555E-01	76	0.0000E+00	77	9.2172E-01	78	1.0886E+00
79	1.0817E+00	80	1.1028E+00	81	8.6901E-01	82	8.6168E-01	83	1.1028E+00	84	1.0876E+00
85	9.1760E-01	86	9.4922E-01	87	9.4555E-01	88	9.6114E-01	89	9.5655E-01	90	9.6435E-01
91	1.1747E+00	92	9.6114E-01	93	9.5014E-01	94	9.3501E-01	95	9.2722E-01	96	1.0876E+00
97	1.1119E+00	98	8.6397E-01	99	8.7864E-01	100	1.0977E+00	101	1.0817E+00	102	9.2722E-01
103	0.0000E+00	104	9.6068E-01	105	1.1747E+00	106	9.5747E-01	107	0.0000E+00	108	9.5976E-01
109	9.5747E-01	110	9.5655E-01	111	9.5930E-01	112	0.0000E+00	113	9.1760E-01	114	1.0840E+00
115	1.1005E+00	116	8.7497E-01	117	8.7680E-01	118	1.1073E+00	119	1.0679E+00	120	1.0886E+00
121	9.3501E-01	122	9.5930E-01	123	9.6435E-01	124	9.5976E-01	125	9.8360E-01	126	9.7489E-01
127	9.8360E-01	128	0.0000E+00	129	9.6435E-01	130	9.6068E-01	131	9.4922E-01	132	1.1023E+00
133	1.0808E+00	134	1.0927E+00	135	8.6993E-01	136	8.7451E-01	137	1.1087E+00	138	1.0734E+00
139	1.0913E+00	140	9.2172E-01	141	9.5014E-01	142	9.5655E-01	143	0.0000E+00	144	9.7489E-01
145	9.5518E-01	146	9.5518E-01	147	9.7489E-01	148	9.5976E-01	149	1.1747E+00	150	9.4555E-01
151	9.3043E-01	152	1.0794E+00	153	1.0730E+00	154	1.1170E+00	155	8.9193E-01	156	9.1897E-01
157	1.1339E+00	158	1.0734E+00	159	1.0725E+00	160	9.0660E-01	161	0.0000E+00	162	9.6114E-01
163	9.5747E-01	164	9.8360E-01	165	9.5518E-01	166	0.0000E+00	167	9.5518E-01	168	9.8360E-01
169	9.5747E-01	170	9.6114E-01	171	0.0000E+00	172	9.0660E-01	173	1.0725E+00	174	1.0734E+00
175	1.1339E+00	176	9.1897E-01	177	8.9193E-01	178	1.1170E+00	179	1.0730E+00	180	1.0794E+00
181	9.3043E-01	182	9.4555E-01	183	1.1747E+00	184	9.5976E-01	185	9.7489E-01	186	9.5518E-01
187	9.5518E-01	188	9.7489E-01	189	0.0000E+00	190	9.5655E-01	191	9.5014E-01	192	9.2172E-01
193	1.0913E+00	194	1.0734E+00	195	1.1087E+00	196	8.7451E-01	197	8.6993E-01	198	1.0927E+00
199	1.0808E+00	200	1.1023E+00	201	9.4922E-01	202	9.6068E-01	203	9.6435E-01	204	0.0000E+00
205	9.8360E-01	206	9.7489E-01	207	9.8360E-01	208	9.5976E-01	209	9.6435E-01	210	9.5930E-01
211	9.3501E-01	212	1.0886E+00	213	1.0679E+00	214	1.1073E+00	215	8.7680E-01	216	8.7497E-01
217	1.1005E+00	218	1.0840E+00	219	9.1760E-01	220	0.0000E+00	221	9.5930E-01	222	9.5655E-01
223	9.5747E-01	224	9.5976E-01	225	0.0000E+00	226	9.5747E-01	227	1.1747E+00	228	9.6068E-01
229	0.0000E+00	230	9.2722E-01	231	1.0817E+00	232	1.0977E+00	233	8.7864E-01	234	8.6397E-01
235	1.1119E+00	236	1.0876E+00	237	9.2722E-01	238	9.3501E-01	239	9.5014E-01	240	9.6114E-01
241	1.1747E+00	242	9.6435E-01	243	9.5655E-01	244	9.6114E-01	245	9.4555E-01	246	9.4922E-01
247	9.1760E-01	248	1.0876E+00	249	1.1028E+00	250	8.6168E-01	251	8.6901E-01	252	1.1028E+00
253	1.0817E+00	254	1.0886E+00	255	9.2172E-01	256	0.0000E+00	257	9.4555E-01	258	9.6068E-01
259	9.5930E-01	260	9.5014E-01	261	0.0000E+00	262	9.3043E-01	263	1.1023E+00	264	1.0840E+00
265	1.1119E+00	266	8.6901E-01	267	8.6168E-01	268	1.0977E+00	269	1.0679E+00	270	1.0913E+00
271	9.0660E-01	272	9.3043E-01	273	9.4922E-01	274	0.0000E+00	275	9.3501E-01	276	9.2172E-01
277	9.0660E-01	278	1.0794E+00	279	1.0808E+00	280	1.1005E+00	281	8.6397E-01	282	8.7864E-01
283	1.1073E+00	284	1.0734E+00	285	1.0725E+00	286	1.0794E+00	287	1.1023E+00	288	9.1760E-01
289	9.2722E-01	290	1.0886E+00	291	1.0913E+00	292	1.0725E+00	293	1.0730E+00	294	1.0927E+00
295	8.7497E-01	296	8.7680E-01	297	1.1087E+00	298	1.0734E+00	299	1.0730E+00	300	1.0808E+00
301	1.0840E+00	302	1.0876E+00	303	1.0817E+00	304	1.0679E+00	305	1.0734E+00	306	1.0734E+00
307	1.1170E+00	308	8.6993E-01	309	8.7451E-01	310	1.1339E+00	311	1.1170E+00	312	1.0927E+00
313	1.1005E+00	314	1.1119E+00	315	1.1028E+00	316	1.0977E+00	317	1.1073E+00	318	1.1087E+00
319	1.1339E+00	320	8.9193E-01	321	9.1897E-01	322	8.9193E-01	323	8.6993E-01	324	8.7497E-01
325	8.6397E-01	326	8.6901E-01	327	8.6168E-01	328	8.7864E-01	329	8.7680E-01	330	8.7451E-01
331	9.1897E-01										

Variant 11
State 1

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4031E-01	3.2239E-01	1.3614E-01	5.4147E-01
29	1.3977E-01	3.2416E-01	1.3670E-01	5.3914E-01
72	1.3972E-01	3.2268E-01	1.3621E-01	5.4111E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.6955E-02	1.8194E-02	5.1165E-02
29	7.1732E-02	2.2065E-02	6.2228E-02
72	6.7977E-02	1.9230E-02	5.4115E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.82405E+01	1.88618E-04	1.15775E+02	3.74949E-04
	U-236	7.01240E+00	3.84545E-05	7.37611E-01	4.04490E-06
	Pu-238	3.94534E+01	1.02887E-05	7.60308E+00	1.98274E-06
	Pu-239	1.72427E+02	6.67892E-04	3.19855E+02	1.23895E-03
	Pu-240	1.09217E+02	2.57314E-04	1.75575E+00	4.13653E-06
	Pu-241	1.66684E+02	2.11290E-04	3.60190E+02	4.56579E-04
	Pu-242	2.74062E+01	3.05662E-05	1.34741E+00	1.50277E-06
	Xe-135	2.24085E+05	4.67896E-05	0.00000E+00	0.00000E+00
	Sm-149	6.75872E+03	1.76772E-05	0.00000E+00	0.00000E+00
	Total FP	8.64221E+00	3.99027E-04	0.00000E+00	0.00000E+00
29	U-235	4.97838E+01	2.13880E-04	9.84116E+01	4.22794E-04
	U-236	6.81897E+00	3.72396E-05	7.61840E-01	4.16054E-06
	Pu-238	3.32636E+01	1.25125E-05	7.21681E+00	2.71469E-06
	Pu-239	1.47278E+02	8.46682E-04	2.72540E+02	1.56679E-03
	Pu-240	9.84871E+01	2.64903E-04	1.83386E+00	4.93258E-06
	Pu-241	1.41781E+02	2.64553E-04	3.06428E+02	5.71772E-04
	Pu-242	2.60462E+01	3.09987E-05	1.41803E+00	1.68766E-06
	Xe-135	1.84654E+05	6.17748E-05	0.00000E+00	0.00000E+00
	Sm-149	5.63897E+03	2.47743E-05	0.00000E+00	0.00000E+00
	Total FP	8.58931E+00	4.23772E-04	0.00000E+00	0.00000E+00
72	U-235	5.62993E+01	1.95339E-04	1.11869E+02	3.88147E-04
	U-236	6.82908E+00	3.72906E-05	7.38783E-01	4.03417E-06
	Pu-238	3.80256E+01	1.09236E-05	7.50945E+00	2.15724E-06
	Pu-239	1.66780E+02	7.11403E-04	3.09261E+02	1.31916E-03
	Pu-240	1.06756E+02	2.60088E-04	1.77599E+00	4.32683E-06
	Pu-241	1.60986E+02	2.25169E-04	3.47869E+02	4.86558E-04
	Pu-242	2.64321E+01	3.01157E-05	1.36513E+00	1.55538E-06
	Xe-135	2.16377E+05	5.06535E-05	0.00000E+00	0.00000E+00
	Sm-149	6.57783E+03	1.94436E-05	0.00000E+00	0.00000E+00
	Total FP	8.60560E+00	4.03644E-04	0.00000E+00	0.00000E+00

Variant 11
State 2

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.8331	.9836	.0014
10.00	.7729	.9139	.0013
20.00	.7139	.8417	.0011
30.00	.6642	.7846	.0011
40.00	.6122	.7238	.0011
50.00	.5673	.6731	.0010
60.00	.5258	.6230	.0010

Additional data

Burnup = 0 MWd/kgU

Power distribution by pin

1	1.3354E+00	2	1.2725E+00	3	1.2568E+00	4	1.2366E+00	5	1.2279E+00	6	1.2190E+00
7	1.2216E+00	8	1.2264E+00	9	1.2605E+00	10	1.2508E+00	11	1.3354E+00	12	1.2508E+00
13	1.2043E+00	14	1.1939E+00	15	1.1512E+00	16	1.1231E+00	17	1.1235E+00	18	1.1081E+00
19	1.1321E+00	20	1.1512E+00	21	1.1714E+00	22	1.2043E+00	23	1.2725E+00	24	1.2605E+00
25	1.1714E+00	26	1.1059E+00	27	1.0961E+00	28	1.0710E+00	29	1.0321E+00	30	1.0287E+00
31	1.0223E+00	32	1.0624E+00	33	1.1021E+00	34	1.1059E+00	35	1.1939E+00	36	1.2568E+00
37	1.2264E+00	38	1.1512E+00	39	1.1021E+00	40	1.0392E+00	41	9.8677E-01	42	9.1749E-01
43	8.9877E-01	44	9.1187E-01	45	9.5831E-01	46	1.0051E+00	47	1.0392E+00	48	1.0961E+00
49	1.1512E+00	50	1.2366E+00	51	1.2216E+00	52	1.1321E+00	53	1.0624E+00	54	1.0051E+00
55	8.9540E-01	56	8.4709E-01	57	8.1975E-01	58	0.0000E+00	59	8.0365E-01	60	8.4559E-01
61	8.9540E-01	62	9.8677E-01	63	1.0710E+00	64	1.1231E+00	65	1.2279E+00	66	1.2190E+00
67	1.1081E+00	68	1.0223E+00	69	9.5831E-01	70	8.4559E-01	71	0.0000E+00	72	7.6358E-01
73	7.6358E-01	74	7.4111E-01	75	7.6582E-01	76	0.0000E+00	77	8.4709E-01	78	9.1749E-01
79	1.0321E+00	80	1.1235E+00	81	1.2190E+00	82	1.2279E+00	83	1.1235E+00	84	1.0287E+00
85	9.1187E-01	86	8.0365E-01	87	7.6582E-01	88	7.4860E-01	89	7.2238E-01	90	7.2912E-01
91	7.6208E-01	92	7.4860E-01	93	7.6358E-01	94	8.1975E-01	95	8.9877E-01	96	1.0287E+00
97	1.1081E+00	98	1.2216E+00	99	1.2366E+00	100	1.1231E+00	101	1.0321E+00	102	8.9877E-01
103	0.0000E+00	104	7.4111E-01	105	7.6208E-01	106	7.0403E-01	107	0.0000E+00	108	7.2838E-01
109	7.0403E-01	110	7.2238E-01	111	7.6358E-01	112	0.0000E+00	113	9.1187E-01	114	1.0223E+00
115	1.1321E+00	116	1.2264E+00	117	1.2568E+00	118	1.1512E+00	119	1.0710E+00	120	9.1749E-01
121	8.1975E-01	122	7.6358E-01	123	7.2912E-01	124	7.2838E-01	125	7.1077E-01	126	7.3736E-01
127	7.1077E-01	128	0.0000E+00	129	7.2912E-01	130	7.4111E-01	131	8.0365E-01	132	9.5831E-01
133	1.0624E+00	134	1.1512E+00	135	1.2605E+00	136	1.2725E+00	137	1.1939E+00	138	1.0961E+00
139	9.8677E-01	140	8.4709E-01	141	7.6358E-01	142	7.2238E-01	143	0.0000E+00	144	7.3736E-01
145	8.0739E-01	146	8.0739E-01	147	7.3736E-01	148	7.2838E-01	149	7.6208E-01	150	7.6582E-01
151	8.4559E-01	152	1.0051E+00	153	1.1021E+00	154	1.1714E+00	155	1.2508E+00	156	1.3354E+00
157	1.2043E+00	158	1.1059E+00	159	1.0392E+00	160	8.9540E-01	161	0.0000E+00	162	7.4860E-01
163	7.0403E-01	164	7.1077E-01	165	8.0739E-01	166	0.0000E+00	167	8.0739E-01	168	7.1077E-01
169	7.0403E-01	170	7.4860E-01	171	0.0000E+00	172	8.9540E-01	173	1.0392E+00	174	1.1059E+00
175	1.2043E+00	176	1.3354E+00	177	1.2508E+00	178	1.1714E+00	179	1.1021E+00	180	1.0051E+00
181	8.4559E-01	182	7.6582E-01	183	7.6208E-01	184	7.2838E-01	185	7.3736E-01	186	8.0739E-01
187	8.0739E-01	188	7.3736E-01	189	0.0000E+00	190	7.2238E-01	191	7.6358E-01	192	8.4709E-01
193	9.8677E-01	194	1.0961E+00	195	1.1939E+00	196	1.2725E+00	197	1.2605E+00	198	1.1512E+00
199	1.0624E+00	200	9.5831E-01	201	8.0365E-01	202	7.4111E-01	203	7.2912E-01	204	0.0000E+00
205	7.1077E-01	206	7.3736E-01	207	7.1077E-01	208	7.2838E-01	209	7.2912E-01	210	7.6358E-01
211	8.1975E-01	212	9.1749E-01	213	1.0710E+00	214	1.1512E+00	215	1.2568E+00	216	1.2264E+00
217	1.1321E+00	218	1.0223E+00	219	9.1187E-01	220	0.0000E+00	221	7.6358E-01	222	7.2238E-01
223	7.0403E-01	224	7.2838E-01	225	0.0000E+00	226	7.0403E-01	227	7.6208E-01	228	7.4111E-01
229	0.0000E+00	230	8.9877E-01	231	1.0321E+00	232	1.1231E+00	233	1.2366E+00	234	1.2216E+00
235	1.1081E+00	236	1.0287E+00	237	8.9877E-01	238	8.1975E-01	239	7.6358E-01	240	7.4860E-01
241	7.6208E-01	242	7.2912E-01	243	7.2238E-01	244	7.4860E-01	245	7.6582E-01	246	8.0365E-01
247	9.1187E-01	248	1.0287E+00	249	1.1235E+00	250	1.2279E+00	251	1.2190E+00	252	1.1235E+00
253	1.0321E+00	254	9.1749E-01	255	8.4709E-01	256	0.0000E+00	257	7.6582E-01	258	7.4111E-01
259	7.6358E-01	260	7.6358E-01	261	0.0000E+00	262	8.4559E-01	263	9.5831E-01	264	1.0223E+00
265	1.1081E+00	266	1.2190E+00	267	1.2279E+00	268	1.1231E+00	269	1.0710E+00	270	9.8677E-01
271	8.9540E-01	272	8.4559E-01	273	8.0365E-01	274	0.0000E+00	275	8.1975E-01	276	8.4709E-01
277	8.9540E-01	278	1.0051E+00	279	1.0624E+00	280	1.1321E+00	281	1.2216E+00	282	1.2366E+00
283	1.1512E+00	284	1.0961E+00	285	1.0392E+00	286	1.0051E+00	287	9.5831E-01	288	9.1187E-01
289	8.9877E-01	290	9.1749E-01	291	9.8677E-01	292	1.0392E+00	293	1.1021E+00	294	1.1512E+00
295	1.2264E+00	296	1.2568E+00	297	1.1939E+00	298	1.1059E+00	299	1.1021E+00	300	1.0624E+00
301	1.0223E+00	302	1.0287E+00	303	1.0321E+00	304	1.0710E+00	305	1.0961E+00	306	1.1059E+00
307	1.1714E+00	308	1.2605E+00	309	1.2725E+00	310	1.2043E+00	311	1.1714E+00	312	1.1512E+00
313	1.1321E+00	314	1.1081E+00	315	1.1235E+00	316	1.1231E+00	317	1.1512E+00	318	1.1939E+00
319	1.2043E+00	320	1.2508E+00	321	1.3354E+00	322	1.2508E+00	323	1.2605E+00	324	1.2264E+00
325	1.2216E+00	326	1.2190E+00	327	1.2279E+00	328	1.2366E+00	329	1.2568E+00	330	1.2725E+00
331	1.3354E+00										

Variant 11
State 2

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4512E-01	3.2473E-01	1.3645E-01	5.3881E-01
29	1.3600E-01	3.2409E-01	1.3739E-01	5.3852E-01
72	1.2237E-01	3.2512E-01	1.3776E-01	5.3712E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.9090E-02	3.6118E-02	8.8811E-02
29	5.9906E-02	3.0041E-02	7.3987E-02
72	5.1892E-02	2.4465E-02	6.0419E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.81810E+01	1.98377E-03	9.53593E+01	3.92626E-03
	U-236	8.92318E+00	0.00000E+00	8.20095E-01	0.00000E+00
	Pu-238	3.17744E+01	0.00000E+00	7.05448E+00	0.00000E+00
	Pu-239	1.58990E+02	0.00000E+00	2.91356E+02	0.00000E+00
	Pu-240	2.06018E+02	0.00000E+00	1.88745E+00	0.00000E+00
	Pu-241	1.44317E+02	0.00000E+00	3.10903E+02	0.00000E+00
	Pu-242	3.07963E+01	0.00000E+00	1.41852E+00	0.00000E+00
	Xe-135	1.73640E+05	7.73941E-05	0.00000E+00	0.00000E+00
	Sm-149	5.37363E+03	1.86550E-05	0.00000E+00	0.00000E+00
	Total FP	2.45192E+04	9.60491E-05	0.00000E+00	0.00000E+00
29	U-235	3.99691E+01	1.53922E-03	7.84318E+01	3.02043E-03
	U-236	8.62657E+00	0.00000E+00	8.11807E-01	0.00000E+00
	Pu-238	2.57713E+01	0.00000E+00	6.63050E+00	0.00000E+00
	Pu-239	1.35627E+02	0.00000E+00	2.47213E+02	0.00000E+00
	Pu-240	1.94904E+02	0.00000E+00	1.90659E+00	0.00000E+00
	Pu-241	1.20035E+02	0.00000E+00	2.58252E+02	0.00000E+00
	Pu-242	3.00893E+01	0.00000E+00	1.43402E+00	0.00000E+00
	Xe-135	1.33603E+05	5.56971E-05	0.00000E+00	0.00000E+00
	Sm-149	4.17963E+03	1.35714E-05	0.00000E+00	0.00000E+00
	Total FP	1.89056E+04	6.92685E-05	0.00000E+00	0.00000E+00
72	U-235	3.23404E+01	1.12410E-03	6.28019E+01	2.18290E-03
	U-236	7.54711E+00	0.00000E+00	7.91645E-01	0.00000E+00
	Pu-238	2.05002E+01	0.00000E+00	6.31207E+00	0.00000E+00
	Pu-239	1.05862E+02	0.00000E+00	1.92627E+02	0.00000E+00
	Pu-240	1.69587E+02	0.00000E+00	1.93022E+00	0.00000E+00
	Pu-241	9.46744E+01	0.00000E+00	2.04191E+02	0.00000E+00
	Pu-242	2.61507E+01	0.00000E+00	1.46016E+00	0.00000E+00
	Xe-135	9.99486E+04	3.76079E-05	0.00000E+00	0.00000E+00
	Sm-149	3.15193E+03	9.23734E-06	0.00000E+00	0.00000E+00
	Total FP	1.41656E+04	4.68452E-05	0.00000E+00	0.00000E+00

Burnup = 10 MWd/kgU

Power distribution by pin

1	1.3255E+00	2	1.2596E+00	3	1.2201E+00	4	1.2180E+00	5	1.1942E+00	6	1.1801E+00
7	1.1950E+00	8	1.2063E+00	9	1.2366E+00	10	1.2411E+00	11	1.3255E+00	12	1.2411E+00
13	1.2233E+00	14	1.2124E+00	15	1.1538E+00	16	1.1409E+00	17	1.1300E+00	18	1.1562E+00
19	1.1756E+00	20	1.1914E+00	21	1.1950E+00	22	1.2233E+00	23	1.2596E+00	24	1.2366E+00
25	1.1950E+00	26	1.1712E+00	27	1.1058E+00	28	1.0654E+00	29	1.0282E+00	30	1.0541E+00
31	1.0258E+00	32	1.0779E+00	33	1.1175E+00	34	1.1712E+00	35	1.2124E+00	36	1.2201E+00
37	1.2063E+00	38	1.1914E+00	39	1.1175E+00	40	1.0359E+00	41	9.7693E-01	42	9.6522E-01
43	8.8930E-01	44	8.9172E-01	45	9.6482E-01	46	1.0044E+00	47	1.0359E+00	48	1.1058E+00
49	1.1538E+00	50	1.2180E+00	51	1.1950E+00	52	1.1756E+00	53	1.0779E+00	54	1.0044E+00
55	8.6506E-01	56	8.5053E-01	57	7.9560E-01	58	0.0000E+00	59	8.1579E-01	60	8.3760E-01
61	8.6506E-01	62	9.7693E-01	63	1.0654E+00	64	1.1409E+00	65	1.1942E+00	66	1.1801E+00
67	1.1562E+00	68	1.0258E+00	69	9.6482E-01	70	8.3760E-01	71	0.0000E+00	72	7.5643E-01
73	7.2614E-01	74	7.3785E-01	75	7.5723E-01	76	0.0000E+00	77	8.5053E-01	78	9.6522E-01
79	1.0282E+00	80	1.1300E+00	81	1.1801E+00	82	1.1942E+00	83	1.1300E+00	84	1.0541E+00
85	8.9172E-01	86	8.1579E-01	87	7.5723E-01	88	7.3704E-01	89	7.2291E-01	90	7.2291E-01
91	7.6652E-01	92	7.3704E-01	93	7.5643E-01	94	7.9560E-01	95	8.8930E-01	96	1.0541E+00
97	1.1562E+00	98	1.1950E+00	99	1.2180E+00	100	1.1409E+00	101	1.0282E+00	102	8.8930E-01
103	0.0000E+00	104	7.3785E-01	105	7.6652E-01	106	7.0675E-01	107	0.0000E+00	108	7.0837E-01
109	7.0675E-01	110	7.2291E-01	111	7.2614E-01	112	0.0000E+00	113	8.9172E-01	114	1.0258E+00
115	1.1756E+00	116	1.2063E+00	117	1.2201E+00	118	1.1538E+00	119	1.0654E+00	120	9.6522E-01
121	7.9560E-01	122	7.2614E-01	123	7.2291E-01	124	7.0837E-01	125	7.2654E-01	126	7.4027E-01

127	7.2654E-01	128	0.0000E+00	129	7.2291E-01	130	7.3785E-01	131	8.1579E-01	132	9.6482E-01
133	1.0779E+00	134	1.1914E+00	135	1.2366E+00	136	1.2596E+00	137	1.2124E+00	138	1.1058E+00
139	9.7693E-01	140	8.5053E-01	141	7.5643E-01	142	7.2291E-01	143	0.0000E+00	144	7.4027E-01
145	7.9722E-01	146	7.9722E-01	147	7.4027E-01	148	7.0837E-01	149	7.6652E-01	150	7.5723E-01
151	8.3760E-01	152	1.0044E+00	153	1.1175E+00	154	1.1950E+00	155	1.2411E+00	156	1.3255E+00
157	1.2233E+00	158	1.1712E+00	159	1.0359E+00	160	8.6506E-01	161	0.0000E+00	162	7.3704E-01
163	7.0675E-01	164	7.2654E-01	165	7.9722E-01	166	0.0000E+00	167	7.9722E-01	168	7.2654E-01
169	7.0675E-01	170	7.3704E-01	171	0.0000E+00	172	8.6506E-01	173	1.0359E+00	174	1.1712E+00
175	1.2233E+00	176	1.3255E+00	177	1.2411E+00	178	1.1950E+00	179	1.1175E+00	180	1.0044E+00
181	8.3760E-01	182	7.5723E-01	183	7.6652E-01	184	7.0837E-01	185	7.4027E-01	186	7.9722E-01
187	7.9722E-01	188	7.4027E-01	189	0.0000E+00	190	7.2291E-01	191	7.5643E-01	192	8.5053E-01
193	9.7693E-01	194	1.1058E+00	195	1.2124E+00	196	1.2596E+00	197	1.2366E+00	198	1.1914E+00
199	1.0779E+00	200	9.6482E-01	201	8.1579E-01	202	7.3785E-01	203	7.2291E-01	204	0.0000E+00
205	7.2654E-01	206	7.4027E-01	207	7.2654E-01	208	7.0837E-01	209	7.2291E-01	210	7.2614E-01
211	7.9560E-01	212	9.6522E-01	213	1.0654E+00	214	1.1538E+00	215	1.2201E+00	216	1.2063E+00
217	1.1756E+00	218	1.0258E+00	219	8.9172E-01	220	0.0000E+00	221	7.2614E-01	222	7.2291E-01
223	7.0675E-01	224	7.0837E-01	225	0.0000E+00	226	7.0675E-01	227	7.6652E-01	228	7.3785E-01
229	0.0000E+00	230	8.8930E-01	231	1.0282E+00	232	1.1409E+00	233	1.2180E+00	234	1.1950E+00
235	1.1562E+00	236	1.0541E+00	237	8.8930E-01	238	7.9560E-01	239	7.5643E-01	240	7.3704E-01
241	7.6652E-01	242	7.2291E-01	243	7.2291E-01	244	7.3704E-01	245	7.5723E-01	246	8.1579E-01
247	8.9172E-01	248	1.0541E+00	249	1.1300E+00	250	1.1942E+00	251	1.1801E+00	252	1.1300E+00
253	1.0282E+00	254	9.6522E-01	255	8.5053E-01	256	0.0000E+00	257	7.5723E-01	258	7.3785E-01
259	7.2614E-01	260	7.5643E-01	261	0.0000E+00	262	8.3760E-01	263	9.6482E-01	264	1.0258E+00
265	1.1562E+00	266	1.1801E+00	267	1.1942E+00	268	1.1409E+00	269	1.0654E+00	270	9.7693E-01
271	8.6506E-01	272	8.3760E-01	273	8.1579E-01	274	0.0000E+00	275	7.9560E-01	276	8.5053E-01
277	8.6506E-01	278	1.0044E+00	279	1.0779E+00	280	1.1756E+00	281	1.1950E+00	282	1.2180E+00
283	1.1538E+00	284	1.1058E+00	285	1.0359E+00	286	1.0044E+00	287	9.6482E-01	288	8.9172E-01
289	8.8930E-01	290	9.6522E-01	291	9.7693E-01	292	1.0359E+00	293	1.1175E+00	294	1.1914E+00
295	1.2063E+00	296	1.2201E+00	297	1.2124E+00	298	1.1712E+00	299	1.1175E+00	300	1.0779E+00
301	1.0258E+00	302	1.0541E+00	303	1.0282E+00	304	1.0654E+00	305	1.1058E+00	306	1.1712E+00
307	1.1950E+00	308	1.2366E+00	309	1.2596E+00	310	1.2233E+00	311	1.1950E+00	312	1.1914E+00
313	1.1756E+00	314	1.1562E+00	315	1.1300E+00	316	1.1409E+00	317	1.1538E+00	318	1.2124E+00
319	1.2233E+00	320	1.2411E+00	321	1.3255E+00	322	1.2411E+00	323	1.2366E+00	324	1.2063E+00
325	1.1950E+00	326	1.1801E+00	327	1.1942E+00	328	1.2180E+00	329	1.2201E+00	330	1.2596E+00
331	1.3255E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4420E-01	3.2517E-01	1.3665E-01	5.3817E-01
29	1.3518E-01	3.2509E-01	1.3698E-01	5.3793E-01
72	1.2147E-01	3.2553E-01	1.3749E-01	5.3697E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.9822E-02	3.2491E-02	8.2573E-02
29	6.1080E-02	2.7275E-02	6.9698E-02
72	5.1580E-02	2.1647E-02	5.5316E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.71223E+01	1.43412E-03	9.30546E+01	2.83202E-03
	U-236	7.61967E+00	1.44292E-05	7.83129E-01	1.48300E-06
	Pu-238	3.11709E+01	9.69469E-08	7.01723E+00	2.18248E-08
	Pu-239	1.50153E+02	4.04929E-04	2.75851E+02	7.43910E-04
	Pu-240	1.71355E+02	6.46292E-05	1.87688E+00	7.07896E-07
	Pu-241	1.38859E+02	1.77860E-05	2.99390E+02	3.83479E-05
	Pu-242	3.39784E+01	3.03630E-07	1.42227E+00	1.27094E-08
	Xe-135	1.67658E+05	7.17694E-05	0.00000E+00	0.00000E+00
	Sm-149	5.18167E+03	1.97366E-05	0.00000E+00	0.00000E+00
	Total FP	1.73397E+01	1.66103E-04	0.00000E+00	0.00000E+00
29	U-235	3.74406E+01	1.09215E-03	7.31143E+01	2.13275E-03
	U-236	8.07531E+00	1.40722E-05	8.05724E-01	1.40407E-06
	Pu-238	2.40608E+01	8.49786E-08	6.55767E+00	2.31605E-08
	Pu-239	1.20301E+02	3.56549E-04	2.19825E+02	6.51520E-04
	Pu-240	1.50687E+02	5.60105E-05	1.90827E+00	7.09306E-07
	Pu-241	1.08509E+02	1.57804E-05	2.33917E+02	3.40182E-05
	Pu-242	2.99463E+01	2.75408E-07	1.45315E+00	1.33642E-08
	Xe-135	1.21265E+05	5.46670E-05	0.00000E+00	0.00000E+00
	Sm-149	3.77158E+03	1.60957E-05	0.00000E+00	0.00000E+00
	Total FP	1.52875E+01	1.30505E-04	0.00000E+00	0.00000E+00

72	U-235	3.04478E+01	7.86155E-04	5.88460E+01	1.51939E-03
	U-236	7.22426E+00	1.14929E-05	7.94140E-01	1.26337E-06
	Pu-238	1.92295E+01	5.33067E-08	6.25350E+00	1.73355E-08
	Pu-239	9.69454E+01	2.31343E-04	1.76511E+02	4.21213E-04
	Pu-240	1.32282E+02	4.28640E-05	1.93673E+00	6.27567E-07
	Pu-241	8.70527E+01	1.00243E-05	1.87821E+02	2.16281E-05
	Pu-242	2.63708E+01	2.06806E-07	1.48150E+00	1.16183E-08
	Xe-135	9.03065E+04	3.36813E-05	0.00000E+00	0.00000E+00
	Sm-149	2.84113E+03	9.55786E-06	0.00000E+00	0.00000E+00
	Total FP	1.13584E+01	9.05767E-05	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Power distribution by pin

1	1.3089E+00	2	1.2350E+00	3	1.2084E+00	4	1.1787E+00	5	1.1625E+00	6	1.1813E+00
7	1.1800E+00	8	1.1839E+00	9	1.2080E+00	10	1.2171E+00	11	1.3089E+00	12	1.2171E+00
13	1.2551E+00	14	1.2407E+00	15	1.1830E+00	16	1.1503E+00	17	1.1546E+00	18	1.1747E+00
19	1.1734E+00	20	1.1634E+00	21	1.2368E+00	22	1.2551E+00	23	1.2350E+00	24	1.2080E+00
25	1.2368E+00	26	1.1721E+00	27	1.0956E+00	28	1.0838E+00	29	1.0633E+00	30	1.0550E+00
31	1.1031E+00	32	1.1048E+00	33	1.1083E+00	34	1.1721E+00	35	1.2407E+00	36	1.2084E+00
37	1.1839E+00	38	1.1634E+00	39	1.1083E+00	40	1.0738E+00	41	1.0074E+00	42	9.8987E-01
43	8.5527E-01	44	8.7756E-01	45	1.0047E+00	46	1.0340E+00	47	1.0738E+00	48	1.0956E+00
49	1.1830E+00	50	1.1787E+00	51	1.1800E+00	52	1.1734E+00	53	1.1048E+00	54	1.0340E+00
55	8.7624E-01	56	8.2861E-01	57	7.9976E-01	58	0.0000E+00	59	8.1375E-01	60	8.3079E-01
61	8.7624E-01	62	1.0074E+00	63	1.0838E+00	64	1.1503E+00	65	1.1625E+00	66	1.1813E+00
67	1.1747E+00	68	1.1031E+00	69	1.0047E+00	70	8.3079E-01	71	0.0000E+00	72	7.4033E-01
73	7.1323E-01	74	7.5213E-01	75	7.3377E-01	76	0.0000E+00	77	8.2861E-01	78	9.8987E-01
79	1.0633E+00	80	1.1546E+00	81	1.1813E+00	82	1.1625E+00	83	1.1546E+00	84	1.0550E+00
85	8.7756E-01	86	8.1375E-01	87	7.3377E-01	88	7.1498E-01	89	6.9794E-01	90	6.8264E-01
91	7.8491E-01	92	7.1498E-01	93	7.4033E-01	94	7.9976E-01	95	8.5527E-01	96	1.0550E+00
97	1.1747E+00	98	1.1800E+00	99	1.1787E+00	100	1.1503E+00	101	1.0633E+00	102	8.5527E-01
103	0.0000E+00	104	7.5213E-01	105	7.8491E-01	106	6.9706E-01	107	0.0000E+00	108	7.0100E-01
109	6.9706E-01	110	6.9794E-01	111	7.1323E-01	112	0.0000E+00	113	8.7756E-01	114	1.1031E+00
115	1.1734E+00	116	1.1839E+00	117	1.2084E+00	118	1.1830E+00	119	1.0838E+00	120	9.8987E-01
121	7.9976E-01	122	7.1323E-01	123	6.8264E-01	124	7.0100E-01	125	7.0755E-01	126	7.1498E-01
127	7.0755E-01	128	0.0000E+00	129	6.8264E-01	130	7.5213E-01	131	8.1375E-01	132	1.0047E+00
133	1.1048E+00	134	1.1634E+00	135	1.2080E+00	136	1.2350E+00	137	1.2407E+00	138	1.0956E+00
139	1.0074E+00	140	8.2861E-01	141	7.4033E-01	142	6.9794E-01	143	0.0000E+00	144	7.1498E-01
145	7.8578E-01	146	7.8578E-01	147	7.1498E-01	148	7.0100E-01	149	7.8491E-01	150	7.3377E-01
151	8.3079E-01	152	1.0340E+00	153	1.1083E+00	154	1.2368E+00	155	1.2171E+00	156	1.3089E+00
157	1.2551E+00	158	1.1721E+00	159	1.0738E+00	160	8.7624E-01	161	0.0000E+00	162	7.1498E-01
163	6.9706E-01	164	7.0755E-01	165	7.8578E-01	166	0.0000E+00	167	7.8578E-01	168	7.0755E-01
169	6.9706E-01	170	7.1498E-01	171	0.0000E+00	172	8.7624E-01	173	1.0738E+00	174	1.1721E+00
175	1.2551E+00	176	1.3089E+00	177	1.2171E+00	178	1.2368E+00	179	1.1083E+00	180	1.0340E+00
181	8.3079E-01	182	7.3377E-01	183	7.8491E-01	184	7.0100E-01	185	7.1498E-01	186	7.8578E-01
187	7.8578E-01	188	7.1498E-01	189	0.0000E+00	190	6.9794E-01	191	7.4033E-01	192	8.2861E-01
193	1.0074E+00	194	1.0956E+00	195	1.2407E+00	196	1.2350E+00	197	1.2080E+00	198	1.1634E+00
199	1.1048E+00	200	1.0047E+00	201	8.1375E-01	202	7.5213E-01	203	6.8264E-01	204	0.0000E+00
205	7.0755E-01	206	7.1498E-01	207	7.0755E-01	208	7.0100E-01	209	6.8264E-01	210	7.1323E-01
211	7.9976E-01	212	9.8987E-01	213	1.0838E+00	214	1.1830E+00	215	1.2084E+00	216	1.1839E+00
217	1.1734E+00	218	1.1031E+00	219	8.7756E-01	220	0.0000E+00	221	7.1323E-01	222	6.9794E-01
223	6.9706E-01	224	7.0100E-01	225	0.0000E+00	226	6.9706E-01	227	7.8491E-01	228	7.5213E-01
229	0.0000E+00	230	8.5527E-01	231	1.0633E+00	232	1.1503E+00	233	1.1787E+00	234	1.1800E+00
235	1.1747E+00	236	1.0550E+00	237	8.5527E-01	238	7.9976E-01	239	7.4033E-01	240	7.1498E-01
241	7.8491E-01	242	6.8264E-01	243	6.9794E-01	244	7.1498E-01	245	7.3377E-01	246	8.1375E-01
247	8.7756E-01	248	1.0550E+00	249	1.1546E+00	250	1.1625E+00	251	1.1813E+00	252	1.1546E+00
253	1.0633E+00	254	9.8987E-01	255	8.2861E-01	256	0.0000E+00	257	7.3377E-01	258	7.5213E-01
259	7.1323E-01	260	7.4033E-01	261	0.0000E+00	262	8.3079E-01	263	1.0047E+00	264	1.1031E+00
265	1.1747E+00	266	1.1813E+00	267	1.1625E+00	268	1.1503E+00	269	1.0838E+00	270	1.0074E+00
271	8.7624E-01	272	8.3079E-01	273	8.1375E-01	274	0.0000E+00	275	7.9976E-01	276	8.2861E-01
277	8.7624E-01	278	1.0340E+00	279	1.1048E+00	280	1.1734E+00	281	1.1800E+00	282	1.1787E+00
283	1.1830E+00	284	1.0956E+00	285	1.0738E+00	286	1.0340E+00	287	1.0047E+00	288	8.7756E-01
289	8.5527E-01	290	9.8987E-01	291	1.0074E+00	292	1.0738E+00	293	1.1083E+00	294	1.1634E+00
295	1.1839E+00	296	1.2084E+00	297	1.2407E+00	298	1.1721E+00	299	1.1083E+00	300	1.1048E+00
301	1.1031E+00	302	1.0550E+00	303	1.0633E+00	304	1.0838E+00	305	1.0956E+00	306	1.1721E+00
307	1.2368E+00	308	1.2080E+00	309	1.2350E+00	310	1.2551E+00	311	1.2368E+00	312	1.1634E+00
313	1.1734E+00	314	1.1747E+00	315	1.1546E+00	316	1.1503E+00	317	1.1830E+00	318	1.2407E+00
319	1.2551E+00	320	1.2171E+00	321	1.3089E+00	322	1.2171E+00	323	1.2080E+00	324	1.1839E+00
325	1.1800E+00	326	1.1813E+00	327	1.1625E+00	328	1.1787E+00	329	1.2084E+00	330	1.2350E+00
331	1.3089E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell

1	1.4450E-01	3.2476E-01	1.3713E-01	5.3812E-01
29	1.3532E-01	3.2503E-01	1.3648E-01	5.3849E-01
72	1.2114E-01	3.2424E-01	1.3818E-01	5.3757E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.8601E-02	2.8709E-02	7.4744E-02
29	6.1636E-02	2.4999E-02	6.5539E-02
72	5.1709E-02	1.9361E-02	5.0625E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.72344E+01	1.04194E-03	9.33614E+01	2.05945E-03
	U-236	7.35680E+00	2.44459E-05	7.80399E-01	2.59319E-06
	Pu-238	3.11977E+01	5.78500E-07	7.02360E+00	1.30239E-07
	Pu-239	1.47698E+02	5.66862E-04	2.71901E+02	1.04355E-03
	Pu-240	1.41517E+02	1.35368E-04	1.86638E+00	1.78529E-06
	Pu-241	1.37522E+02	6.58477E-05	2.96585E+02	1.42010E-04
	Pu-242	2.97600E+01	2.32898E-06	1.42712E+00	1.11684E-07
	Xe-135	1.69458E+05	6.57369E-05	0.00000E+00	0.00000E+00
	Sm-149	5.21541E+03	2.07108E-05	0.00000E+00	0.00000E+00
	Total FP	1.21889E+01	2.23612E-04	0.00000E+00	0.00000E+00
29	U-235	3.69417E+01	8.04320E-04	7.20710E+01	1.56918E-03
	U-236	6.77830E+00	2.08248E-05	7.77510E-01	2.38873E-06
	Pu-238	2.38137E+01	5.17703E-07	6.54913E+00	1.42376E-07
	Pu-239	1.14825E+02	5.11322E-04	2.10340E+02	9.36655E-04
	Pu-240	1.25837E+02	1.18188E-04	1.91151E+00	1.79532E-06
	Pu-241	1.06331E+02	5.89019E-05	2.29338E+02	1.27042E-04
	Pu-242	2.99116E+01	2.35530E-06	1.46722E+00	1.15532E-07
	Xe-135	1.20935E+05	5.28156E-05	0.00000E+00	0.00000E+00
	Sm-149	3.79253E+03	1.82329E-05	0.00000E+00	0.00000E+00
	Total FP	1.08320E+01	1.80371E-04	0.00000E+00	0.00000E+00
72	U-235	3.06508E+01	5.73797E-04	5.91288E+01	1.10692E-03
	U-236	6.73611E+00	1.86829E-05	7.74278E-01	2.14749E-06
	Pu-238	1.93963E+01	3.21396E-07	6.27077E+00	1.03907E-07
	Pu-239	9.30303E+01	3.17813E-04	1.69919E+02	5.80484E-04
	Pu-240	1.10014E+02	8.95928E-05	1.91380E+00	1.55856E-06
	Pu-241	8.60218E+01	3.68077E-05	1.85738E+02	7.94754E-05
	Pu-242	2.66255E+01	1.79823E-06	1.47038E+00	9.93057E-08
	Xe-135	9.11979E+04	3.10938E-05	0.00000E+00	0.00000E+00
	Sm-149	2.85760E+03	1.01406E-05	0.00000E+00	0.00000E+00
	Total FP	8.50110E+00	1.29550E-04	0.00000E+00	0.00000E+00

Burnup = 30 MWd/kgU

Power distribution by pin

1	1.2420E+00	2	1.2096E+00	3	1.1663E+00	4	1.1537E+00	5	1.1649E+00	6	1.1466E+00
7	1.1264E+00	8	1.1424E+00	9	1.1931E+00	10	1.1861E+00	11	1.2420E+00	12	1.1861E+00
13	1.3322E+00	14	1.2697E+00	15	1.2208E+00	16	1.2006E+00	17	1.1739E+00	18	1.2011E+00
19	1.1983E+00	20	1.2067E+00	21	1.2622E+00	22	1.3322E+00	23	1.2096E+00	24	1.1931E+00
25	1.2622E+00	26	1.1903E+00	27	1.1377E+00	28	1.0954E+00	29	1.0719E+00	30	1.0945E+00
31	1.0879E+00	32	1.1156E+00	33	1.1617E+00	34	1.1903E+00	35	1.2697E+00	36	1.1663E+00
37	1.1424E+00	38	1.2067E+00	39	1.1617E+00	40	1.0701E+00	41	1.0367E+00	42	1.0029E+00
43	8.6713E-01	44	8.7136E-01	45	1.0057E+00	46	1.0597E+00	47	1.0701E+00	48	1.1377E+00
49	1.2208E+00	50	1.1537E+00	51	1.1264E+00	52	1.1983E+00	53	1.1156E+00	54	1.0597E+00
55	8.5304E-01	56	7.9150E-01	57	7.6755E-01	58	0.0000E+00	59	7.8633E-01	60	7.9714E-01
61	8.5304E-01	62	1.0367E+00	63	1.0954E+00	64	1.2006E+00	65	1.1649E+00	66	1.1466E+00
67	1.2011E+00	68	1.0879E+00	69	1.0057E+00	70	7.9714E-01	71	0.0000E+00	72	7.3889E-01
73	7.3654E-01	74	7.0977E-01	75	7.4829E-01	76	0.0000E+00	77	7.9150E-01	78	1.0029E+00
79	1.0719E+00	80	1.1739E+00	81	1.1466E+00	82	1.1649E+00	83	1.1739E+00	84	1.0945E+00
85	8.7136E-01	86	7.8633E-01	87	7.4829E-01	88	7.1212E-01	89	6.7172E-01	90	7.0225E-01
91	7.8446E-01	92	7.1212E-01	93	7.3889E-01	94	7.6755E-01	95	8.6713E-01	96	1.0945E+00
97	1.2011E+00	98	1.1264E+00	99	1.1537E+00	100	1.2006E+00	101	1.0719E+00	102	8.6713E-01
103	0.0000E+00	104	7.0977E-01	105	7.8446E-01	106	6.7313E-01	107	0.0000E+00	108	6.7595E-01
109	6.7313E-01	110	6.7172E-01	111	7.3654E-01	112	0.0000E+00	113	8.7136E-01	114	1.0879E+00
115	1.1983E+00	116	1.1424E+00	117	1.1663E+00	118	1.2208E+00	119	1.0954E+00	120	1.0029E+00
121	7.6755E-01	122	7.3654E-01	123	7.0225E-01	124	6.7595E-01	125	7.0742E-01	126	7.0178E-01
127	7.0742E-01	128	0.0000E+00	129	7.0225E-01	130	7.0977E-01	131	7.8633E-01	132	1.0057E+00
133	1.1156E+00	134	1.2067E+00	135	1.1931E+00	136	1.2096E+00	137	1.2697E+00	138	1.1377E+00

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139 1.0367E+00 140 7.9150E-01 141 7.3889E-01 142 6.7172E-01 143 0.0000E+00 144 7.0178E-01
145 7.7694E-01 146 7.7694E-01 147 7.0178E-01 148 6.7595E-01 149 7.8446E-01 150 7.4829E-01
151 7.9714E-01 152 1.0597E+00 153 1.1617E+00 154 1.2622E+00 155 1.1861E+00 156 1.2420E+00
157 1.3322E+00 158 1.1903E+00 159 1.0701E+00 160 8.5304E-01 161 0.0000E+00 162 7.1212E-01
163 6.7313E-01 164 7.0742E-01 165 7.7694E-01 166 0.0000E+00 167 7.7694E-01 168 7.0742E-01
169 6.7313E-01 170 7.1212E-01 171 0.0000E+00 172 8.5304E-01 173 1.0701E+00 174 1.1903E+00
175 1.3322E+00 176 1.2420E+00 177 1.1861E+00 178 1.2622E+00 179 1.1617E+00 180 1.0597E+00
181 7.9714E-01 182 7.4829E-01 183 7.8446E-01 184 6.7595E-01 185 7.0178E-01 186 7.7694E-01
187 7.7694E-01 188 7.0178E-01 189 0.0000E+00 190 6.7172E-01 191 7.3889E-01 192 7.9150E-01
193 1.0367E+00 194 1.1377E+00 195 1.2697E+00 196 1.2096E+00 197 1.1931E+00 198 1.2067E+00
199 1.1156E+00 200 1.0057E+00 201 7.8633E-01 202 7.0977E-01 203 7.0225E-01 204 0.0000E+00
205 7.0742E-01 206 7.0178E-01 207 7.0742E-01 208 6.7595E-01 209 7.0225E-01 210 7.3654E-01
211 7.6755E-01 212 1.0029E+00 213 1.0954E+00 214 1.2208E+00 215 1.1663E+00 216 1.1424E+00
217 1.1983E+00 218 1.0879E+00 219 8.7136E-01 220 0.0000E+00 221 7.3654E-01 222 6.7172E-01
223 6.7313E-01 224 6.7595E-01 225 0.0000E+00 226 6.7313E-01 227 7.8446E-01 228 7.0977E-01
229 0.0000E+00 230 8.6713E-01 231 1.0719E+00 232 1.2006E+00 233 1.1537E+00 234 1.1264E+00
235 1.2011E+00 236 1.0945E+00 237 8.6713E-01 238 7.6755E-01 239 7.3889E-01 240 7.1212E-01
241 7.8446E-01 242 7.0225E-01 243 6.7172E-01 244 7.1212E-01 245 7.4829E-01 246 7.8633E-01
247 8.7136E-01 248 1.0945E+00 249 1.1739E+00 250 1.1649E+00 251 1.1466E+00 252 1.1739E+00
253 1.0719E+00 254 1.0029E+00 255 7.9150E-01 256 0.0000E+00 257 7.4829E-01 258 7.0977E-01
259 7.3654E-01 260 7.3889E-01 261 0.0000E+00 262 7.9714E-01 263 1.0057E+00 264 1.0879E+00
265 1.2011E+00 266 1.1466E+00 267 1.1649E+00 268 1.2006E+00 269 1.0954E+00 270 1.0367E+00
271 8.5304E-01 272 7.9714E-01 273 7.8633E-01 274 0.0000E+00 275 7.6755E-01 276 7.9150E-01
277 8.5304E-01 278 1.0597E+00 279 1.1156E+00 280 1.1983E+00 281 1.1264E+00 282 1.1537E+00
283 1.2208E+00 284 1.1377E+00 285 1.0701E+00 286 1.0597E+00 287 1.0057E+00 288 8.7136E-01
289 8.6713E-01 290 1.0029E+00 291 1.0367E+00 292 1.0701E+00 293 1.1617E+00 294 1.2067E+00
295 1.1424E+00 296 1.1663E+00 297 1.2697E+00 298 1.1903E+00 299 1.1617E+00 300 1.1156E+00
301 1.0879E+00 302 1.0945E+00 303 1.0719E+00 304 1.0954E+00 305 1.1377E+00 306 1.1903E+00
307 1.2622E+00 308 1.1931E+00 309 1.2096E+00 310 1.3322E+00 311 1.2622E+00 312 1.2067E+00
313 1.1983E+00 314 1.2011E+00 315 1.1739E+00 316 1.2006E+00 317 1.2208E+00 318 1.2697E+00
319 1.3322E+00 320 1.1861E+00 321 1.2420E+00 322 1.1861E+00 323 1.1931E+00 324 1.1424E+00
325 1.1264E+00 326 1.1466E+00 327 1.1649E+00 328 1.1537E+00 329 1.1663E+00 330 1.2096E+00
331 1.2420E+00
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Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4619E-01	3.2394E-01	1.3646E-01	5.3961E-01
29	1.3435E-01	3.2517E-01	1.3688E-01	5.3794E-01
72	1.2068E-01	3.2447E-01	1.3773E-01	5.3780E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.7234E-02	2.4983E-02	6.6395E-02
29	6.3154E-02	2.3487E-02	6.2879E-02
72	5.2073E-02	1.7567E-02	4.6880E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.81876E+01	7.47463E-04	9.51457E+01	1.47585E-03
	U-236	6.59451E+00	2.90795E-05	7.56379E-01	3.33537E-06
	Pu-238	3.20466E+01	1.69309E-06	7.11559E+00	3.75932E-07
	Pu-239	1.45736E+02	6.24095E-04	2.68986E+02	1.15190E-03
	Pu-240	1.23429E+02	1.85653E-04	1.85407E+00	2.78876E-06
	Pu-241	1.38399E+02	1.16535E-04	2.98941E+02	2.51714E-04
	Pu-242	3.11613E+01	7.43412E-06	1.42284E+00	3.39445E-07
	Xe-135	1.75578E+05	6.03051E-05	0.00000E+00	0.00000E+00
	Sm-149	5.41082E+03	2.07347E-05	0.00000E+00	0.00000E+00
	Total FP	1.02669E+01	2.73821E-04	0.00000E+00	0.00000E+00
29	U-235	3.83430E+01	5.99712E-04	7.48806E+01	1.17119E-03
	U-236	6.85453E+00	2.76324E-05	7.88227E-01	3.17755E-06
	Pu-238	2.50266E+01	1.57422E-06	6.67049E+00	4.19586E-07
	Pu-239	1.14673E+02	5.91860E-04	2.10935E+02	1.08870E-03
	Pu-240	1.08655E+02	1.59947E-04	1.92112E+00	2.82801E-06
	Pu-241	1.08529E+02	1.07929E-04	2.34465E+02	2.33168E-04
	Pu-242	3.02436E+01	7.08221E-06	1.48382E+00	3.47468E-07
	Xe-135	1.28389E+05	5.26094E-05	0.00000E+00	0.00000E+00
	Sm-149	3.96195E+03	1.94258E-05	0.00000E+00	0.00000E+00
	Total FP	9.54297E+00	2.32194E-04	0.00000E+00	0.00000E+00
72	U-235	3.18705E+01	4.18869E-04	6.15492E+01	8.08933E-04
	U-236	6.42403E+00	2.33746E-05	7.70305E-01	2.80285E-06

Variant 11
State 2

Pu-238	2.03581E+01	9.55996E-07	6.35549E+00	2.98447E-07
Pu-239	9.45376E+01	3.60574E-04	1.73105E+02	6.60235E-04
Pu-240	9.42796E+01	1.19577E-04	1.90695E+00	2.41862E-06
Pu-241	8.79493E+01	6.58157E-05	1.90107E+02	1.42264E-04
Pu-242	2.71192E+01	5.48494E-06	1.47371E+00	2.98062E-07
Xe-135	9.56483E+04	2.90810E-05	0.00000E+00	0.00000E+00
Sm-149	2.96902E+03	1.02211E-05	0.00000E+00	0.00000E+00
Total FP	7.49387E+00	1.64892E-04	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Power distribution by pin

1	1.2191E+00	2	1.1524E+00	3	1.1294E+00	4	1.1136E+00	5	1.1095E+00	6	1.0968E+00
7	1.1141E+00	8	1.1289E+00	9	1.1508E+00	10	1.1651E+00	11	1.2191E+00	12	1.1651E+00
13	1.3251E+00	14	1.2803E+00	15	1.2410E+00	16	1.2319E+00	17	1.2186E+00	18	1.2252E+00
19	1.2543E+00	20	1.2548E+00	21	1.2711E+00	22	1.3251E+00	23	1.1524E+00	24	1.1508E+00
25	1.2711E+00	26	1.2263E+00	27	1.1692E+00	28	1.1345E+00	29	1.1136E+00	30	1.1146E+00
31	1.1228E+00	32	1.1366E+00	33	1.1682E+00	34	1.2263E+00	35	1.2803E+00	36	1.1294E+00
37	1.1289E+00	38	1.2548E+00	39	1.1682E+00	40	1.1111E+00	41	1.0520E+00	42	1.0326E+00
43	8.3841E-01	44	8.3739E-01	45	1.0265E+00	46	1.0667E+00	47	1.1111E+00	48	1.1692E+00
49	1.2410E+00	50	1.1136E+00	51	1.1141E+00	52	1.2543E+00	53	1.1366E+00	54	1.0667E+00
55	8.3892E-01	56	7.9559E-01	57	7.7419E-01	58	0.0000E+00	59	7.7011E-01	60	7.8744E-01
61	8.3892E-01	62	1.0520E+00	63	1.1345E+00	64	1.2319E+00	65	1.1095E+00	66	1.0968E+00
67	1.2252E+00	68	1.1228E+00	69	1.0265E+00	70	7.8744E-01	71	0.0000E+00	72	7.2220E-01
73	6.9468E-01	74	7.0538E-01	75	7.2985E-01	76	0.0000E+00	77	7.9559E-01	78	1.0326E+00
79	1.1136E+00	80	1.2186E+00	81	1.0968E+00	82	1.1095E+00	83	1.2186E+00	84	1.1146E+00
85	8.3739E-01	86	7.7011E-01	87	7.2985E-01	88	6.9927E-01	89	6.6716E-01	90	6.8805E-01
91	8.1394E-01	92	6.9927E-01	93	7.2220E-01	94	7.7419E-01	95	8.3841E-01	96	1.1146E+00
97	1.2252E+00	98	1.1141E+00	99	1.1136E+00	100	1.2319E+00	101	1.1136E+00	102	8.3841E-01
103	0.0000E+00	104	7.0538E-01	105	8.1394E-01	106	6.8347E-01	107	0.0000E+00	108	6.8652E-01
109	6.8347E-01	110	6.6716E-01	111	6.9468E-01	112	0.0000E+00	113	8.3739E-01	114	1.1228E+00
115	1.2543E+00	116	1.1289E+00	117	1.1294E+00	118	1.2410E+00	119	1.1345E+00	120	1.0326E+00
121	7.7419E-01	122	6.9468E-01	123	6.8805E-01	124	6.8652E-01	125	6.7786E-01	126	6.8092E-01
127	6.7786E-01	128	0.0000E+00	129	6.8805E-01	130	7.0538E-01	131	7.7011E-01	132	1.0265E+00
133	1.1366E+00	134	1.2548E+00	135	1.1508E+00	136	1.1524E+00	137	1.2803E+00	138	1.1692E+00
139	1.0520E+00	140	7.9559E-01	141	7.2220E-01	142	6.6716E-01	143	0.0000E+00	144	6.8092E-01
145	7.5176E-01	146	7.5176E-01	147	6.8092E-01	148	6.8652E-01	149	8.1394E-01	150	7.2985E-01
151	7.8744E-01	152	1.0667E+00	153	1.1682E+00	154	1.2711E+00	155	1.1651E+00	156	1.2191E+00
157	1.3251E+00	158	1.2263E+00	159	1.1111E+00	160	8.3892E-01	161	0.0000E+00	162	6.9927E-01
163	6.8347E-01	164	6.7786E-01	165	7.5176E-01	166	0.0000E+00	167	7.5176E-01	168	6.7786E-01
169	6.8347E-01	170	6.9927E-01	171	0.0000E+00	172	8.3892E-01	173	1.1111E+00	174	1.2263E+00
175	1.3251E+00	176	1.2191E+00	177	1.1651E+00	178	1.2711E+00	179	1.1682E+00	180	1.0667E+00
181	7.8744E-01	182	7.2985E-01	183	8.1394E-01	184	6.8652E-01	185	6.8092E-01	186	7.5176E-01
187	7.5176E-01	188	6.8092E-01	189	0.0000E+00	190	6.6716E-01	191	7.2220E-01	192	7.9559E-01
193	1.0520E+00	194	1.1692E+00	195	1.2803E+00	196	1.1524E+00	197	1.1508E+00	198	1.2548E+00
199	1.1366E+00	200	1.0265E+00	201	7.7011E-01	202	7.0538E-01	203	6.8805E-01	204	0.0000E+00
205	6.7786E-01	206	6.8092E-01	207	6.7786E-01	208	6.8652E-01	209	6.8805E-01	210	6.9468E-01
211	7.7419E-01	212	1.0326E+00	213	1.1345E+00	214	1.2410E+00	215	1.1294E+00	216	1.1289E+00
217	1.2543E+00	218	1.1228E+00	219	8.3739E-01	220	0.0000E+00	221	6.9468E-01	222	6.6716E-01
223	6.8347E-01	224	6.8652E-01	225	0.0000E+00	226	6.8347E-01	227	8.1394E-01	228	7.0538E-01
229	0.0000E+00	230	8.3841E-01	231	1.1136E+00	232	1.2319E+00	233	1.1136E+00	234	1.1141E+00
235	1.2252E+00	236	1.1146E+00	237	8.3841E-01	238	7.7419E-01	239	7.2220E-01	240	6.9927E-01
241	8.1394E-01	242	6.8805E-01	243	6.6716E-01	244	6.9927E-01	245	7.2985E-01	246	7.7011E-01
247	8.3739E-01	248	1.1146E+00	249	1.2186E+00	250	1.1095E+00	251	1.0968E+00	252	1.2186E+00
253	1.1136E+00	254	1.0326E+00	255	7.9559E-01	256	0.0000E+00	257	7.2985E-01	258	7.0538E-01
259	6.9468E-01	260	7.2220E-01	261	0.0000E+00	262	7.8744E-01	263	1.0265E+00	264	1.1228E+00
265	1.2252E+00	266	1.0968E+00	267	1.1095E+00	268	1.2319E+00	269	1.1345E+00	270	1.0520E+00
271	8.3892E-01	272	7.8744E-01	273	7.7011E-01	274	0.0000E+00	275	7.7419E-01	276	7.9559E-01
277	8.3892E-01	278	1.0667E+00	279	1.1366E+00	280	1.2543E+00	281	1.1141E+00	282	1.1136E+00
283	1.2410E+00	284	1.1692E+00	285	1.1111E+00	286	1.0667E+00	287	1.0265E+00	288	8.3739E-01
289	8.3841E-01	290	1.0326E+00	291	1.0520E+00	292	1.1111E+00	293	1.1682E+00	294	1.2548E+00
295	1.1289E+00	296	1.1294E+00	297	1.2803E+00	298	1.2263E+00	299	1.1682E+00	300	1.1366E+00
301	1.1228E+00	302	1.1146E+00	303	1.1136E+00	304	1.1345E+00	305	1.1692E+00	306	1.2263E+00
307	1.2711E+00	308	1.1508E+00	309	1.1524E+00	310	1.3251E+00	311	1.2711E+00	312	1.2548E+00
313	1.2543E+00	314	1.2252E+00	315	1.2186E+00	316	1.2319E+00	317	1.2410E+00	318	1.2803E+00
319	1.3251E+00	320	1.1651E+00	321	1.2191E+00	322	1.1651E+00	323	1.1508E+00	324	1.1289E+00
325	1.1141E+00	326	1.0968E+00	327	1.1095E+00	328	1.1136E+00	329	1.1294E+00	330	1.1524E+00
331	1.2191E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4605E-01	3.2356E-01	1.3697E-01	5.3947E-01
29	1.3653E-01	3.2533E-01	1.3719E-01	5.3748E-01

72 1.2118E-01 3.2568E-01 1.3735E-01 5.3697E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.5383E-02	2.1870E-02	5.9294E-02
29	6.2714E-02	2.1536E-02	5.8741E-02
72	5.0914E-02	1.5518E-02	4.2207E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.92670E+01	5.06289E-04	9.73551E+01	1.00046E-03
	U-236	6.80599E+00	3.48324E-05	7.61406E-01	3.89680E-06
	Pu-238	3.27210E+01	3.49754E-06	7.15523E+00	7.64821E-07
	Pu-239	1.50107E+02	6.48892E-04	2.76953E+02	1.19722E-03
	Pu-240	1.11090E+02	2.14384E-04	1.83526E+00	3.54172E-06
	Pu-241	1.41830E+02	1.56133E-04	3.06190E+02	3.37067E-04
	Pu-242	2.78948E+01	1.33219E-05	1.41210E+00	6.74385E-07
	Xe-135	1.79273E+05	5.30727E-05	0.00000E+00	0.00000E+00
	Sm-149	5.47094E+03	1.91109E-05	0.00000E+00	0.00000E+00
	Total FP	9.22579E+00	3.14307E-04	0.00000E+00	0.00000E+00
29	U-235	3.90296E+01	4.31687E-04	7.63610E+01	8.44589E-04
	U-236	6.59989E+00	3.15742E-05	7.77518E-01	3.71968E-06
	Pu-238	2.55698E+01	3.42666E-06	6.70461E+00	8.98498E-07
	Pu-239	1.14627E+02	6.39106E-04	2.11352E+02	1.17840E-03
	Pu-240	9.61674E+01	1.88820E-04	1.90806E+00	3.74639E-06
	Pu-241	1.09508E+02	1.51681E-04	2.36779E+02	3.27966E-04
	Pu-242	2.64294E+01	1.26005E-05	1.47699E+00	7.04174E-07
	Xe-135	1.32718E+05	5.14645E-05	0.00000E+00	0.00000E+00
	Sm-149	4.07432E+03	1.98392E-05	0.00000E+00	0.00000E+00
	Total FP	8.56528E+00	2.77586E-04	0.00000E+00	0.00000E+00
72	U-235	3.23354E+01	2.87658E-04	6.25128E+01	5.56119E-04
	U-236	6.22246E+00	2.65788E-05	7.67422E-01	3.27799E-06
	Pu-238	2.06574E+01	2.00198E-06	6.36925E+00	6.17265E-07
	Pu-239	9.53883E+01	3.75136E-04	1.74823E+02	6.87531E-04
	Pu-240	8.47044E+01	1.40017E-04	1.90487E+00	3.14876E-06
	Pu-241	8.94740E+01	8.93676E-05	1.93358E+02	1.93128E-04
	Pu-242	2.41367E+01	9.87353E-06	1.47557E+00	6.03606E-07
	Xe-135	9.98589E+04	2.69414E-05	0.00000E+00	0.00000E+00
	Sm-149	3.08107E+03	9.92680E-06	0.00000E+00	0.00000E+00
	Total FP	6.79908E+00	1.94410E-04	0.00000E+00	0.00000E+00

Burnup = 50 MWd/kgU

Power distribution by pin

1	1.1880E+00	2	1.1336E+00	3	1.0868E+00	4	1.0984E+00	5	1.0940E+00	6	1.0759E+00
7	1.0825E+00	8	1.0841E+00	9	1.1094E+00	10	1.1528E+00	11	1.1880E+00	12	1.1528E+00
13	1.3639E+00	14	1.3161E+00	15	1.2760E+00	16	1.2639E+00	17	1.2485E+00	18	1.2820E+00
19	1.2578E+00	20	1.2837E+00	21	1.3485E+00	22	1.3639E+00	23	1.1336E+00	24	1.1094E+00
25	1.3485E+00	26	1.2215E+00	27	1.1704E+00	28	1.1380E+00	29	1.1336E+00	30	1.1341E+00
31	1.1534E+00	32	1.1506E+00	33	1.2078E+00	34	1.2215E+00	35	1.3161E+00	36	1.0868E+00
37	1.0841E+00	38	1.2837E+00	39	1.2078E+00	40	1.1391E+00	41	1.0698E+00	42	1.0577E+00
43	8.4056E-01	44	8.2132E-01	45	1.0451E+00	46	1.0764E+00	47	1.1391E+00	48	1.1704E+00
49	1.2760E+00	50	1.0984E+00	51	1.0825E+00	52	1.2578E+00	53	1.1506E+00	54	1.0764E+00
55	8.1033E-01	56	7.7020E-01	57	7.4271E-01	58	0.0000E+00	59	7.4436E-01	60	7.9988E-01
61	8.1033E-01	62	1.0698E+00	63	1.1380E+00	64	1.2639E+00	65	1.0940E+00	66	1.0759E+00
67	1.2820E+00	68	1.1534E+00	69	1.0451E+00	70	7.9988E-01	71	0.0000E+00	72	7.0203E-01
73	6.9598E-01	74	7.1027E-01	75	7.2182E-01	76	0.0000E+00	77	7.7020E-01	78	1.0577E+00
79	1.1336E+00	80	1.2485E+00	81	1.0759E+00	82	1.0940E+00	83	1.2485E+00	84	1.1341E+00
85	8.2132E-01	86	7.4436E-01	87	7.2182E-01	88	6.7289E-01	89	6.5145E-01	90	6.6959E-01
91	8.1637E-01	92	6.7289E-01	93	7.0203E-01	94	7.4271E-01	95	8.4056E-01	96	1.1341E+00
97	1.2820E+00	98	1.0825E+00	99	1.0984E+00	100	1.2639E+00	101	1.1336E+00	102	8.4056E-01
103	0.0000E+00	104	7.1027E-01	105	8.1637E-01	106	6.4540E-01	107	0.0000E+00	108	6.6025E-01
109	6.4540E-01	110	6.5145E-01	111	6.9598E-01	112	0.0000E+00	113	8.2132E-01	114	1.1534E+00
115	1.2578E+00	116	1.0841E+00	117	1.0868E+00	118	1.2760E+00	119	1.1380E+00	120	1.0577E+00
121	7.4271E-01	122	6.9598E-01	123	6.6959E-01	124	6.6025E-01	125	6.6959E-01	126	6.8663E-01
127	6.6959E-01	128	0.0000E+00	129	6.6959E-01	130	7.1027E-01	131	7.4436E-01	132	1.0451E+00
133	1.1506E+00	134	1.2837E+00	135	1.1094E+00	136	1.1336E+00	137	1.3161E+00	138	1.1704E+00
139	1.0698E+00	140	7.7020E-01	141	7.0203E-01	142	6.5145E-01	143	0.0000E+00	144	6.8663E-01
145	7.2512E-01	146	7.2512E-01	147	6.8663E-01	148	6.6025E-01	149	8.1637E-01	150	7.2182E-01

151 7.9988E-01 152 1.0764E+00 153 1.2078E+00 154 1.3485E+00 155 1.1528E+00 156 1.1880E+00
157 1.3639E+00 158 1.2215E+00 159 1.1391E+00 160 8.1033E-01 161 0.0000E+00 162 6.7289E-01
163 6.4540E-01 164 6.6959E-01 165 7.2512E-01 166 0.0000E+00 167 7.2512E-01 168 6.6959E-01
169 6.4540E-01 170 6.7289E-01 171 0.0000E+00 172 8.1033E-01 173 1.1391E+00 174 1.2215E+00
175 1.3639E+00 176 1.1880E+00 177 1.1528E+00 178 1.3485E+00 179 1.2078E+00 180 1.0764E+00
181 7.9988E-01 182 7.2182E-01 183 8.1637E-01 184 6.6025E-01 185 6.8663E-01 186 7.2512E-01
187 7.2512E-01 188 6.8663E-01 189 0.0000E+00 190 6.5145E-01 191 7.0203E-01 192 7.7020E-01
193 1.0698E+00 194 1.1704E+00 195 1.3161E+00 196 1.1336E+00 197 1.1094E+00 198 1.2837E+00
199 1.1506E+00 200 1.0451E+00 201 7.4436E-01 202 7.1027E-01 203 6.6959E-01 204 0.0000E+00
205 6.6959E-01 206 6.8663E-01 207 6.6959E-01 208 6.6025E-01 209 6.6959E-01 210 6.9598E-01
211 7.4271E-01 212 1.0577E+00 213 1.1380E+00 214 1.2760E+00 215 1.0868E+00 216 1.0841E+00
217 1.2578E+00 218 1.1534E+00 219 8.2132E-01 220 0.0000E+00 221 6.9598E-01 222 6.5145E-01
223 6.4540E-01 224 6.6025E-01 225 0.0000E+00 226 6.4540E-01 227 8.1637E-01 228 7.1027E-01
229 0.0000E+00 230 8.4056E-01 231 1.1336E+00 232 1.2639E+00 233 1.0984E+00 234 1.0825E+00
235 1.2820E+00 236 1.1341E+00 237 8.4056E-01 238 7.4271E-01 239 7.0203E-01 240 6.7289E-01
241 8.1637E-01 242 6.6959E-01 243 6.5145E-01 244 6.7289E-01 245 7.2182E-01 246 7.4436E-01
247 8.2132E-01 248 1.1341E+00 249 1.2485E+00 250 1.0940E+00 251 1.0759E+00 252 1.2485E+00
253 1.1336E+00 254 1.0577E+00 255 7.7020E-01 256 0.0000E+00 257 7.2182E-01 258 7.1027E-01
259 6.9598E-01 260 7.0203E-01 261 0.0000E+00 262 7.9988E-01 263 1.0451E+00 264 1.1534E+00
265 1.2820E+00 266 1.0759E+00 267 1.0940E+00 268 1.2639E+00 269 1.1380E+00 270 1.0698E+00
271 8.1033E-01 272 7.9988E-01 273 7.4436E-01 274 0.0000E+00 275 7.4271E-01 276 7.7020E-01
277 8.1033E-01 278 1.0764E+00 279 1.1506E+00 280 1.2578E+00 281 1.0825E+00 282 1.0984E+00
283 1.2760E+00 284 1.1704E+00 285 1.1391E+00 286 1.0764E+00 287 1.0451E+00 288 8.2132E-01
289 8.4056E-01 290 1.0577E+00 291 1.0698E+00 292 1.1391E+00 293 1.2078E+00 294 1.2837E+00
295 1.0841E+00 296 1.0868E+00 297 1.3161E+00 298 1.2215E+00 299 1.2078E+00 300 1.1506E+00
301 1.1534E+00 302 1.1341E+00 303 1.1336E+00 304 1.1380E+00 305 1.1704E+00 306 1.2215E+00
307 1.3485E+00 308 1.1094E+00 309 1.1336E+00 310 1.3639E+00 311 1.3485E+00 312 1.2837E+00
313 1.2578E+00 314 1.2820E+00 315 1.2485E+00 316 1.2639E+00 317 1.2760E+00 318 1.3161E+00
319 1.3639E+00 320 1.1528E+00 321 1.1880E+00 322 1.1528E+00 323 1.1094E+00 324 1.0841E+00
325 1.0825E+00 326 1.0759E+00 327 1.0940E+00 328 1.0984E+00 329 1.0868E+00 330 1.1336E+00
331 1.1880E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4596E-01	3.2389E-01	1.3654E-01	5.3957E-01
29	1.3623E-01	3.2473E-01	1.3742E-01	5.3785E-01
72	1.2099E-01	3.2418E-01	1.3741E-01	5.3841E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.4243E-02	1.9366E-02	5.3453E-02
29	6.1844E-02	1.9747E-02	5.4774E-02
72	4.9935E-02	1.3697E-02	3.7889E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.13207E+01	3.30521E-04	1.01653E+02	6.54678E-04
	U-236	6.81398E+00	3.77830E-05	7.63429E-01	4.23315E-06
	Pu-238	3.43357E+01	6.10237E-06	7.28700E+00	1.29510E-06
	Pu-239	1.54511E+02	6.52086E-04	2.85684E+02	1.20568E-03
	Pu-240	1.06222E+02	2.37732E-04	1.84071E+00	4.11962E-06
	Pu-241	1.47360E+02	1.84507E-04	3.18454E+02	3.98732E-04
	Pu-242	2.69256E+01	2.08491E-05	1.42124E+00	1.10050E-06
	Xe-135	1.90430E+05	4.86476E-05	0.00000E+00	0.00000E+00
	Sm-149	5.79494E+03	1.81154E-05	0.00000E+00	0.00000E+00
	Total FP	8.62680E+00	3.52730E-04	0.00000E+00	0.00000E+00
29	U-235	3.95205E+01	2.89067E-04	7.73466E+01	5.65740E-04
	U-236	6.44737E+00	3.33251E-05	7.77772E-01	4.02014E-06
	Pu-238	2.59540E+01	5.96043E-06	6.73385E+00	1.54645E-06
	Pu-239	1.15480E+02	6.52269E-04	2.13068E+02	1.20348E-03
	Pu-240	8.64974E+01	2.00738E-04	1.91348E+00	4.44067E-06
	Pu-241	1.10936E+02	1.82107E-04	2.39776E+02	3.93603E-04
	Pu-242	2.54870E+01	1.96365E-05	1.48704E+00	1.14569E-06
	Xe-135	1.34707E+05	4.81502E-05	0.00000E+00	0.00000E+00
	Sm-149	4.12798E+03	1.90485E-05	0.00000E+00	0.00000E+00
	Total FP	7.83190E+00	3.10725E-04	0.00000E+00	0.00000E+00
72	U-235	3.28119E+01	1.84462E-04	6.35010E+01	3.56989E-04
	U-236	6.28524E+00	2.89074E-05	7.63207E-01	3.51018E-06
	Pu-238	2.10650E+01	3.39999E-06	6.42017E+00	1.03625E-06
	Pu-239	9.65452E+01	3.71326E-04	1.77071E+02	6.81037E-04

Pu-240	7.70875E+01	1.47608E-04	1.88973E+00	3.61846E-06
Pu-241	9.02305E+01	1.02821E-04	1.95060E+02	2.22278E-04
Pu-242	2.37808E+01	1.56617E-05	1.46424E+00	9.64332E-07
Xe-135	1.03415E+05	2.43060E-05	0.00000E+00	0.00000E+00
Sm-149	3.19689E+03	9.28315E-06	0.00000E+00	0.00000E+00
Total FP	6.32779E+00	2.17143E-04	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Power distribution by pin

1	1.1488E+00	2	1.0960E+00	3	1.0717E+00	4	1.0646E+00	5	1.0468E+00	6	1.0456E+00
7	1.0206E+00	8	1.0580E+00	9	1.0800E+00	10	1.1120E+00	11	1.1488E+00	12	1.1120E+00
13	1.3963E+00	14	1.3494E+00	15	1.3162E+00	16	1.2918E+00	17	1.2806E+00	18	1.2924E+00
19	1.3007E+00	20	1.3084E+00	21	1.3506E+00	22	1.3963E+00	23	1.0960E+00	24	1.0800E+00
25	1.3506E+00	26	1.2788E+00	27	1.2289E+00	28	1.1921E+00	29	1.1435E+00	30	1.1583E+00
31	1.1726E+00	32	1.1672E+00	33	1.2313E+00	34	1.2788E+00	35	1.3494E+00	36	1.0717E+00
37	1.0580E+00	38	1.3084E+00	39	1.2313E+00	40	1.1470E+00	41	1.1126E+00	42	1.0746E+00
43	7.8684E-01	44	8.3135E-01	45	1.0616E+00	46	1.0770E+00	47	1.1470E+00	48	1.2289E+00
49	1.3162E+00	50	1.0646E+00	51	1.0206E+00	52	1.3007E+00	53	1.1672E+00	54	1.0770E+00
55	8.2126E-01	56	7.7676E-01	57	7.3641E-01	58	0.0000E+00	59	7.4115E-01	60	7.6370E-01
61	8.2126E-01	62	1.1126E+00	63	1.1921E+00	64	1.2918E+00	65	1.0468E+00	66	1.0456E+00
67	1.2924E+00	68	1.1726E+00	69	1.0616E+00	70	7.6370E-01	71	0.0000E+00	72	6.9368E-01
73	6.8775E-01	74	6.9131E-01	75	7.0377E-01	76	0.0000E+00	77	7.7676E-01	78	1.0746E+00
79	1.1435E+00	80	1.2806E+00	81	1.0456E+00	82	1.0468E+00	83	1.2806E+00	84	1.1583E+00
85	8.3135E-01	86	7.4115E-01	87	7.0377E-01	88	6.6757E-01	89	6.5333E-01	90	6.3494E-01
91	8.1889E-01	92	6.6757E-01	93	6.9368E-01	94	7.3641E-01	95	7.8684E-01	96	1.1583E+00
97	1.2924E+00	98	1.0206E+00	99	1.0646E+00	100	1.2918E+00	101	1.1435E+00	102	7.8684E-01
103	0.0000E+00	104	6.9131E-01	105	8.1889E-01	106	6.4858E-01	107	0.0000E+00	108	6.4265E-01
109	6.4858E-01	110	6.5333E-01	111	6.8775E-01	112	0.0000E+00	113	8.3135E-01	114	1.1726E+00
115	1.3007E+00	116	1.0580E+00	117	1.0717E+00	118	1.3162E+00	119	1.1921E+00	120	1.0746E+00
121	7.3641E-01	122	6.8775E-01	123	6.3494E-01	124	6.4265E-01	125	6.5570E-01	126	6.7232E-01
127	6.5570E-01	128	0.0000E+00	129	6.3494E-01	130	6.9131E-01	131	7.4115E-01	132	1.0616E+00
133	1.1672E+00	134	1.3084E+00	135	1.0800E+00	136	1.0960E+00	137	1.3494E+00	138	1.2289E+00
139	1.1126E+00	140	7.7676E-01	141	6.9368E-01	142	6.5333E-01	143	0.0000E+00	144	6.7232E-01
145	6.9605E-01	146	6.9605E-01	147	6.7232E-01	148	6.4265E-01	149	8.1889E-01	150	7.0377E-01
151	7.6370E-01	152	1.0770E+00	153	1.2313E+00	154	1.3506E+00	155	1.1120E+00	156	1.1488E+00
157	1.3963E+00	158	1.2788E+00	159	1.1470E+00	160	8.2126E-01	161	0.0000E+00	162	6.6757E-01
163	6.4858E-01	164	6.5570E-01	165	6.9605E-01	166	0.0000E+00	167	6.9605E-01	168	6.5570E-01
169	6.4858E-01	170	6.6757E-01	171	0.0000E+00	172	8.2126E-01	173	1.1470E+00	174	1.2788E+00
175	1.3963E+00	176	1.1488E+00	177	1.1120E+00	178	1.3506E+00	179	1.2313E+00	180	1.0770E+00
181	7.6370E-01	182	7.0377E-01	183	8.1889E-01	184	6.4265E-01	185	6.7232E-01	186	6.9605E-01
187	6.9605E-01	188	6.7232E-01	189	0.0000E+00	190	6.5333E-01	191	6.9368E-01	192	7.7676E-01
193	1.1126E+00	194	1.2289E+00	195	1.3494E+00	196	1.0960E+00	197	1.0800E+00	198	1.3084E+00
199	1.1672E+00	200	1.0616E+00	201	7.4115E-01	202	6.9131E-01	203	6.3494E-01	204	0.0000E+00
205	6.5570E-01	206	6.7232E-01	207	6.5570E-01	208	6.4265E-01	209	6.3494E-01	210	6.8775E-01
211	7.3641E-01	212	1.0746E+00	213	1.1921E+00	214	1.3162E+00	215	1.0717E+00	216	1.0580E+00
217	1.3007E+00	218	1.1726E+00	219	8.3135E-01	220	0.0000E+00	221	6.8775E-01	222	6.5333E-01
223	6.4858E-01	224	6.4265E-01	225	0.0000E+00	226	6.4858E-01	227	8.1889E-01	228	6.9131E-01
229	0.0000E+00	230	7.8684E-01	231	1.1435E+00	232	1.2918E+00	233	1.0646E+00	234	1.0206E+00
235	1.2924E+00	236	1.1583E+00	237	7.8684E-01	238	7.3641E-01	239	6.9368E-01	240	6.6757E-01
241	8.1889E-01	242	6.3494E-01	243	6.5333E-01	244	6.6757E-01	245	7.0377E-01	246	7.4115E-01
247	8.3135E-01	248	1.1583E+00	249	1.2806E+00	250	1.0468E+00	251	1.0456E+00	252	1.2806E+00
253	1.1435E+00	254	1.0746E+00	255	7.7676E-01	256	0.0000E+00	257	7.0377E-01	258	6.9131E-01
259	6.8775E-01	260	6.9368E-01	261	0.0000E+00	262	7.6370E-01	263	1.0616E+00	264	1.1726E+00
265	1.2924E+00	266	1.0456E+00	267	1.0468E+00	268	1.2918E+00	269	1.1921E+00	270	1.1126E+00
271	8.2126E-01	272	7.6370E-01	273	7.4115E-01	274	0.0000E+00	275	7.3641E-01	276	7.7676E-01
277	8.2126E-01	278	1.0770E+00	279	1.1672E+00	280	1.3007E+00	281	1.0206E+00	282	1.0646E+00
283	1.3162E+00	284	1.2289E+00	285	1.1470E+00	286	1.0770E+00	287	1.0616E+00	288	8.3135E-01
289	7.8684E-01	290	1.0746E+00	291	1.1126E+00	292	1.1470E+00	293	1.2313E+00	294	1.3084E+00
295	1.0580E+00	296	1.0717E+00	297	1.3494E+00	298	1.2788E+00	299	1.2313E+00	300	1.1672E+00
301	1.1726E+00	302	1.1583E+00	303	1.1435E+00	304	1.1921E+00	305	1.2289E+00	306	1.2788E+00
307	1.3506E+00	308	1.0800E+00	309	1.0960E+00	310	1.3963E+00	311	1.3506E+00	312	1.3084E+00
313	1.3007E+00	314	1.2924E+00	315	1.2806E+00	316	1.2918E+00	317	1.3162E+00	318	1.3494E+00
319	1.3963E+00	320	1.1120E+00	321	1.1488E+00	322	1.1120E+00	323	1.0800E+00	324	1.0580E+00
325	1.0206E+00	326	1.0456E+00	327	1.0468E+00	328	1.0646E+00	329	1.0717E+00	330	1.0960E+00
331	1.1488E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.4733E-01	3.2268E-01	1.3673E-01	5.4059E-01
29	1.3762E-01	3.2464E-01	1.3635E-01	5.3901E-01
72	1.2141E-01	3.2376E-01	1.3719E-01	5.3905E-01

Variant 11
State 2

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.2502E-02	1.6756E-02	4.7128E-02
29	6.2109E-02	1.8112E-02	5.1074E-02
72	4.9609E-02	1.2184E-02	3.4288E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	5.29483E+01	1.80223E-04	1.04948E+02	3.57218E-04
	U-236	6.68434E+00	3.85245E-05	7.45358E-01	4.29579E-06
	Pu-238	3.56116E+01	9.76038E-06	7.36866E+00	2.01959E-06
	Pu-239	1.57205E+02	6.39977E-04	2.91161E+02	1.18531E-03
	Pu-240	1.01991E+02	2.52544E-04	1.80552E+00	4.47070E-06
	Pu-241	1.51069E+02	2.01260E-04	3.26464E+02	4.34929E-04
	Pu-242	2.50098E+01	2.93158E-05	1.39211E+00	1.63179E-06
	Xe-135	2.00274E+05	4.39499E-05	0.00000E+00	0.00000E+00
	Sm-149	6.07066E+03	1.66872E-05	0.00000E+00	0.00000E+00
	Total FP	8.00025E+00	3.88222E-04	0.00000E+00	0.00000E+00
29	U-235	4.04379E+01	1.71309E-04	7.92551E+01	3.35753E-04
	U-236	6.50983E+00	3.50563E-05	7.81844E-01	4.21034E-06
	Pu-238	2.66451E+01	9.88331E-06	6.78727E+00	2.51756E-06
	Pu-239	1.17522E+02	6.66211E-04	2.17091E+02	1.23065E-03
	Pu-240	8.71632E+01	2.31180E-04	1.91366E+00	5.07555E-06
	Pu-241	1.12955E+02	2.07831E-04	2.44347E+02	4.49586E-04
	Pu-242	2.48040E+01	2.91093E-05	1.48748E+00	1.74566E-06
	Xe-135	1.40061E+05	4.62040E-05	0.00000E+00	0.00000E+00
	Sm-149	4.29107E+03	1.85899E-05	0.00000E+00	0.00000E+00
	Total FP	7.31502E+00	3.55878E-04	0.00000E+00	0.00000E+00
72	U-235	3.41634E+01	1.03354E-04	6.62287E+01	2.00360E-04
	U-236	6.28099E+00	2.99050E-05	7.68046E-01	3.65682E-06
	Pu-238	2.20798E+01	5.53051E-06	6.49014E+00	1.62564E-06
	Pu-239	9.82473E+01	3.65403E-04	1.80713E+02	6.72110E-04
	Pu-240	7.80747E+01	1.65851E-04	1.90446E+00	4.04557E-06
	Pu-241	9.40870E+01	1.14743E-04	2.03587E+02	2.48284E-04
	Pu-242	2.27019E+01	2.25529E-05	1.48049E+00	1.47077E-06
	Xe-135	1.10005E+05	2.24538E-05	0.00000E+00	0.00000E+00
	Sm-149	3.38923E+03	8.73522E-06	0.00000E+00	0.00000E+00
	Total FP	6.02689E+00	2.46484E-04	0.00000E+00	0.00000E+00

VARIANT 11, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1238	1.3310	.0014
10.00	1.0345	1.2258	.0016
10.00	1.0345	1.2258	.0016
20.00	.9599	1.1343	.0013
30.00	.8916	1.0560	.0012
40.00	.8315	.9835	.0012
50.00	.7767	.9205	.0012
60.00	.7239	.8577	.0012

VARIANT 11, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1105	1.3143	.0015
10.00	.9865	1.1680	.0014
10.00	.9865	1.1680	.0014
20.00	.9107	1.0795	.0012
30.00	.8465	1.0026	.0013
40.00	.7891	.9331	.0012
50.00	.7367	.8716	.0010
60.00	.6810	.8076	.0010

VARIANT 11, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1230	1.3294	.0016
10.00	.9993	1.1825	.0013
10.00	.9993	1.1825	.0013
20.00	.9236	1.0950	.0013
30.00	.8591	1.0175	.0011
40.00	.8001	.9482	.0012
50.00	.7452	.8837	.0011
60.00	.6905	.8194	.0011

VARIANT 11, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.2151	1.3629	.0013
10.00	1.0852	1.2173	.0013
10.00	1.0852	1.2173	.0013
20.00	1.0065	1.1289	.0012
30.00	.9308	1.0454	.0012
40.00	.8616	.9663	.0010
50.00	.7952	.8924	.0009
60.00	.7266	.8168	.0009

Variant 12
State 1

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
.00	1.0429	1.2285	.0007	u-235	3.8393E-05	3.8393E-05	3.8393E-05
				u-236	0.0000E+00	0.0000E+00	0.0000E+00
				pu-238	0.0000E+00	0.0000E+00	0.0000E+00
				pu-239	6.5875E-04	6.5875E-04	6.5875E-04
				pu-240	4.2323E-05	4.2323E-05	4.2323E-05
				pu-241	7.0246E-06	7.0246E-06	7.0246E-06
				pu-242	0.0000E+00	0.0000E+00	0.0000E+00
				xe-135	9.4581E-09	9.4581E-09	9.4581E-09
				sm-149	7.3667E-08	7.3667E-08	7.3667E-08
				Total FP	8.3125E-08	8.3125E-08	8.3125E-08
2.00	1.0017	1.1811	.0013	u-235	3.6966E-05	3.7072E-05	3.7005E-05
				u-236	3.0491E-07	3.0246E-07	3.0227E-07
				pu-238	2.1665E-09	2.4030E-09	2.1659E-09
				pu-239	6.1734E-04	6.2666E-04	6.2044E-04
				pu-240	5.7451E-05	5.4786E-05	5.6548E-05
				pu-241	1.2171E-05	1.2529E-05	1.2215E-05
				pu-242	2.4280E-07	2.1815E-07	2.3336E-07
				xe-135	1.6369E-08	1.6910E-08	1.6407E-08
				sm-149	1.4601E-07	1.6235E-07	1.4929E-07
				Total FP	4.4797E-05	3.9984E-05	4.3003E-05
4.00	.9843	1.1569	.0015	u-235	3.5553E-05	3.5757E-05	3.5610E-05
				u-236	6.0205E-07	6.0060E-07	6.0153E-07
				pu-238	7.8510E-09	8.8886E-09	7.9679E-09
				pu-239	5.7781E-04	5.9597E-04	5.8322E-04
				pu-240	7.0976E-05	6.6030E-05	6.9504E-05
				pu-241	1.7730E-05	1.8483E-05	1.7886E-05
				pu-242	6.2658E-07	5.6732E-07	6.0851E-07
				xe-135	1.5734E-08	1.6736E-08	1.5955E-08
				sm-149	1.4847E-07	1.7516E-07	1.5358E-07
				Total FP	8.7894E-05	7.9081E-05	8.5173E-05
6.00	.9640	1.1341	.0013	u-235	3.4137E-05	3.4449E-05	3.4232E-05
				u-236	8.9479E-07	8.9252E-07	8.9199E-07
				pu-238	1.7892E-08	2.0324E-08	1.8116E-08
				pu-239	5.3964E-04	5.6640E-04	5.4773E-04
				pu-240	8.3219E-05	7.6227E-05	8.1099E-05
				pu-241	2.3529E-05	2.4622E-05	2.3706E-05
				pu-242	1.1716E-06	1.0587E-06	1.1327E-06
				xe-135	1.5180E-08	1.6416E-08	1.5388E-08
				sm-149	1.4742E-07	1.7851E-07	1.5351E-07
				Total FP	1.3016E-04	1.1757E-04	1.2604E-04
8.00	.9455	1.1137	.0013	u-235	3.2732E-05	3.3145E-05	3.2857E-05
				u-236	1.1800E-06	1.1786E-06	1.1768E-06
				pu-238	3.3170E-08	3.7786E-08	3.3632E-08
				pu-239	5.0324E-04	5.3786E-04	5.1356E-04
				pu-240	9.4150E-05	8.5485E-05	9.1567E-05
				pu-241	2.9343E-05	3.0826E-05	2.9587E-05
				pu-242	1.8845E-06	1.7010E-06	1.8208E-06
				xe-135	1.4586E-08	1.6118E-08	1.4908E-08
				sm-149	1.4571E-07	1.8049E-07	1.5270E-07
				Total FP	1.7133E-04	1.5572E-04	1.6626E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
10.00	.9288	1.0953	.0007	u-235	3.1332E-05	3.1854E-05	3.1498E-05
				u-236	1.4589E-06	1.4568E-06	1.4532E-06
				pu-238	5.4789E-08	6.2368E-08	5.5479E-08
				pu-239	4.6845E-04	5.1052E-04	4.8103E-04
				pu-240	1.0389E-04	9.3810E-05	1.0088E-04
				pu-241	3.5070E-05	3.6954E-05	3.5353E-05
				pu-242	2.7761E-06	2.4948E-06	2.6727E-06
				xe-135	1.4032E-08	1.5786E-08	1.4388E-08
				sm-149	1.4350E-07	1.8165E-07	1.5126E-07
				Total FP	2.1171E-04	1.9338E-04	2.0554E-04
12.00	.9145	1.0784	.0013	u-235	2.9944E-05	3.0576E-05	3.0142E-05
				u-236	1.7302E-06	1.7269E-06	1.7237E-06
				pu-238	8.3846E-08	9.5283E-08	8.4949E-08
				pu-239	4.3541E-04	4.8437E-04	4.4985E-04
				pu-240	1.1245E-04	1.0125E-04	1.0918E-04

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				pu-241	4.0583E-05	4.2921E-05	4.0965E-05
				pu-242	3.8486E-06	3.4410E-06	3.7010E-06
				xe-135	1.3475E-08	1.5462E-08	1.3931E-08
				sm-149	1.4084E-07	1.8210E-07	1.4941E-07
				Total FP	2.5124E-04	2.3063E-04	2.4439E-04
14.00	.9001	1.0607	.0013	u-235	2.8577E-05	2.9310E-05	2.8803E-05
				u-236	1.9922E-06	1.9894E-06	1.9855E-06
				pu-238	1.2135E-07	1.3786E-07	1.2309E-07
				pu-239	4.0433E-04	4.5935E-04	4.2032E-04
				pu-240	1.1985E-04	1.0787E-04	1.1642E-04
				pu-241	4.5767E-05	4.8675E-05	4.6289E-05
				pu-242	5.0961E-06	4.5419E-06	4.8986E-06
				xe-135	1.2910E-08	1.5160E-08	1.3439E-08
				sm-149	1.3777E-07	1.8200E-07	1.4707E-07
				Total FP	2.8973E-04	2.6764E-04	2.8248E-04
16.00	.8891	1.0468	.0012	u-235	2.7215E-05	2.8062E-05	2.7480E-05
				u-236	2.2479E-06	2.2427E-06	2.2391E-06
				pu-238	1.6868E-07	1.9125E-07	1.7107E-07
				pu-239	3.7484E-04	4.3558E-04	3.9238E-04
				pu-240	1.2621E-04	1.1368E-04	1.2267E-04
				pu-241	5.0620E-05	5.4131E-05	5.1274E-05
				pu-242	6.5334E-06	5.7900E-06	6.2665E-06
				xe-135	1.2411E-08	1.4834E-08	1.2970E-08
				sm-149	1.3457E-07	1.8135E-07	1.4442E-07
				Total FP	3.2773E-04	3.0425E-04	3.1994E-04
18.00	.8740	1.0304	.0013	u-235	2.5881E-05	2.6822E-05	2.6180E-05
				u-236	2.4932E-06	2.4890E-06	2.4831E-06
				pu-238	2.2657E-07	2.5700E-07	2.2984E-07
				pu-239	3.4738E-04	4.1283E-04	3.6614E-04
				pu-240	1.3149E-04	1.1876E-04	1.2795E-04
				pu-241	5.5010E-05	5.9300E-05	5.5849E-05
				pu-242	8.1361E-06	7.1957E-06	7.7948E-06
				xe-135	1.1870E-08	1.4570E-08	1.2497E-08
				sm-149	1.3100E-07	1.8041E-07	1.4146E-07
				Total FP	3.6466E-04	3.4090E-04	3.5663E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
20.00	.8628	1.0167	.0006	u-235	2.4555E-05	2.5610E-05	2.4894E-05
				u-236	2.7317E-06	2.7243E-06	2.7190E-06
				pu-238	2.9634E-07	3.3577E-07	3.0056E-07
				pu-239	3.2151E-04	3.9144E-04	3.4142E-04
				pu-240	1.3581E-04	1.2307E-04	1.3233E-04
				pu-241	5.8974E-05	6.4059E-05	6.0008E-05
				pu-242	9.9247E-06	8.7328E-06	9.4894E-06
				xe-135	1.1403E-08	1.4225E-08	1.2064E-08
				sm-149	1.2748E-07	1.7887E-07	1.3838E-07
				Total FP	4.0119E-04	3.7699E-04	3.9285E-04
22.00	.8509	1.0024	.0013	u-235	2.3263E-05	2.4412E-05	2.3631E-05
				u-236	2.9589E-06	2.9512E-06	2.9455E-06
				pu-238	3.7830E-07	4.2890E-07	3.8395E-07
				pu-239	2.9769E-04	3.7115E-04	3.1834E-04
				pu-240	1.3914E-04	1.2670E-04	1.3584E-04
				pu-241	6.2403E-05	6.8442E-05	6.3698E-05
				pu-242	1.1859E-05	1.0412E-05	1.1336E-05
				xe-135	1.0892E-08	1.3947E-08	1.1623E-08
				sm-149	1.2365E-07	1.7719E-07	1.3507E-07
				Total FP	4.3661E-04	4.1300E-04	4.2842E-04
24.00	.8374	.9877	.0014	u-235	2.2002E-05	2.3238E-05	2.2385E-05
				u-236	3.1755E-06	3.1680E-06	3.1636E-06
				pu-238	4.7294E-07	5.3705E-07	4.8090E-07
				pu-239	2.7577E-04	3.5208E-04	2.9674E-04
				pu-240	1.4156E-04	1.2966E-04	1.3853E-04
				pu-241	6.5304E-05	7.2395E-05	6.6924E-05
				pu-242	1.3933E-05	1.2217E-05	1.3338E-05
				xe-135	1.0417E-08	1.3641E-08	1.1218E-08
				sm-149	1.1983E-07	1.7514E-07	1.3175E-07
				Total FP	4.7109E-04	4.4871E-04	4.6361E-04
26.00	.8281	.9757	.0012	u-235	2.0760E-05	2.2082E-05	2.1173E-05

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State 1

				u-236	3.3837E-06	3.3758E-06	3.3706E-06
				pu-238	5.8093E-07	6.6112E-07	5.9145E-07
				pu-239	2.5547E-04	3.3410E-04	2.7685E-04
				pu-240	1.4315E-04	1.3200E-04	1.4042E-04
				pu-241	6.7709E-05	7.5929E-05	6.9632E-05
				pu-242	1.6158E-05	1.4150E-05	1.5461E-05
				xe-135	9.9935E-09	1.3368E-08	1.0787E-08
				sm-149	1.1615E-07	1.7297E-07	1.2820E-07
				Total FP	5.0506E-04	4.8436E-04	4.9795E-04
28.00	.8174	.9624	.0012	u-235	1.9545E-05	2.0948E-05	1.9988E-05
				u-236	3.5823E-06	3.5738E-06	3.5677E-06
				pu-238	7.0236E-07	8.0156E-07	7.1590E-07
				pu-239	2.3684E-04	3.1724E-04	2.5849E-04
				pu-240	1.4396E-04	1.3374E-04	1.4158E-04
				pu-241	6.9602E-05	7.9024E-05	7.1847E-05
				pu-242	1.8514E-05	1.6200E-05	1.7707E-05
				xe-135	9.5738E-09	1.3088E-08	1.0392E-08
				sm-149	1.1241E-07	1.7060E-07	1.2469E-07
				Total FP	5.3838E-04	5.1986E-04	5.3172E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
30.00	.8070	.9514	.0006	u-235	1.8362E-05	1.9841E-05	1.8826E-05
				u-236	3.7705E-06	3.7612E-06	3.7556E-06
				pu-238	8.3697E-07	9.5844E-07	8.5439E-07
				pu-239	2.1988E-04	3.0152E-04	2.4153E-04
				pu-240	1.4404E-04	1.3491E-04	1.4206E-04
				pu-241	7.0988E-05	8.1666E-05	7.3585E-05
				pu-242	2.0978E-05	1.8350E-05	2.0074E-05
				xe-135	9.1667E-09	1.2799E-08	1.0025E-08
				sm-149	1.0870E-07	1.6800E-07	1.2125E-07
				Total FP	5.7095E-04	5.5511E-04	5.6511E-04
32.00	.7964	.9390	.0012	u-235	1.7219E-05	1.8762E-05	1.7698E-05
				u-236	3.9473E-06	3.9378E-06	3.9328E-06
				pu-238	9.8407E-07	1.1316E-06	1.0064E-06
				pu-239	2.0458E-04	2.8691E-04	2.2604E-04
				pu-240	1.4346E-04	1.3556E-04	1.4191E-04
				pu-241	7.1885E-05	8.3860E-05	7.4843E-05
				pu-242	2.3522E-05	2.0588E-05	2.2531E-05
				xe-135	8.7719E-09	1.2515E-08	9.6537E-09
				sm-149	1.0502E-07	1.6528E-07	1.1774E-07
				Total FP	6.0262E-04	5.9010E-04	5.9785E-04
34.00	.7864	.9284	.0013	u-235	1.6115E-05	1.7710E-05	1.6602E-05
				u-236	4.1130E-06	4.1039E-06	4.0996E-06
				pu-238	1.1428E-06	1.3208E-06	1.1714E-06
				pu-239	1.9082E-04	2.7335E-04	2.1192E-04
				pu-240	1.4229E-04	1.3573E-04	1.4118E-04
				pu-241	7.2330E-05	8.5619E-05	7.5647E-05
				pu-242	2.6132E-05	2.2907E-05	2.5070E-05
				xe-135	8.4037E-09	1.2244E-08	9.3045E-09
				sm-149	1.0148E-07	1.6249E-07	1.1430E-07
				Total FP	6.3348E-04	6.2491E-04	6.3005E-04
36.00	.7758	.9158	.0011	u-235	1.5047E-05	1.6683E-05	1.5544E-05
				u-236	4.2682E-06	4.2598E-06	4.2552E-06
				pu-238	1.3123E-06	1.5257E-06	1.3483E-06
				pu-239	1.7844E-04	2.6076E-04	1.9915E-04
				pu-240	1.4060E-04	1.3545E-04	1.3994E-04
				pu-241	7.2361E-05	8.6963E-05	7.6020E-05
				pu-242	2.8800E-05	2.5303E-05	2.7663E-05
				xe-135	8.0648E-09	1.1990E-08	8.9622E-09
				sm-149	9.8093E-08	1.5969E-07	1.1087E-07
				Total FP	6.6370E-04	6.5968E-04	6.6156E-04
38.00	.7683	.9069	.0011	u-235	1.4023E-05	1.5694E-05	1.4511E-05
				u-236	4.4120E-06	4.4036E-06	4.4016E-06
				pu-238	1.4911E-06	1.7449E-06	1.5363E-06
				pu-239	1.6741E-04	2.4922E-04	1.8749E-04
				pu-240	1.3847E-04	1.3478E-04	1.3823E-04
				pu-241	7.2014E-05	8.7890E-05	7.6003E-05
				pu-242	3.1492E-05	2.7735E-05	3.0330E-05
				xe-135	7.7352E-09	1.1702E-08	8.6649E-09

				sm-149	9.4769E-08	1.5665E-07	1.0769E-07
				Total FP	6.9309E-04	6.9395E-04	6.9291E-04
Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
40.00	.7580	.8946	.0006	u-235	1.3028E-05	1.4734E-05	1.3530E-05
				u-236	4.5465E-06	4.5369E-06	4.5353E-06
				pu-238	1.6779E-06	1.9775E-06	1.7336E-06
				pu-239	1.5747E-04	2.3857E-04	1.7713E-04
				pu-240	1.3593E-04	1.3375E-04	1.3615E-04
				pu-241	7.1330E-05	8.8438E-05	7.5619E-05
				pu-242	3.4234E-05	3.0215E-05	3.2991E-05
				xe-135	7.4507E-09	1.1455E-08	8.3347E-09
				sm-149	9.1720E-08	1.5372E-07	1.0431E-07
				Total FP	7.2221E-04	7.2813E-04	7.2325E-04
42.00	.7493	.8844	.0012	u-235	1.2079E-05	1.3807E-05	1.2581E-05
				u-236	4.6696E-06	4.6591E-06	4.6590E-06
				pu-238	1.8712E-06	2.2221E-06	1.9386E-06
				pu-239	1.4868E-04	2.2880E-04	1.6777E-04
				pu-240	1.3308E-04	1.3240E-04	1.3372E-04
				pu-241	7.0350E-05	8.8630E-05	7.4914E-05
				pu-242	3.6966E-05	3.2720E-05	3.5680E-05
				xe-135	7.1592E-09	1.1203E-08	8.0591E-09
				sm-149	8.8653E-08	1.5076E-07	1.0126E-07
				Total FP	7.5056E-04	7.6207E-04	7.5328E-04
44.00	.7425	.8759	.0010	u-235	1.1176E-05	1.2916E-05	1.1669E-05
				u-236	4.7815E-06	4.7701E-06	4.7723E-06
				pu-238	2.0690E-06	2.4771E-06	2.1496E-06
				pu-239	1.4092E-04	2.1987E-04	1.5936E-04
				pu-240	1.2998E-04	1.3078E-04	1.3100E-04
				pu-241	6.9120E-05	8.8492E-05	7.3923E-05
				pu-242	3.9673E-05	3.5233E-05	3.8375E-05
				xe-135	6.8887E-09	1.0952E-08	7.7922E-09
				sm-149	8.5739E-08	1.4775E-07	9.8278E-08
				Total FP	7.7822E-04	7.9571E-04	7.8292E-04
46.00	.7332	.8651	.0011	u-235	1.0315E-05	1.2061E-05	1.0797E-05
				u-236	4.8829E-06	4.8700E-06	4.8748E-06
				pu-238	2.2692E-06	2.7405E-06	2.3648E-06
				pu-239	1.3406E-04	2.1171E-04	1.5185E-04
				pu-240	1.2668E-04	1.2893E-04	1.2805E-04
				pu-241	6.7680E-05	8.8056E-05	7.2685E-05
				pu-242	4.2351E-05	3.7740E-05	4.1053E-05
				xe-135	6.6414E-09	1.0709E-08	7.5346E-09
				sm-149	8.2997E-08	1.4476E-07	9.5371E-08
				Total FP	8.0532E-04	8.2905E-04	8.1210E-04
48.00	.7240	.8556	.0011	u-235	9.4969E-06	1.1239E-05	9.9709E-06
				u-236	4.9739E-06	4.9592E-06	4.9661E-06
				pu-238	2.4698E-06	3.0105E-06	2.5820E-06
				pu-239	1.2801E-04	2.0424E-04	1.4520E-04
				pu-240	1.2323E-04	1.2689E-04	1.2494E-04
				pu-241	6.6071E-05	8.7352E-05	7.1246E-05
				pu-242	4.4985E-05	4.0239E-05	4.3680E-05
				xe-135	6.4107E-09	1.0484E-08	7.2820E-09
				sm-149	8.0391E-08	1.4185E-07	9.2521E-08
				Total FP	8.3191E-04	8.6226E-04	8.4060E-04
Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
50.00	.7186	.8476	.0005	u-235	8.7223E-06	1.0454E-05	9.1874E-06
				u-236	5.0546E-06	5.0376E-06	5.0469E-06
				pu-238	2.6689E-06	3.2851E-06	2.7990E-06
				pu-239	1.2268E-04	1.9744E-04	1.3929E-04
				pu-240	1.1968E-04	1.2470E-04	1.2171E-04
				pu-241	6.4331E-05	8.6414E-05	6.9644E-05
				pu-242	4.7561E-05	4.2707E-05	4.6255E-05
				xe-135	6.1946E-09	1.0254E-08	7.0512E-09
				sm-149	7.7913E-08	1.3893E-07	8.9835E-08
				Total FP	8.5800E-04	8.9516E-04	8.6860E-04
52.00	.7104	.8377	.0012	u-235	7.9902E-06	9.7056E-06	8.4447E-06

				u-236	5.1252E-06	5.1053E-06	5.1175E-06
				pu-238	2.8644E-06	3.5620E-06	3.0136E-06
				pu-239	1.1799E-04	1.9124E-04	1.3403E-04
				pu-240	1.1608E-04	1.2239E-04	1.1840E-04
				pu-241	6.2494E-05	8.5274E-05	6.7913E-05
				pu-242	5.0069E-05	4.5134E-05	4.8771E-05
				xe-135	5.9944E-09	1.0033E-08	6.8370E-09
				sm-149	7.5573E-08	1.3605E-07	8.7285E-08
				Total FP	8.8364E-04	9.2777E-04	8.9618E-04
54.00	.7033	.8307	.0011	u-235	7.3002E-06	8.9894E-06	7.7488E-06
				u-236	5.1860E-06	5.1630E-06	5.1776E-06
				pu-238	3.0544E-06	3.8390E-06	3.2242E-06
				pu-239	1.1385E-04	1.8556E-04	1.2938E-04
				pu-240	1.1247E-04	1.1998E-04	1.1508E-04
				pu-241	6.0592E-05	8.3958E-05	6.6099E-05
				pu-242	5.2500E-05	4.7524E-05	5.1195E-05
				xe-135	5.8079E-09	9.8340E-09	6.6252E-09
				sm-149	7.3359E-08	1.3332E-07	8.4791E-08
				Total FP	9.0888E-04	9.6032E-04	9.2310E-04
56.00	.6957	.8219	.0012	u-235	6.6549E-06	8.3127E-06	7.0924E-06
				u-236	5.2370E-06	5.2103E-06	5.2282E-06
				pu-238	3.2374E-06	4.1142E-06	3.4282E-06
				pu-239	1.1021E-04	1.8041E-04	1.2524E-04
				pu-240	1.0890E-04	1.1753E-04	1.1176E-04
				pu-241	5.8662E-05	8.2505E-05	6.4221E-05
				pu-242	5.4834E-05	4.9843E-05	5.3542E-05
				xe-135	5.6296E-09	9.6185E-09	6.4381E-09
				sm-149	7.1236E-08	1.3051E-07	8.2488E-08
				Total FP	9.3361E-04	9.9246E-04	9.4966E-04
58.00	.6913	.8161	.0010	u-235	6.0515E-06	7.6725E-06	6.4726E-06
				u-236	5.2787E-06	5.2477E-06	5.2696E-06
				pu-238	3.4114E-06	4.3851E-06	3.6236E-06
				pu-239	1.0700E-04	1.7571E-04	1.2153E-04
				pu-240	1.0539E-04	1.1506E-04	1.0845E-04
				pu-241	5.6724E-05	8.0942E-05	6.2301E-05
				pu-242	5.7071E-05	5.2091E-05	5.5812E-05
				xe-135	5.4666E-09	9.4186E-09	6.2666E-09
				sm-149	6.9252E-08	1.2782E-07	8.0326E-08
				Total FP	9.5793E-04	1.0243E-03	9.7603E-04

Burnup (MWd/kgU)	k-eff	k-0	1 sigma	Nuclide	Number Density (per barn-cm**2) Pin 1	Pin 23	Pin 72
60.00	.6825	.8068	.0005	u-235	5.4915E-06	7.0682E-06	5.9002E-06
				u-236	5.3114E-06	5.2756E-06	5.3015E-06
				pu-238	3.5752E-06	4.6497E-06	3.8104E-06
				pu-239	1.0417E-04	1.7141E-04	1.1826E-04
				pu-240	1.0198E-04	1.1259E-04	1.0524E-04
				pu-241	5.4809E-05	7.9296E-05	6.0393E-05
				pu-242	5.9196E-05	5.4261E-05	5.7957E-05
				xe-135	5.3110E-09	9.2271E-09	6.0851E-09
				sm-149	6.7356E-08	1.2521E-07	7.8141E-08
				Total FP	9.8176E-04	1.0559E-03	1.0016E-03

Additional data

Burnup = 0 MWd/kgU

Power distribution by pin

1	1.1085E+00	2	1.0601E+00	3	1.0538E+00	4	1.0463E+00	5	1.0487E+00	6	1.0430E+00
7	1.0514E+00	8	1.0451E+00	9	1.0622E+00	10	1.0565E+00	11	1.1085E+00	12	1.0565E+00
13	9.8141E-01	14	9.6197E-01	15	9.5479E-01	16	9.5838E-01	17	9.5449E-01	18	9.5957E-01
19	9.6286E-01	20	9.5778E-01	21	9.5927E-01	22	9.8141E-01	23	1.0601E+00	24	1.0622E+00
25	9.5927E-01	26	9.4492E-01	27	9.3325E-01	28	9.2697E-01	29	9.3923E-01	30	9.4222E-01
31	9.3355E-01	32	9.2876E-01	33	9.3564E-01	34	9.4492E-01	35	9.6197E-01	36	1.0538E+00
37	1.0451E+00	38	9.5778E-01	39	9.3564E-01	40	9.2876E-01	41	9.4312E-01	42	9.4462E-01
43	9.9337E-01	44	1.0041E+00	45	9.4372E-01	46	9.4192E-01	47	9.2876E-01	48	9.3325E-01
49	9.5479E-01	50	1.0463E+00	51	1.0514E+00	52	9.6286E-01	53	9.2876E-01	54	9.4192E-01

55	9.9128E-01	56	1.0191E+00	57	1.0092E+00	58	0.0000E+00	59	1.0104E+00	60	9.9726E-01
61	9.9128E-01	62	9.4312E-01	63	9.2697E-01	64	9.5838E-01	65	1.0487E+00	66	1.0430E+00
67	9.5957E-01	68	9.3355E-01	69	9.4372E-01	70	9.9726E-01	71	0.0000E+00	72	1.0406E+00
73	1.0317E+00	74	1.0308E+00	75	1.0329E+00	76	0.0000E+00	77	1.0191E+00	78	9.4462E-01
79	9.3923E-01	80	9.5449E-01	81	1.0430E+00	82	1.0487E+00	83	9.5449E-01	84	9.4222E-01
85	1.0041E+00	86	1.0104E+00	87	1.0329E+00	88	1.0323E+00	89	1.0427E+00	90	1.0487E+00
91	1.0012E+00	92	1.0323E+00	93	1.0406E+00	94	1.0092E+00	95	9.9337E-01	96	9.4222E-01
97	9.5957E-01	98	1.0514E+00	99	1.0463E+00	100	9.5838E-01	101	9.3923E-01	102	9.9337E-01
103	0.0000E+00	104	1.0308E+00	105	1.0012E+00	106	1.0478E+00	107	0.0000E+00	108	1.0526E+00
109	1.0478E+00	110	1.0427E+00	111	1.0317E+00	112	0.0000E+00	113	1.0041E+00	114	9.3355E-01
115	9.6286E-01	116	1.0451E+00	117	1.0538E+00	118	9.5479E-01	119	9.2697E-01	120	9.4462E-01
121	1.0092E+00	122	1.0317E+00	123	1.0487E+00	124	1.0526E+00	125	1.0574E+00	126	1.0702E+00
127	1.0574E+00	128	0.0000E+00	129	1.0487E+00	130	1.0308E+00	131	1.0104E+00	132	9.4372E-01
133	9.2876E-01	134	9.5778E-01	135	1.0622E+00	136	1.0601E+00	137	9.6197E-01	138	9.3325E-01
139	9.4312E-01	140	1.0191E+00	141	1.0406E+00	142	1.0427E+00	143	0.0000E+00	144	1.0702E+00
145	1.0735E+00	146	1.0735E+00	147	1.0702E+00	148	1.0526E+00	149	1.0012E+00	150	1.0329E+00
151	9.9726E-01	152	9.4192E-01	153	9.3564E-01	154	9.5927E-01	155	1.0565E+00	156	1.1085E+00
157	9.8141E-01	158	9.4492E-01	159	9.2876E-01	160	9.9128E-01	161	0.0000E+00	162	1.0323E+00
163	1.0478E+00	164	1.0574E+00	165	1.0735E+00	166	0.0000E+00	167	1.0735E+00	168	1.0574E+00
169	1.0478E+00	170	1.0323E+00	171	0.0000E+00	172	9.9128E-01	173	9.2876E-01	174	9.4492E-01
175	9.8141E-01	176	1.1085E+00	177	1.0565E+00	178	9.5927E-01	179	9.3564E-01	180	9.4192E-01
181	9.9726E-01	182	1.0329E+00	183	1.0012E+00	184	1.0526E+00	185	1.0702E+00	186	1.0735E+00
187	1.0735E+00	188	1.0702E+00	189	0.0000E+00	190	1.0427E+00	191	1.0406E+00	192	1.0191E+00
193	9.4312E-01	194	9.3325E-01	195	9.6197E-01	196	1.0601E+00	197	1.0622E+00	198	9.5778E-01
199	9.2876E-01	200	9.4372E-01	201	1.0104E+00	202	1.0308E+00	203	1.0487E+00	204	0.0000E+00
205	1.0574E+00	206	1.0702E+00	207	1.0574E+00	208	1.0526E+00	209	1.0487E+00	210	1.0317E+00
211	1.0092E+00	212	9.4462E-01	213	9.2697E-01	214	9.5479E-01	215	1.0538E+00	216	1.0451E+00
217	9.6286E-01	218	9.3355E-01	219	1.0041E+00	220	0.0000E+00	221	1.0317E+00	222	1.0427E+00
223	1.0478E+00	224	1.0526E+00	225	0.0000E+00	226	1.0478E+00	227	1.0012E+00	228	1.0308E+00
229	0.0000E+00	230	9.9337E-01	231	9.3923E-01	232	9.5838E-01	233	1.0463E+00	234	1.0514E+00
235	9.5957E-01	236	9.4222E-01	237	9.9337E-01	238	1.0092E+00	239	1.0406E+00	240	1.0323E+00
241	1.0012E+00	242	1.0487E+00	243	1.0427E+00	244	1.0323E+00	245	1.0329E+00	246	1.0104E+00
247	1.0041E+00	248	9.4222E-01	249	9.5449E-01	250	1.0487E+00	251	1.0430E+00	252	9.5449E-01
253	9.3923E-01	254	9.4462E-01	255	1.0191E+00	256	0.0000E+00	257	1.0329E+00	258	1.0308E+00
259	1.0317E+00	260	1.0406E+00	261	0.0000E+00	262	9.9726E-01	263	9.4372E-01	264	9.3355E-01
265	9.5957E-01	266	1.0430E+00	267	1.0487E+00	268	9.5838E-01	269	9.2697E-01	270	9.4312E-01
271	9.9128E-01	272	9.9726E-01	273	1.0104E+00	274	0.0000E+00	275	1.0092E+00	276	1.0191E+00
277	9.9128E-01	278	9.4192E-01	279	9.2876E-01	280	9.6286E-01	281	1.0514E+00	282	1.0463E+00
283	9.5479E-01	284	9.3325E-01	285	9.2876E-01	286	9.4192E-01	287	9.4372E-01	288	1.0041E+00
289	9.9337E-01	290	9.4462E-01	291	9.4312E-01	292	9.2876E-01	293	9.3564E-01	294	9.5778E-01
295	1.0451E+00	296	1.0538E+00	297	9.6197E-01	298	9.4492E-01	299	9.3564E-01	300	9.2876E-01
301	9.3355E-01	302	9.4222E-01	303	9.3923E-01	304	9.2697E-01	305	9.3325E-01	306	9.4492E-01
307	9.5927E-01	308	1.0622E+00	309	1.0601E+00	310	9.8141E-01	311	9.5927E-01	312	9.5778E-01
313	9.6286E-01	314	9.5957E-01	315	9.5449E-01	316	9.5838E-01	317	9.5479E-01	318	9.6197E-01
319	9.8141E-01	320	1.0565E+00	321	1.1085E+00	322	1.0565E+00	323	1.0622E+00	324	1.0451E+00
325	1.0514E+00	326	1.0430E+00	327	1.0487E+00	328	1.0463E+00	329	1.0538E+00	330	1.0601E+00
331	1.1085E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1261E-01	3.3347E-01	1.3613E-01	5.3040E-01
29	1.1131E-01	3.3283E-01	1.3593E-01	5.3124E-01
72	1.1223E-01	3.3392E-01	1.3610E-01	5.2997E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.7782E-02	3.4197E-02	9.8258E-02
29	6.9203E-02	2.9388E-02	8.4431E-02
72	7.4228E-02	3.2239E-02	9.2626E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.00990E+01	4.33938E-05	5.75911E+01	8.30293E-05
	U-236	9.56512E+00	0.00000E+00	8.92679E-01	0.00000E+00
	Pu-238	1.90274E+01	0.00000E+00	6.27401E+00	0.00000E+00
	Pu-239	7.22176E+01	1.78644E-03	1.34537E+02	3.32803E-03
	Pu-240	1.08368E+02	1.72226E-04	1.98506E+00	3.15482E-06
	Pu-241	7.67743E+01	2.02517E-05	1.66890E+02	4.40225E-05
	Pu-242	3.51101E+01	0.00000E+00	1.53628E+00	0.00000E+00
	Xe-135	8.83786E+04	3.13888E-05	0.00000E+00	0.00000E+00

	Sm-149	2.78662E+03	7.70859E-06	0.00000E+00	0.00000E+00
	Total FP	1.25254E+04	3.90974E-05	0.00000E+00	0.00000E+00
29	U-235	2.61805E+01	3.72397E-05	4.95590E+01	7.04939E-05
	U-236	9.16126E+00	0.00000E+00	8.92544E-01	0.00000E+00
	Pu-238	1.61651E+01	0.00000E+00	6.07934E+00	0.00000E+00
	Pu-239	6.14488E+01	1.49972E-03	1.14124E+02	2.78532E-03
	Pu-240	1.03693E+02	1.62594E-04	2.01591E+00	3.16100E-06
	Pu-241	6.53826E+01	1.70161E-05	1.42191E+02	3.70058E-05
	Pu-242	3.46515E+01	0.00000E+00	1.56382E+00	0.00000E+00
	Xe-135	6.94807E+04	2.43470E-05	0.00000E+00	0.00000E+00
	Sm-149	2.23165E+03	6.09083E-06	0.00000E+00	0.00000E+00
	Total FP	9.88335E+03	3.04378E-05	0.00000E+00	0.00000E+00
72	U-235	2.84922E+01	4.09947E-05	5.42899E+01	7.81127E-05
	U-236	9.22110E+00	0.00000E+00	8.88969E-01	0.00000E+00
	Pu-238	1.78483E+01	0.00000E+00	6.20035E+00	0.00000E+00
	Pu-239	6.78569E+01	1.67519E-03	1.26234E+02	3.11635E-03
	Pu-240	1.05991E+02	1.68110E-04	2.00148E+00	3.17451E-06
	Pu-241	7.22136E+01	1.90104E-05	1.56951E+02	4.13176E-05
	Pu-242	3.50968E+01	0.00000E+00	1.55205E+00	0.00000E+00
	Xe-135	8.06659E+04	2.85920E-05	0.00000E+00	0.00000E+00
	Sm-149	2.55758E+03	7.06077E-06	0.00000E+00	0.00000E+00
	Total FP	1.14449E+04	3.56527E-05	0.00000E+00	0.00000E+00

Burnup = 10 MWd/kgU

Power distribution by pin

1	1.0717E+00	2	1.0243E+00	3	1.0153E+00	4	1.0240E+00	5	1.0072E+00	6	1.0166E+00
7	1.0206E+00	8	1.0159E+00	9	1.0273E+00	10	1.0337E+00	11	1.0717E+00	12	1.0337E+00
13	1.0008E+00	14	9.8603E-01	15	9.7393E-01	16	9.8166E-01	17	9.9006E-01	18	9.8737E-01
19	9.7393E-01	20	9.7729E-01	21	9.8905E-01	22	1.0008E+00	23	1.0243E+00	24	1.0273E+00
25	9.8905E-01	26	9.5142E-01	27	9.5814E-01	28	9.5478E-01	29	9.6116E-01	30	9.7393E-01
31	9.5613E-01	32	9.5881E-01	33	9.4840E-01	34	9.5142E-01	35	9.8603E-01	36	1.0153E+00
37	1.0159E+00	38	9.7729E-01	39	9.4840E-01	40	9.4907E-01	41	9.5344E-01	42	9.7057E-01
43	9.9174E-01	44	9.8065E-01	45	9.7561E-01	46	9.6788E-01	47	9.4907E-01	48	9.5814E-01
49	9.7393E-01	50	1.0240E+00	51	1.0206E+00	52	9.7393E-01	53	9.5881E-01	54	9.6788E-01
55	9.8233E-01	56	9.8972E-01	57	1.0089E+00	58	0.0000E+00	59	1.0139E+00	60	1.0005E+00
61	9.8233E-01	62	9.5344E-01	63	9.5478E-01	64	9.8166E-01	65	1.0072E+00	66	1.0166E+00
67	9.8737E-01	68	9.5613E-01	69	9.7561E-01	70	1.0005E+00	71	0.0000E+00	72	1.0183E+00
73	1.0310E+00	74	1.0240E+00	75	1.0223E+00	76	0.0000E+00	77	9.8972E-01	78	9.7057E-01
79	9.6116E-01	80	9.9006E-01	81	1.0166E+00	82	1.0072E+00	83	9.9006E-01	84	9.7393E-01
85	9.8065E-01	86	1.0139E+00	87	1.0223E+00	88	1.0384E+00	89	1.0361E+00	90	1.0277E+00
91	1.0337E+00	92	1.0384E+00	93	1.0183E+00	94	1.0089E+00	95	9.9174E-01	96	9.7393E-01
97	9.8737E-01	98	1.0206E+00	99	1.0240E+00	100	9.8166E-01	101	9.6116E-01	102	9.9174E-01
103	0.0000E+00	104	1.0240E+00	105	1.0337E+00	106	1.0287E+00	107	0.0000E+00	108	1.0354E+00
109	1.0287E+00	110	1.0361E+00	111	1.0310E+00	112	0.0000E+00	113	9.8065E-01	114	9.5613E-01
115	9.7393E-01	116	1.0159E+00	117	1.0153E+00	118	9.7393E-01	119	9.5478E-01	120	9.7057E-01
121	1.0089E+00	122	1.0310E+00	123	1.0277E+00	124	1.0354E+00	125	1.0499E+00	126	1.0482E+00
127	1.0499E+00	128	0.0000E+00	129	1.0277E+00	130	1.0240E+00	131	1.0139E+00	132	9.7561E-01
133	9.5881E-01	134	9.7729E-01	135	1.0273E+00	136	1.0243E+00	137	9.8603E-01	138	9.5814E-01
139	9.5344E-01	140	9.8972E-01	141	1.0183E+00	142	1.0361E+00	143	0.0000E+00	144	1.0482E+00
145	1.0425E+00	146	1.0425E+00	147	1.0482E+00	148	1.0354E+00	149	1.0337E+00	150	1.0223E+00
151	1.0005E+00	152	9.6788E-01	153	9.4840E-01	154	9.8905E-01	155	1.0337E+00	156	1.0717E+00
157	1.0008E+00	158	9.5142E-01	159	9.4907E-01	160	9.8233E-01	161	0.0000E+00	162	1.0384E+00
163	1.0287E+00	164	1.0499E+00	165	1.0425E+00	166	0.0000E+00	167	1.0425E+00	168	1.0499E+00
169	1.0287E+00	170	1.0384E+00	171	0.0000E+00	172	9.8233E-01	173	9.4907E-01	174	9.5142E-01
175	1.0008E+00	176	1.0717E+00	177	1.0337E+00	178	9.8905E-01	179	9.4840E-01	180	9.6788E-01
181	1.0005E+00	182	1.0223E+00	183	1.0337E+00	184	1.0354E+00	185	1.0482E+00	186	1.0425E+00
187	1.0425E+00	188	1.0482E+00	189	0.0000E+00	190	1.0361E+00	191	1.0183E+00	192	9.8972E-01
193	9.5344E-01	194	9.5814E-01	195	9.8603E-01	196	1.0243E+00	197	1.0273E+00	198	9.7729E-01
199	9.5881E-01	200	9.7561E-01	201	1.0139E+00	202	1.0240E+00	203	1.0277E+00	204	0.0000E+00
205	1.0499E+00	206	1.0482E+00	207	1.0499E+00	208	1.0354E+00	209	1.0277E+00	210	1.0310E+00
211	1.0089E+00	212	9.7057E-01	213	9.5478E-01	214	9.7393E-01	215	1.0153E+00	216	1.0159E+00
217	9.7393E-01	218	9.5613E-01	219	9.8065E-01	220	0.0000E+00	221	1.0310E+00	222	1.0361E+00
223	1.0287E+00	224	1.0354E+00	225	0.0000E+00	226	1.0287E+00	227	1.0337E+00	228	1.0240E+00
229	0.0000E+00	230	9.9174E-01	231	9.6116E-01	232	9.8166E-01	233	1.0240E+00	234	1.0206E+00
235	9.8737E-01	236	9.7393E-01	237	9.9174E-01	238	1.0089E+00	239	1.0183E+00	240	1.0384E+00
241	1.0337E+00	242	1.0277E+00	243	1.0361E+00	244	1.0384E+00	245	1.0223E+00	246	1.0139E+00
247	9.8065E-01	248	9.7393E-01	249	9.9006E-01	250	1.0072E+00	251	1.0166E+00	252	9.9006E-01
253	9.6116E-01	254	9.7057E-01	255	9.8972E-01	256	0.0000E+00	257	1.0223E+00	258	1.0240E+00
259	1.0310E+00	260	1.0183E+00	261	0.0000E+00	262	1.0005E+00	263	9.7561E-01	264	9.5613E-01
265	9.8737E-01	266	1.0166E+00	267	1.0072E+00	268	9.8166E-01	269	9.5478E-01	270	9.5344E-01
271	9.8233E-01	272	1.0005E+00	273	1.0139E+00	274	0.0000E+00	275	1.0089E+00	276	9.8972E-01
277	9.8233E-01	278	9.6788E-01	279	9.5881E-01	280	9.7393E-01	281	1.0206E+00	282	1.0240E+00
283	9.7393E-01	284	9.5814E-01	285	9.4907E-01	286	9.6788E-01	287	9.7561E-01	288	9.8065E-01

289 9.9174E-01 290 9.7057E-01 291 9.5344E-01 292 9.4907E-01 293 9.4840E-01 294 9.7729E-01
295 1.0159E+00 296 1.0153E+00 297 9.8603E-01 298 9.5142E-01 299 9.4840E-01 300 9.5881E-01
301 9.5613E-01 302 9.7393E-01 303 9.6116E-01 304 9.5478E-01 305 9.5814E-01 306 9.5142E-01
307 9.8905E-01 308 1.0273E+00 309 1.0243E+00 310 1.0008E+00 311 9.8905E-01 312 9.7729E-01
313 9.7393E-01 314 9.8737E-01 315 9.9006E-01 316 9.8166E-01 317 9.7393E-01 318 9.8603E-01
319 1.0008E+00 320 1.0337E+00 321 1.0717E+00 322 1.0337E+00 323 1.0273E+00 324 1.0159E+00
325 1.0206E+00 326 1.0166E+00 327 1.0072E+00 328 1.0240E+00 329 1.0153E+00 330 1.0243E+00
331 1.0717E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1244E-01	3.3357E-01	1.3617E-01	5.3026E-01
29	1.1170E-01	3.3300E-01	1.3601E-01	5.3099E-01
72	1.1195E-01	3.3377E-01	1.3613E-01	5.3010E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.6182E-02	2.9624E-02	8.5227E-02
29	6.9291E-02	2.6533E-02	7.6340E-02
72	7.3588E-02	2.8411E-02	8.1739E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.17882E+01	3.73565E-05	6.11022E+01	7.18054E-05
	U-236	9.34474E+00	5.11334E-07	8.85026E-01	4.84276E-08
	Pu-238	2.02681E+01	4.16503E-08	6.36663E+00	1.30832E-08
	Pu-239	8.13189E+01	1.42878E-03	1.50829E+02	2.65008E-03
	Pu-240	7.23029E+01	2.81735E-04	1.96196E+00	7.64497E-06
	Pu-241	8.33844E+01	1.09681E-04	1.80922E+02	2.37979E-04
	Pu-242	3.38629E+01	3.52591E-06	1.53489E+00	1.59818E-07
	Xe-135	9.68800E+04	5.09877E-05	0.00000E+00	0.00000E+00
	Sm-149	3.03667E+03	1.63441E-05	0.00000E+00	0.00000E+00
	Total FP	1.72824E+01	1.37234E-04	0.00000E+00	0.00000E+00
29	U-235	2.73195E+01	3.23694E-05	5.19301E+01	6.15292E-05
	U-236	8.72832E+00	4.72964E-07	8.79221E-01	4.76427E-08
	Pu-238	1.70931E+01	3.96533E-08	6.15587E+00	1.42807E-08
	Pu-239	6.62478E+01	1.25800E-03	1.22880E+02	2.33341E-03
	Pu-240	7.19853E+01	2.51183E-04	1.99696E+00	6.96813E-06
	Pu-241	6.91831E+01	9.50954E-05	1.50296E+02	2.06589E-04
	Pu-242	3.29040E+01	3.05339E-06	1.56262E+00	1.45006E-07
	Xe-135	7.53598E+04	4.42496E-05	0.00000E+00	0.00000E+00
	Sm-149	2.38578E+03	1.61199E-05	0.00000E+00	0.00000E+00
	Total FP	1.65593E+01	1.19108E-04	0.00000E+00	0.00000E+00
72	U-235	3.01689E+01	3.55075E-05	5.78104E+01	6.80404E-05
	U-236	8.80797E+00	4.78277E-07	8.75736E-01	4.75529E-08
	Pu-238	1.91609E+01	3.97212E-08	6.29488E+00	1.30495E-08
	Pu-239	7.56724E+01	1.36015E-03	1.40436E+02	2.52423E-03
	Pu-240	7.22622E+01	2.72392E-04	1.97851E+00	7.45800E-06
	Pu-241	7.82101E+01	1.03316E-04	1.69770E+02	2.24267E-04
	Pu-242	3.37201E+01	3.36758E-06	1.54793E+00	1.54590E-07
	Xe-135	8.96567E+04	4.82016E-05	0.00000E+00	0.00000E+00
	Sm-149	2.80869E+03	1.58747E-05	0.00000E+00	0.00000E+00
	Total FP	1.68558E+01	1.29459E-04	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Power distribution by pin

1 1.0351E+00 2 1.0011E+00 3 9.7755E-01 4 9.6742E-01 5 9.7502E-01 6 9.6164E-01
7 9.7285E-01 8 9.8080E-01 9 9.7936E-01 10 1.0021E+00 11 1.0351E+00 12 1.0021E+00
13 1.0322E+00 14 1.0065E+00 15 1.0105E+00 16 1.0209E+00 17 1.0195E+00 18 1.0206E+00
19 1.0126E+00 20 1.0228E+00 21 1.0195E+00 22 1.0322E+00 23 1.0011E+00 24 9.7936E-01
25 1.0195E+00 26 9.8225E-01 27 9.7321E-01 28 9.8189E-01 29 9.9599E-01 30 1.0050E+00
31 9.8514E-01 32 9.8623E-01 33 9.8659E-01 34 9.8225E-01 35 1.0065E+00 36 9.7755E-01
37 9.8080E-01 38 1.0228E+00 39 9.8659E-01 40 9.7936E-01 41 9.8514E-01 42 9.8876E-01
43 9.6091E-01 44 9.5947E-01 45 1.0036E+00 46 9.8912E-01 47 9.7936E-01 48 9.7321E-01
49 1.0105E+00 50 9.6742E-01 51 9.7285E-01 52 1.0126E+00 53 9.8623E-01 54 9.8912E-01
55 9.5838E-01 56 9.6995E-01 57 9.8297E-01 58 0.0000E+00 59 9.8406E-01 60 9.6778E-01
61 9.5838E-01 62 9.8514E-01 63 9.8189E-01 64 1.0209E+00 65 9.7502E-01 66 9.6164E-01

67	1.0206E+00	68	9.8514E-01	69	1.0036E+00	70	9.6778E-01	71	0.0000E+00	72	1.0253E+00
73	1.0130E+00	74	1.0043E+00	75	1.0101E+00	76	0.0000E+00	77	9.6995E-01	78	9.8876E-01
79	9.9599E-01	80	1.0195E+00	81	9.6164E-01	82	9.7502E-01	83	1.0195E+00	84	1.0050E+00
85	9.5947E-01	86	9.8406E-01	87	1.0101E+00	88	1.0228E+00	89	1.0112E+00	90	1.0206E+00
91	1.0665E+00	92	1.0228E+00	93	1.0253E+00	94	9.8297E-01	95	9.6091E-01	96	1.0050E+00
97	1.0206E+00	98	9.7285E-01	99	9.6742E-01	100	1.0209E+00	101	9.9599E-01	102	9.6091E-01
103	0.0000E+00	104	1.0043E+00	105	1.0665E+00	106	1.0235E+00	107	0.0000E+00	108	1.0285E+00
109	1.0235E+00	110	1.0112E+00	111	1.0130E+00	112	0.0000E+00	113	9.5947E-01	114	9.8514E-01
115	1.0126E+00	116	9.8080E-01	117	9.7755E-01	118	1.0105E+00	119	9.8189E-01	120	9.8876E-01
121	9.8297E-01	122	1.0130E+00	123	1.0206E+00	124	1.0285E+00	125	1.0448E+00	126	1.0473E+00
127	1.0448E+00	128	0.0000E+00	129	1.0206E+00	130	1.0043E+00	131	9.8406E-01	132	1.0036E+00
133	9.8623E-01	134	1.0228E+00	135	9.7936E-01	136	1.0011E+00	137	1.0065E+00	138	9.7321E-01
139	9.8514E-01	140	9.6995E-01	141	1.0253E+00	142	1.0112E+00	143	0.0000E+00	144	1.0473E+00
145	1.0383E+00	146	1.0383E+00	147	1.0473E+00	148	1.0285E+00	149	1.0665E+00	150	1.0101E+00
151	9.6778E-01	152	9.8912E-01	153	9.8659E-01	154	1.0195E+00	155	1.0021E+00	156	1.0351E+00
157	1.0322E+00	158	9.8225E-01	159	9.7936E-01	160	9.5838E-01	161	0.0000E+00	162	1.0228E+00
163	1.0235E+00	164	1.0448E+00	165	1.0383E+00	166	0.0000E+00	167	1.0383E+00	168	1.0448E+00
169	1.0235E+00	170	1.0228E+00	171	0.0000E+00	172	9.5838E-01	173	9.7936E-01	174	9.8225E-01
175	1.0322E+00	176	1.0351E+00	177	1.0021E+00	178	1.0195E+00	179	9.8659E-01	180	9.8912E-01
181	9.6778E-01	182	1.0101E+00	183	1.0665E+00	184	1.0285E+00	185	1.0473E+00	186	1.0383E+00
187	1.0383E+00	188	1.0473E+00	189	0.0000E+00	190	1.0112E+00	191	1.0253E+00	192	9.6995E-01
193	9.8514E-01	194	9.7321E-01	195	1.0065E+00	196	1.0011E+00	197	9.7936E-01	198	1.0228E+00
199	9.8623E-01	200	1.0036E+00	201	9.8406E-01	202	1.0043E+00	203	1.0206E+00	204	0.0000E+00
205	1.0448E+00	206	1.0473E+00	207	1.0448E+00	208	1.0285E+00	209	1.0206E+00	210	1.0130E+00
211	9.8297E-01	212	9.8876E-01	213	9.8189E-01	214	1.0105E+00	215	9.7755E-01	216	9.8080E-01
217	1.0126E+00	218	9.8514E-01	219	9.5947E-01	220	0.0000E+00	221	1.0130E+00	222	1.0112E+00
223	1.0235E+00	224	1.0285E+00	225	0.0000E+00	226	1.0235E+00	227	1.0665E+00	228	1.0043E+00
229	0.0000E+00	230	9.6091E-01	231	9.9599E-01	232	1.0209E+00	233	9.6742E-01	234	9.7285E-01
235	1.0206E+00	236	1.0050E+00	237	9.6091E-01	238	9.8297E-01	239	1.0253E+00	240	1.0228E+00
241	1.0665E+00	242	1.0206E+00	243	1.0112E+00	244	1.0228E+00	245	1.0101E+00	246	9.8406E-01
247	9.5947E-01	248	1.0050E+00	249	1.0195E+00	250	9.7502E-01	251	9.6164E-01	252	1.0195E+00
253	9.9599E-01	254	9.8876E-01	255	9.6995E-01	256	0.0000E+00	257	1.0101E+00	258	1.0043E+00
259	1.0130E+00	260	1.0253E+00	261	0.0000E+00	262	9.6778E-01	263	1.0036E+00	264	9.8514E-01
265	1.0206E+00	266	9.6164E-01	267	9.7502E-01	268	1.0209E+00	269	9.8189E-01	270	9.8514E-01
271	9.5838E-01	272	9.6778E-01	273	9.8406E-01	274	0.0000E+00	275	9.8297E-01	276	9.6995E-01
277	9.5838E-01	278	9.8912E-01	279	9.8623E-01	280	1.0126E+00	281	9.7285E-01	282	9.6742E-01
283	1.0105E+00	284	9.7321E-01	285	9.7936E-01	286	9.8912E-01	287	1.0036E+00	288	9.5947E-01
289	9.6091E-01	290	9.8876E-01	291	9.8514E-01	292	9.7936E-01	293	9.8659E-01	294	1.0228E+00
295	9.8080E-01	296	9.7755E-01	297	1.0065E+00	298	9.8225E-01	299	9.8659E-01	300	9.8623E-01
301	9.8514E-01	302	1.0050E+00	303	9.9599E-01	304	9.8189E-01	305	9.7321E-01	306	9.8225E-01
307	1.0195E+00	308	9.7936E-01	309	1.0011E+00	310	1.0322E+00	311	1.0195E+00	312	1.0228E+00
313	1.0126E+00	314	1.0206E+00	315	1.0195E+00	316	1.0209E+00	317	1.0105E+00	318	1.0065E+00
319	1.0322E+00	320	1.0021E+00	321	1.0351E+00	322	1.0021E+00	323	9.7936E-01	324	9.8080E-01
325	9.7285E-01	326	9.6164E-01	327	9.7502E-01	328	9.6742E-01	329	9.7755E-01	330	1.0011E+00
331	1.0351E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1340E-01	3.3335E-01	1.3576E-01	5.3089E-01
29	1.1281E-01	3.3398E-01	1.3625E-01	5.2977E-01
72	1.1332E-01	3.3315E-01	1.3608E-01	5.3077E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.3967E-02	2.6087E-02	7.5211E-02
29	7.0130E-02	2.5237E-02	7.2768E-02
72	7.2893E-02	2.5921E-02	7.4732E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.50812E+01	3.25640E-05	6.79037E+01	6.30314E-05
	U-236	8.83497E+00	9.12350E-07	8.64526E-01	8.92760E-08
	Pu-238	2.26471E+01	2.53704E-07	6.52216E+00	7.30644E-08
	Pu-239	9.26538E+01	1.12611E-03	1.71834E+02	2.08846E-03
	Pu-240	6.69800E+01	3.43875E-04	1.93384E+00	9.92835E-06
	Pu-241	9.34638E+01	2.08366E-04	2.02544E+02	4.51548E-04
	Pu-242	3.08635E+01	1.15794E-05	1.51361E+00	5.67878E-07
	Xe-135	1.12502E+05	4.84957E-05	0.00000E+00	0.00000E+00
	Sm-149	3.48208E+03	1.67805E-05	0.00000E+00	0.00000E+00
	Total FP	1.26121E+01	1.91278E-04	0.00000E+00	0.00000E+00

29	U-235	2.95980E+01	2.85596E-05	5.66322E+01	5.46454E-05
	U-236	8.35015E+00	8.57097E-07	8.64876E-01	8.87748E-08
	Pu-238	1.87993E+01	2.37829E-07	6.27636E+00	7.94019E-08
	Pu-239	7.47722E+01	1.10277E-03	1.38549E+02	2.04339E-03
	Pu-240	6.33637E+01	2.93815E-04	1.97788E+00	9.17134E-06
	Pu-241	7.66588E+01	1.85022E-04	1.66420E+02	4.01667E-04
	Pu-242	3.17552E+01	1.04484E-05	1.55067E+00	5.10214E-07
	Xe-135	8.70539E+04	4.66575E-05	0.00000E+00	0.00000E+00
	Sm-149	2.73262E+03	1.84161E-05	0.00000E+00	0.00000E+00
	Total FP	1.22389E+01	1.73841E-04	0.00000E+00	0.00000E+00
72	U-235	3.34198E+01	3.14087E-05	6.45067E+01	6.06251E-05
	U-236	8.42273E+00	8.64600E-07	8.55218E-01	8.77887E-08
	Pu-238	2.15035E+01	2.44002E-07	6.44934E+00	7.31811E-08
	Pu-239	8.73676E+01	1.12614E-03	1.62000E+02	2.08813E-03
	Pu-240	6.55592E+01	3.27525E-04	1.94697E+00	9.72681E-06
	Pu-241	8.83525E+01	2.00162E-04	1.91535E+02	4.33920E-04
	Pu-242	3.15954E+01	1.13192E-05	1.52554E+00	5.46532E-07
	Xe-135	1.04958E+05	4.78035E-05	0.00000E+00	0.00000E+00
	Sm-149	3.26322E+03	1.70480E-05	0.00000E+00	0.00000E+00
	Total FP	1.24412E+01	1.84518E-04	0.00000E+00	0.00000E+00

Burnup = 30 MWd/kgU

Power distribution by pin

1	9.9362E-01	2	9.5689E-01	3	9.3215E-01	4	9.3601E-01	5	9.3176E-01	6	9.2867E-01
7	9.2673E-01	8	9.2789E-01	9	9.4065E-01	10	9.6385E-01	11	9.9362E-01	12	9.6385E-01
13	1.0818E+00	14	1.0524E+00	15	1.0477E+00	16	1.0439E+00	17	1.0412E+00	18	1.0493E+00
19	1.0505E+00	20	1.0389E+00	21	1.0508E+00	22	1.0818E+00	23	9.5689E-01	24	9.4065E-01
25	1.0508E+00	26	1.0199E+00	27	1.0017E+00	28	1.0095E+00	29	1.0261E+00	30	1.0242E+00
31	1.0269E+00	32	1.0017E+00	33	1.0191E+00	34	1.0199E+00	35	1.0524E+00	36	9.3215E-01
37	9.2789E-01	38	1.0389E+00	39	1.0191E+00	40	1.0106E+00	41	1.0226E+00	42	1.0423E+00
43	9.3988E-01	44	9.3872E-01	45	1.0497E+00	46	1.0029E+00	47	1.0106E+00	48	1.0017E+00
49	1.0477E+00	50	9.3601E-01	51	9.2673E-01	52	1.0505E+00	53	1.0017E+00	54	1.0029E+00
55	9.4607E-01	56	9.6076E-01	57	9.6617E-01	58	0.0000E+00	59	9.6656E-01	60	9.5303E-01
61	9.4607E-01	62	1.0226E+00	63	1.0095E+00	64	1.0439E+00	65	9.3176E-01	66	9.2867E-01
67	1.0493E+00	68	1.0269E+00	69	1.0497E+00	70	9.5303E-01	71	0.0000E+00	72	1.0048E+00
73	1.0021E+00	74	1.0037E+00	75	9.7468E-01	76	0.0000E+00	77	9.6076E-01	78	1.0423E+00
79	1.0261E+00	80	1.0412E+00	81	9.2867E-01	82	9.3176E-01	83	1.0412E+00	84	1.0242E+00
85	9.3872E-01	86	9.6656E-01	87	9.7468E-01	88	9.9710E-01	89	1.0118E+00	90	9.9555E-01
91	1.1026E+00	92	9.9710E-01	93	1.0048E+00	94	9.6617E-01	95	9.3988E-01	96	1.0242E+00
97	1.0493E+00	98	9.2673E-01	99	9.3601E-01	100	1.0439E+00	101	1.0261E+00	102	9.3988E-01
103	0.0000E+00	104	1.0037E+00	105	1.1026E+00	106	1.0106E+00	107	0.0000E+00	108	1.0133E+00
109	1.0106E+00	110	1.0118E+00	111	1.0021E+00	112	0.0000E+00	113	9.3872E-01	114	1.0269E+00
115	1.0505E+00	116	9.2789E-01	117	9.3215E-01	118	1.0477E+00	119	1.0095E+00	120	1.0423E+00
121	9.6617E-01	122	1.0021E+00	123	9.9555E-01	124	1.0133E+00	125	1.0176E+00	126	1.0284E+00
127	1.0176E+00	128	0.0000E+00	129	9.9555E-01	130	1.0037E+00	131	9.6656E-01	132	1.0497E+00
133	1.0017E+00	134	1.0389E+00	135	9.4065E-01	136	9.5689E-01	137	1.0524E+00	138	1.0017E+00
139	1.0226E+00	140	9.6076E-01	141	1.0048E+00	142	1.0118E+00	143	0.0000E+00	144	1.0284E+00
145	1.0145E+00	146	1.0145E+00	147	1.0284E+00	148	1.0133E+00	149	1.1026E+00	150	9.7468E-01
151	9.5303E-01	152	1.0029E+00	153	1.0191E+00	154	1.0508E+00	155	9.6385E-01	156	9.9362E-01
157	1.0818E+00	158	1.0199E+00	159	1.0106E+00	160	9.4607E-01	161	0.0000E+00	162	9.9710E-01
163	1.0106E+00	164	1.0176E+00	165	1.0145E+00	166	0.0000E+00	167	1.0145E+00	168	1.0176E+00
169	1.0106E+00	170	9.9710E-01	171	0.0000E+00	172	9.4607E-01	173	1.0106E+00	174	1.0199E+00
175	1.0818E+00	176	9.9362E-01	177	9.6385E-01	178	1.0508E+00	179	1.0191E+00	180	1.0029E+00
181	9.5303E-01	182	9.7468E-01	183	1.1026E+00	184	1.0133E+00	185	1.0284E+00	186	1.0145E+00
187	1.0145E+00	188	1.0284E+00	189	0.0000E+00	190	1.0118E+00	191	1.0048E+00	192	9.6076E-01
193	1.0226E+00	194	1.0017E+00	195	1.0524E+00	196	9.5689E-01	197	9.4065E-01	198	1.0389E+00
199	1.0017E+00	200	1.0497E+00	201	9.6656E-01	202	1.0037E+00	203	9.9555E-01	204	0.0000E+00
205	1.0176E+00	206	1.0284E+00	207	1.0176E+00	208	1.0133E+00	209	9.9555E-01	210	1.0021E+00
211	9.6617E-01	212	1.0423E+00	213	1.0095E+00	214	1.0477E+00	215	9.3215E-01	216	9.2789E-01
217	1.0505E+00	218	1.0269E+00	219	9.3872E-01	220	0.0000E+00	221	1.0021E+00	222	1.0118E+00
223	1.0106E+00	224	1.0133E+00	225	0.0000E+00	226	1.0106E+00	227	1.1026E+00	228	1.0037E+00
229	0.0000E+00	230	9.3988E-01	231	1.0261E+00	232	1.0439E+00	233	9.3601E-01	234	9.2673E-01
235	1.0493E+00	236	1.0242E+00	237	9.3988E-01	238	9.6617E-01	239	1.0048E+00	240	9.9710E-01
241	1.1026E+00	242	9.9555E-01	243	1.0118E+00	244	9.9710E-01	245	9.7468E-01	246	9.6656E-01
247	9.3872E-01	248	1.0242E+00	249	1.0412E+00	250	9.3176E-01	251	9.2867E-01	252	1.0412E+00
253	1.0261E+00	254	1.0423E+00	255	9.6076E-01	256	0.0000E+00	257	9.7468E-01	258	1.0037E+00
259	1.0021E+00	260	1.0048E+00	261	0.0000E+00	262	9.5303E-01	263	1.0497E+00	264	1.0269E+00
265	1.0493E+00	266	9.2867E-01	267	9.3176E-01	268	1.0439E+00	269	1.0095E+00	270	1.0226E+00
271	9.4607E-01	272	9.5303E-01	273	9.6656E-01	274	0.0000E+00	275	9.6617E-01	276	9.6076E-01
277	9.4607E-01	278	1.0029E+00	279	1.0017E+00	280	1.0505E+00	281	9.2673E-01	282	9.3601E-01
283	1.0477E+00	284	1.0017E+00	285	1.0106E+00	286	1.0029E+00	287	1.0497E+00	288	9.3872E-01
289	9.3988E-01	290	1.0423E+00	291	1.0226E+00	292	1.0106E+00	293	1.0191E+00	294	1.0389E+00
295	9.2789E-01	296	9.3215E-01	297	1.0524E+00	298	1.0199E+00	299	1.0191E+00	300	1.0017E+00

301 1.0269E+00 302 1.0242E+00 303 1.0261E+00 304 1.0095E+00 305 1.0017E+00 306 1.0199E+00
307 1.0508E+00 308 9.4065E-01 309 9.5689E-01 310 1.0818E+00 311 1.0508E+00 312 1.0389E+00
313 1.0505E+00 314 1.0493E+00 315 1.0412E+00 316 1.0439E+00 317 1.0477E+00 318 1.0524E+00
319 1.0818E+00 320 9.6385E-01 321 9.9362E-01 322 9.6385E-01 323 9.4065E-01 324 9.2789E-01
325 9.2673E-01 326 9.2867E-01 327 9.3176E-01 328 9.3601E-01 329 9.3215E-01 330 9.5689E-01
331 9.9362E-01

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1466E-01	3.3305E-01	1.3605E-01	5.3090E-01
29	1.1337E-01	3.3295E-01	1.3611E-01	5.3095E-01
72	1.1414E-01	3.3355E-01	1.3601E-01	5.3045E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.1676E-02	2.3174E-02	6.6993E-02
29	7.0787E-02	2.4304E-02	7.0257E-02
72	7.0859E-02	2.3283E-02	6.7309E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.87009E+01	2.71364E-05	7.53689E+01	5.28474E-05
	U-236	8.82748E+00	1.27101E-06	8.47379E-01	1.22008E-07
	Pu-238	2.52646E+01	8.07486E-07	6.68730E+00	2.13734E-07
	Pu-239	1.06089E+02	8.90775E-04	1.96539E+02	1.65024E-03
	Pu-240	6.48002E+01	3.56428E-04	1.89237E+00	1.04088E-05
	Pu-241	1.05293E+02	2.85429E-04	2.28056E+02	6.18213E-04
	Pu-242	2.80257E+01	2.24509E-05	1.48028E+00	1.18582E-06
	Xe-135	1.30089E+05	4.55370E-05	0.00000E+00	0.00000E+00
	Sm-149	4.00476E+03	1.66233E-05	0.00000E+00	0.00000E+00
	Total FP	1.09508E+01	2.38757E-04	0.00000E+00	0.00000E+00
29	U-235	3.22351E+01	2.41423E-05	6.21493E+01	4.65463E-05
	U-236	8.13684E+00	1.15523E-06	8.54469E-01	1.21313E-07
	Pu-238	2.06983E+01	7.48833E-07	6.40355E+00	2.31670E-07
	Pu-239	8.50998E+01	9.68567E-04	1.57552E+02	1.79318E-03
	Pu-240	6.12559E+01	3.11944E-04	1.96456E+00	1.00045E-05
	Pu-241	8.52440E+01	2.62778E-04	1.84877E+02	5.69913E-04
	Pu-242	2.87317E+01	1.99013E-05	1.54220E+00	1.06822E-06
	Xe-135	1.00384E+05	4.84981E-05	0.00000E+00	0.00000E+00
	Sm-149	3.13461E+03	1.98782E-05	0.00000E+00	0.00000E+00
	Total FP	1.06662E+01	2.23497E-04	0.00000E+00	0.00000E+00
72	U-235	3.64604E+01	2.61327E-05	7.08271E+01	5.07649E-05
	U-236	8.38452E+00	1.19885E-06	8.46309E-01	1.21008E-07
	Pu-238	2.37124E+01	7.71325E-07	6.60737E+00	2.14927E-07
	Pu-239	9.82124E+01	9.03115E-04	1.82042E+02	1.67398E-03
	Pu-240	6.38748E+01	3.45467E-04	1.92618E+00	1.04177E-05
	Pu-241	9.84731E+01	2.75875E-04	2.13339E+02	5.97674E-04
	Pu-242	2.84073E+01	2.17105E-05	1.50912E+00	1.15335E-06
	Xe-135	1.20747E+05	4.60857E-05	0.00000E+00	0.00000E+00
	Sm-149	3.74380E+03	1.72822E-05	0.00000E+00	0.00000E+00
	Total FP	1.07708E+01	2.31732E-04	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Power distribution by pin

1 9.4751E-01 2 9.1211E-01 3 9.0429E-01 4 8.9977E-01 5 8.9359E-01 6 9.0347E-01
7 8.9894E-01 8 8.9153E-01 9 9.0841E-01 10 9.1129E-01 11 9.4751E-01 12 9.1129E-01
13 1.1154E+00 14 1.0916E+00 15 1.0702E+00 16 1.0772E+00 17 1.0726E+00 18 1.0870E+00
19 1.0772E+00 20 1.0800E+00 21 1.0825E+00 22 1.1154E+00 23 9.1211E-01 24 9.0841E-01
25 1.0825E+00 26 1.0467E+00 27 1.0401E+00 28 1.0319E+00 29 1.0586E+00 30 1.0549E+00
31 1.0500E+00 32 1.0422E+00 33 1.0331E+00 34 1.0467E+00 35 1.0916E+00 36 9.0429E-01
37 8.9153E-01 38 1.0800E+00 39 1.0331E+00 40 1.0496E+00 41 1.0409E+00 42 1.0805E+00
43 9.2487E-01 44 9.2282E-01 45 1.0665E+00 46 1.0529E+00 47 1.0496E+00 48 1.0401E+00
49 1.0702E+00 50 8.9977E-01 51 8.9894E-01 52 1.0772E+00 53 1.0422E+00 54 1.0529E+00
55 9.2199E-01 56 9.3558E-01 57 9.4463E-01 58 0.0000E+00 59 9.6192E-01 60 9.3516E-01
61 9.2199E-01 62 1.0409E+00 63 1.0319E+00 64 1.0772E+00 65 8.9359E-01 66 9.0347E-01
67 1.0870E+00 68 1.0500E+00 69 1.0665E+00 70 9.3516E-01 71 0.0000E+00 72 9.7797E-01
73 9.8209E-01 74 9.7386E-01 75 9.6974E-01 76 0.0000E+00 77 9.3558E-01 78 1.0805E+00

79	1.0586E+00	80	1.0726E+00	81	9.0347E-01	82	8.9359E-01	83	1.0726E+00	84	1.0549E+00
85	9.2282E-01	86	9.6192E-01	87	9.6974E-01	88	9.8661E-01	89	9.7303E-01	90	9.7921E-01
91	1.1476E+00	92	9.8661E-01	93	9.7797E-01	94	9.4463E-01	95	9.2487E-01	96	1.0549E+00
97	1.0870E+00	98	8.9894E-01	99	8.9977E-01	100	1.0772E+00	101	1.0586E+00	102	9.2487E-01
103	0.0000E+00	104	9.7386E-01	105	1.1476E+00	106	9.9279E-01	107	0.0000E+00	108	9.8661E-01
109	9.9279E-01	110	9.7303E-01	111	9.8209E-01	112	0.0000E+00	113	9.2282E-01	114	1.0500E+00
115	1.0772E+00	116	8.9153E-01	117	9.0429E-01	118	1.0702E+00	119	1.0319E+00	120	1.0805E+00
121	9.4463E-01	122	9.8209E-01	123	9.7921E-01	124	9.8661E-01	125	1.0097E+00	126	1.0150E+00
127	1.0097E+00	128	0.0000E+00	129	9.7921E-01	130	9.7386E-01	131	9.6192E-01	132	1.0665E+00
133	1.0422E+00	134	1.0800E+00	135	9.0841E-01	136	9.1211E-01	137	1.0916E+00	138	1.0401E+00
139	1.0409E+00	140	9.3558E-01	141	9.7797E-01	142	9.7303E-01	143	0.0000E+00	144	1.0150E+00
145	9.8620E-01	146	9.8620E-01	147	1.0150E+00	148	9.8661E-01	149	1.1476E+00	150	9.6974E-01
151	9.3516E-01	152	1.0529E+00	153	1.0331E+00	154	1.0825E+00	155	9.1129E-01	156	9.4751E-01
157	1.1154E+00	158	1.0467E+00	159	1.0496E+00	160	9.2199E-01	161	0.0000E+00	162	9.8661E-01
163	9.9279E-01	164	1.0097E+00	165	9.8620E-01	166	0.0000E+00	167	9.8620E-01	168	1.0097E+00
169	9.9279E-01	170	9.8661E-01	171	0.0000E+00	172	9.2199E-01	173	1.0496E+00	174	1.0467E+00
175	1.1154E+00	176	9.4751E-01	177	9.1129E-01	178	1.0825E+00	179	1.0331E+00	180	1.0529E+00
181	9.3516E-01	182	9.6974E-01	183	1.1476E+00	184	9.8661E-01	185	1.0150E+00	186	9.8620E-01
187	9.8620E-01	188	1.0150E+00	189	0.0000E+00	190	9.7303E-01	191	9.7797E-01	192	9.3558E-01
193	1.0409E+00	194	1.0401E+00	195	1.0916E+00	196	9.1211E-01	197	9.0841E-01	198	1.0800E+00
199	1.0422E+00	200	1.0665E+00	201	9.6192E-01	202	9.7386E-01	203	9.7921E-01	204	0.0000E+00
205	1.0097E+00	206	1.0150E+00	207	1.0097E+00	208	9.8661E-01	209	9.7921E-01	210	9.8209E-01
211	9.4463E-01	212	1.0805E+00	213	1.0319E+00	214	1.0702E+00	215	9.0429E-01	216	8.9153E-01
217	1.0772E+00	218	1.0500E+00	219	9.2282E-01	220	0.0000E+00	221	9.8209E-01	222	9.7303E-01
223	9.9279E-01	224	9.8661E-01	225	0.0000E+00	226	9.9279E-01	227	1.1476E+00	228	9.7386E-01
229	0.0000E+00	230	9.2487E-01	231	1.0586E+00	232	1.0772E+00	233	8.9977E-01	234	8.9894E-01
235	1.0870E+00	236	1.0549E+00	237	9.2487E-01	238	9.4463E-01	239	9.7797E-01	240	9.8661E-01
241	1.1476E+00	242	9.7921E-01	243	9.7303E-01	244	9.8661E-01	245	9.6974E-01	246	9.6192E-01
247	9.2282E-01	248	1.0549E+00	249	1.0726E+00	250	8.9359E-01	251	9.0347E-01	252	1.0726E+00
253	1.0586E+00	254	1.0805E+00	255	9.3558E-01	256	0.0000E+00	257	9.6974E-01	258	9.7386E-01
259	9.8209E-01	260	9.7797E-01	261	0.0000E+00	262	9.3516E-01	263	1.0665E+00	264	1.0500E+00
265	1.0870E+00	266	9.0347E-01	267	8.9359E-01	268	1.0772E+00	269	1.0319E+00	270	1.0409E+00
271	9.2199E-01	272	9.3516E-01	273	9.6192E-01	274	0.0000E+00	275	9.4463E-01	276	9.3558E-01
277	9.2199E-01	278	1.0529E+00	279	1.0422E+00	280	1.0772E+00	281	8.9894E-01	282	8.9977E-01
283	1.0702E+00	284	1.0401E+00	285	1.0496E+00	286	1.0529E+00	287	1.0665E+00	288	9.2282E-01
289	9.2487E-01	290	1.0805E+00	291	1.0409E+00	292	1.0496E+00	293	1.0331E+00	294	1.0800E+00
295	8.9153E-01	296	9.0429E-01	297	1.0916E+00	298	1.0467E+00	299	1.0331E+00	300	1.0422E+00
301	1.0500E+00	302	1.0549E+00	303	1.0586E+00	304	1.0319E+00	305	1.0401E+00	306	1.0467E+00
307	1.0825E+00	308	9.0841E-01	309	9.1211E-01	310	1.1154E+00	311	1.0825E+00	312	1.0800E+00
313	1.0772E+00	314	1.0870E+00	315	1.0726E+00	316	1.0772E+00	317	1.0702E+00	318	1.0916E+00
319	1.1154E+00	320	9.1129E-01	321	9.4751E-01	322	9.1129E-01	323	9.0841E-01	324	8.9153E-01
325	8.9894E-01	326	9.0347E-01	327	8.9359E-01	328	8.9977E-01	329	9.0429E-01	330	9.1211E-01
331	9.4751E-01										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1570E-01	3.3350E-01	1.3578E-01	5.3072E-01
29	1.1470E-01	3.3406E-01	1.3626E-01	5.2968E-01
72	1.1508E-01	3.3352E-01	1.3632E-01	5.3016E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.9167E-02	2.0539E-02	5.9525E-02
29	7.0498E-02	2.3032E-02	6.6746E-02
72	6.9341E-02	2.1236E-02	6.1541E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.22021E+01	2.12146E-05	8.26804E+01	4.15627E-05
	U-236	8.44795E+00	1.48201E-06	8.31560E-01	1.45879E-07
	Pu-238	2.78871E+01	1.80548E-06	6.87269E+00	4.44955E-07
	Pu-239	1.17640E+02	7.14789E-04	2.18117E+02	1.32529E-03
	Pu-240	6.80473E+01	3.56902E-04	1.87857E+00	9.85296E-06
	Pu-241	1.15997E+02	3.19257E-04	2.51087E+02	6.91065E-04
	Pu-242	2.60431E+01	3.44012E-05	1.46697E+00	1.93777E-06
	Xe-135	1.48567E+05	4.27113E-05	0.00000E+00	0.00000E+00
	Sm-149	4.56934E+03	1.61711E-05	0.00000E+00	0.00000E+00
	Total FP	9.99635E+00	2.78565E-04	0.00000E+00	0.00000E+00
29	U-235	3.47930E+01	1.96435E-05	6.74823E+01	3.80994E-05
	U-236	8.23810E+00	1.43217E-06	8.53958E-01	1.48458E-07

	Pu-238	2.25903E+01	1.71177E-06	6.53581E+00	4.95249E-07
	Pu-239	9.37010E+01	8.56578E-04	1.73582E+02	1.58682E-03
	Pu-240	6.15320E+01	3.15357E-04	1.95491E+00	1.00191E-05
	Pu-241	9.33688E+01	3.16408E-04	2.02424E+02	6.85974E-04
	Pu-242	2.54253E+01	2.94372E-05	1.53407E+00	1.77613E-06
	Xe-135	1.14120E+05	5.00915E-05	0.00000E+00	0.00000E+00
	Sm-149	3.55004E+03	2.09108E-05	0.00000E+00	0.00000E+00
	Total FP	9.78351E+00	2.72967E-04	0.00000E+00	0.00000E+00
72	U-235	4.00094E+01	2.07771E-05	7.81702E+01	4.05942E-05
	U-236	8.26965E+00	1.43952E-06	8.33300E-01	1.45055E-07
	Pu-238	2.62955E+01	1.74967E-06	6.76035E+00	4.49824E-07
	Pu-239	1.10629E+02	7.52120E-04	2.05080E+02	1.39425E-03
	Pu-240	6.52111E+01	3.40772E-04	1.89832E+00	9.91998E-06
	Pu-241	1.09352E+02	3.17382E-04	2.36807E+02	6.87306E-04
	Pu-242	2.58004E+01	3.26698E-05	1.48494E+00	1.88031E-06
	Xe-135	1.38327E+05	4.42507E-05	0.00000E+00	0.00000E+00
	Sm-149	4.27068E+03	1.70981E-05	0.00000E+00	0.00000E+00
	Total FP	9.89166E+00	2.74589E-04	0.00000E+00	0.00000E+00

Burnup = 50 MWd/kgU

Power distribution by pin

1	9.1578E-01	2	8.9103E-01	3	8.8061E-01	4	8.7323E-01	5	8.6715E-01	6	8.7019E-01
7	8.7149E-01	8	8.7149E-01	9	8.7410E-01	10	8.9060E-01	11	9.1578E-01	12	8.9060E-01
13	1.1425E+00	14	1.1108E+00	15	1.0964E+00	16	1.1099E+00	17	1.1081E+00	18	1.1095E+00
19	1.1095E+00	20	1.0951E+00	21	1.1060E+00	22	1.1425E+00	23	8.9103E-01	24	8.7410E-01
25	1.1060E+00	26	1.0534E+00	27	1.0456E+00	28	1.0560E+00	29	1.0760E+00	30	1.0817E+00
31	1.0791E+00	32	1.0608E+00	33	1.0552E+00	34	1.0534E+00	35	1.1108E+00	36	8.8061E-01
37	8.7149E-01	38	1.0951E+00	39	1.0552E+00	40	1.0569E+00	41	1.0778E+00	42	1.1016E+00
43	9.0015E-01	44	9.0493E-01	45	1.0934E+00	46	1.0890E+00	47	1.0569E+00	48	1.0456E+00
49	1.0964E+00	50	8.7323E-01	51	8.7149E-01	52	1.1095E+00	53	1.0608E+00	54	1.0890E+00
55	8.9060E-01	56	9.1969E-01	57	9.4097E-01	58	0.0000E+00	59	9.4531E-01	60	9.2621E-01
61	8.9060E-01	62	1.0778E+00	63	1.0560E+00	64	1.1099E+00	65	8.6715E-01	66	8.7019E-01
67	1.1095E+00	68	1.0791E+00	69	1.0934E+00	70	9.2621E-01	71	0.0000E+00	72	9.6442E-01
73	9.7745E-01	74	9.6051E-01	75	9.5400E-01	76	0.0000E+00	77	9.1969E-01	78	1.1016E+00
79	1.0760E+00	80	1.1081E+00	81	8.7019E-01	82	8.6715E-01	83	1.1081E+00	84	1.0817E+00
85	9.0493E-01	86	9.4531E-01	87	9.5400E-01	88	9.7180E-01	89	9.7050E-01	90	9.6398E-01
91	1.1785E+00	92	9.7180E-01	93	9.6442E-01	94	9.4097E-01	95	9.0015E-01	96	1.0817E+00
97	1.1095E+00	98	8.7149E-01	99	8.7323E-01	100	1.1099E+00	101	1.0760E+00	102	9.0015E-01
103	0.0000E+00	104	9.6051E-01	105	1.1785E+00	106	9.8179E-01	107	0.0000E+00	108	9.7788E-01
109	9.8179E-01	110	9.7050E-01	111	9.7745E-01	112	0.0000E+00	113	9.0493E-01	114	1.0791E+00
115	1.1095E+00	116	8.7149E-01	117	8.8061E-01	118	1.0964E+00	119	1.0560E+00	120	1.1016E+00
121	9.4097E-01	122	9.7745E-01	123	9.6398E-01	124	9.7788E-01	125	9.8700E-01	126	9.9655E-01
127	9.8700E-01	128	0.0000E+00	129	9.6398E-01	130	9.6051E-01	131	9.4531E-01	132	1.0934E+00
133	1.0608E+00	134	1.0951E+00	135	8.7410E-01	136	8.9103E-01	137	1.1108E+00	138	1.0456E+00
139	1.0778E+00	140	9.1969E-01	141	9.6442E-01	142	9.7050E-01	143	0.0000E+00	144	9.9655E-01
145	9.6789E-01	146	9.6789E-01	147	9.9655E-01	148	9.7788E-01	149	1.1785E+00	150	9.5400E-01
151	9.2621E-01	152	1.0890E+00	153	1.0552E+00	154	1.1060E+00	155	8.9060E-01	156	9.1578E-01
157	1.1425E+00	158	1.0534E+00	159	1.0569E+00	160	8.9060E-01	161	0.0000E+00	162	9.7180E-01
163	9.8179E-01	164	9.8700E-01	165	9.6789E-01	166	0.0000E+00	167	9.6789E-01	168	9.8700E-01
169	9.8179E-01	170	9.7180E-01	171	0.0000E+00	172	8.9060E-01	173	1.0569E+00	174	1.0534E+00
175	1.1425E+00	176	9.1578E-01	177	8.9060E-01	178	1.1060E+00	179	1.0552E+00	180	1.0890E+00
181	9.2621E-01	182	9.5400E-01	183	1.1785E+00	184	9.7788E-01	185	9.9655E-01	186	9.6789E-01
187	9.6789E-01	188	9.9655E-01	189	0.0000E+00	190	9.7050E-01	191	9.6442E-01	192	9.1969E-01
193	1.0778E+00	194	1.0456E+00	195	1.1108E+00	196	8.9103E-01	197	8.7410E-01	198	1.0951E+00
199	1.0608E+00	200	1.0934E+00	201	9.4531E-01	202	9.6051E-01	203	9.6398E-01	204	0.0000E+00
205	9.8700E-01	206	9.9655E-01	207	9.8700E-01	208	9.7788E-01	209	9.6398E-01	210	9.7745E-01
211	9.4097E-01	212	1.1016E+00	213	1.0560E+00	214	1.0964E+00	215	8.8061E-01	216	8.7149E-01
217	1.1095E+00	218	1.0791E+00	219	9.0493E-01	220	0.0000E+00	221	9.7745E-01	222	9.7050E-01
223	9.8179E-01	224	9.7788E-01	225	0.0000E+00	226	9.8179E-01	227	1.1785E+00	228	9.6051E-01
229	0.0000E+00	230	9.0015E-01	231	1.0760E+00	232	1.1099E+00	233	8.7323E-01	234	8.7149E-01
235	1.1095E+00	236	1.0817E+00	237	9.0015E-01	238	9.4097E-01	239	9.6442E-01	240	9.7180E-01
241	1.1785E+00	242	9.6398E-01	243	9.7050E-01	244	9.7180E-01	245	9.5400E-01	246	9.4531E-01
247	9.0493E-01	248	1.0817E+00	249	1.1081E+00	250	8.6715E-01	251	8.7019E-01	252	1.1081E+00
253	1.0760E+00	254	1.1016E+00	255	9.1969E-01	256	0.0000E+00	257	9.5400E-01	258	9.6051E-01
259	9.7745E-01	260	9.6442E-01	261	0.0000E+00	262	9.2621E-01	263	1.0934E+00	264	1.0791E+00
265	1.1095E+00	266	8.7019E-01	267	8.6715E-01	268	1.1099E+00	269	1.0560E+00	270	1.0778E+00
271	8.9060E-01	272	9.2621E-01	273	9.4531E-01	274	0.0000E+00	275	9.4097E-01	276	9.1969E-01
277	8.9060E-01	278	1.0890E+00	279	1.0608E+00	280	1.1095E+00	281	8.7149E-01	282	8.7323E-01
283	1.0964E+00	284	1.0456E+00	285	1.0569E+00	286	1.0890E+00	287	1.0934E+00	288	9.0493E-01
289	9.0015E-01	290	1.1016E+00	291	1.0778E+00	292	1.0569E+00	293	1.0552E+00	294	1.0951E+00
295	8.7149E-01	296	8.8061E-01	297	1.1108E+00	298	1.0534E+00	299	1.0552E+00	300	1.0608E+00
301	1.0791E+00	302	1.0817E+00	303	1.0760E+00	304	1.0560E+00	305	1.0456E+00	306	1.0534E+00
307	1.1060E+00	308	8.7410E-01	309	8.9103E-01	310	1.1425E+00	311	1.1060E+00	312	1.0951E+00

313 1.1095E+00 314 1.1095E+00 315 1.1081E+00 316 1.1099E+00 317 1.0964E+00 318 1.1108E+00
319 1.1425E+00 320 8.9060E-01 321 9.1578E-01 322 8.9060E-01 323 8.7410E-01 324 8.7149E-01
325 8.7149E-01 326 8.7019E-01 327 8.6715E-01 328 8.7323E-01 329 8.8061E-01 330 8.9103E-01
331 9.1578E-01

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1663E-01	3.3293E-01	1.3609E-01	5.3098E-01
29	1.1615E-01	3.3336E-01	1.3592E-01	5.3072E-01
72	1.1643E-01	3.3336E-01	1.3618E-01	5.3046E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.7612E-02	1.8753E-02	5.4448E-02
29	7.0193E-02	2.1924E-02	6.3648E-02
72	6.8890E-02	1.9807E-02	5.7505E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.60544E+01	1.55983E-05	9.06696E+01	3.07091E-05
	U-236	8.23711E+00	1.61672E-06	8.14751E-01	1.59914E-07
	Pu-238	3.06859E+01	3.18014E-06	7.05863E+00	7.31521E-07
	Pu-239	1.30709E+02	6.22664E-04	2.42426E+02	1.15485E-03
	Pu-240	7.27850E+01	3.38250E-04	1.85048E+00	8.59964E-06
	Pu-241	1.28178E+02	3.20190E-04	2.77264E+02	6.92609E-04
	Pu-242	2.38451E+01	4.40376E-05	1.44197E+00	2.66306E-06
	Xe-135	1.66914E+05	4.01495E-05	0.00000E+00	0.00000E+00
	Sm-149	5.10872E+03	1.54560E-05	0.00000E+00	0.00000E+00
	Total FP	9.40743E+00	3.13423E-04	0.00000E+00	0.00000E+00
29	U-235	3.74335E+01	1.51523E-05	7.29601E+01	2.95328E-05
	U-236	8.16536E+00	1.59271E-06	8.43395E-01	1.64510E-07
	Pu-238	2.44905E+01	3.11518E-06	6.65889E+00	8.47007E-07
	Pu-239	1.02455E+02	7.83261E-04	1.89890E+02	1.45169E-03
	Pu-240	6.40704E+01	3.09357E-04	1.93694E+00	9.35230E-06
	Pu-241	1.01751E+02	3.40454E-04	2.20404E+02	7.37464E-04
	Pu-242	2.31965E+01	3.83582E-05	1.51789E+00	2.51001E-06
	Xe-135	1.27084E+05	5.04569E-05	0.00000E+00	0.00000E+00
	Sm-149	3.94915E+03	2.12440E-05	0.00000E+00	0.00000E+00
	Total FP	9.14209E+00	3.16870E-04	0.00000E+00	0.00000E+00
72	U-235	4.39960E+01	1.56883E-05	8.64254E+01	3.08179E-05
	U-236	8.22346E+00	1.61082E-06	8.20785E-01	1.60777E-07
	Pu-238	2.91862E+01	3.17066E-06	6.95066E+00	7.55089E-07
	Pu-239	1.24504E+02	6.73089E-04	2.30819E+02	1.24784E-03
	Pu-240	7.02273E+01	3.31743E-04	1.87178E+00	8.84200E-06
	Pu-241	1.22268E+02	3.30497E-04	2.64576E+02	7.15161E-04
	Pu-242	2.33637E+01	4.19440E-05	1.46098E+00	2.62284E-06
	Xe-135	1.57365E+05	4.30665E-05	0.00000E+00	0.00000E+00
	Sm-149	4.82396E+03	1.68197E-05	0.00000E+00	0.00000E+00
	Total FP	9.37825E+00	3.16163E-04	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Power distribution by pin

1	8.9413E-01	2	8.7493E-01	3	8.5071E-01	4	8.5162E-01	5	8.5802E-01	6	8.5619E-01
7	8.5528E-01	8	8.5391E-01	9	8.4842E-01	10	8.7493E-01	11	8.9413E-01	12	8.7493E-01
13	1.1597E+00	14	1.1241E+00	15	1.1323E+00	16	1.1245E+00	17	1.1282E+00	18	1.1222E+00
19	1.1286E+00	20	1.1264E+00	21	1.1222E+00	22	1.1597E+00	23	8.7493E-01	24	8.4842E-01
25	1.1222E+00	26	1.0861E+00	27	1.0774E+00	28	1.0866E+00	29	1.0998E+00	30	1.1040E+00
31	1.1053E+00	32	1.0765E+00	33	1.0706E+00	34	1.0861E+00	35	1.1241E+00	36	8.5071E-01
37	8.5391E-01	38	1.1264E+00	39	1.0706E+00	40	1.0720E+00	41	1.0902E+00	42	1.1172E+00
43	8.8773E-01	44	8.9825E-01	45	1.1145E+00	46	1.1021E+00	47	1.0720E+00	48	1.0774E+00
49	1.1323E+00	50	8.5162E-01	51	8.5528E-01	52	1.1286E+00	53	1.0765E+00	54	1.1021E+00
55	8.8179E-01	56	9.0602E-01	57	9.2293E-01	58	0.0000E+00	59	9.2430E-01	60	9.0830E-01
61	8.8179E-01	62	1.0902E+00	63	1.0866E+00	64	1.1245E+00	65	8.5802E-01	66	8.5619E-01
67	1.1222E+00	68	1.1053E+00	69	1.1145E+00	70	9.0830E-01	71	0.0000E+00	72	9.5584E-01
73	9.5813E-01	74	9.5493E-01	75	9.3573E-01	76	0.0000E+00	77	9.0602E-01	78	1.1172E+00
79	1.0998E+00	80	1.1282E+00	81	8.5619E-01	82	8.5802E-01	83	1.1282E+00	84	1.1040E+00
85	8.9825E-01	86	9.2430E-01	87	9.3573E-01	88	9.5722E-01	89	9.5082E-01	90	9.4396E-01

91	1.2004E+00	92	9.5722E-01	93	9.5584E-01	94	9.2293E-01	95	8.8773E-01	96	1.1040E+00				
97	1.1222E+00	98	8.5528E-01	99	8.5162E-01	100	1.1245E+00	101	1.0998E+00	102	8.8773E-01				
103	0.0000E+00	104	9.5493E-01	105	1.2004E+00	106	9.5584E-01	107	0.0000E+00	108	9.5539E-01				
109	9.5584E-01	110	9.5082E-01	111	9.5813E-01	112	0.0000E+00	113	8.9825E-01	114	1.1053E+00				
115	1.1286E+00	116	8.5391E-01	117	8.5071E-01	118	1.1323E+00	119	1.0866E+00	120	1.1172E+00				
121	9.2293E-01	122	9.5813E-01	123	9.4396E-01	124	9.5539E-01	125	9.7367E-01	126	9.7321E-01				
127	9.7367E-01	128	0.0000E+00	129	9.4396E-01	130	9.5493E-01	131	9.2430E-01	132	1.1145E+00				
133	1.0765E+00	134	1.1264E+00	135	8.4842E-01	136	8.7493E-01	137	1.1241E+00	138	1.0774E+00				
139	1.0902E+00	140	9.0602E-01	141	9.5584E-01	142	9.5082E-01	143	0.0000E+00	144	9.7321E-01				
145	9.6681E-01	146	9.6681E-01	147	9.7321E-01	148	9.5539E-01	149	1.2004E+00	150	9.3573E-01				
151	9.0830E-01	152	1.1021E+00	153	1.0706E+00	154	1.1222E+00	155	8.7493E-01	156	8.9413E-01				
157	1.1597E+00	158	1.0861E+00	159	1.0720E+00	160	8.8179E-01	161	0.0000E+00	162	9.5722E-01				
163	9.5584E-01	164	9.7367E-01	165	9.6681E-01	166	0.0000E+00	167	9.6681E-01	168	9.7367E-01				
169	9.5584E-01	170	9.5722E-01	171	0.0000E+00	172	8.8179E-01	173	1.0720E+00	174	1.0861E+00				
175	1.1597E+00	176	8.9413E-01	177	8.7493E-01	178	1.1222E+00	179	1.0706E+00	180	1.1021E+00				
181	9.0830E-01	182	9.3573E-01	183	1.2004E+00	184	9.5539E-01	185	9.7321E-01	186	9.6681E-01				
187	9.6681E-01	188	9.7321E-01	189	0.0000E+00	190	9.5082E-01	191	9.5584E-01	192	9.0602E-01				
193	1.0902E+00	194	1.0774E+00	195	1.1241E+00	196	8.7493E-01	197	8.4842E-01	198	1.1264E+00				
199	1.0765E+00	200	1.1145E+00	201	9.2430E-01	202	9.5493E-01	203	9.4396E-01	204	0.0000E+00				
205	9.7367E-01	206	9.7321E-01	207	9.7367E-01	208	9.5539E-01	209	9.4396E-01	210	9.5813E-01				
211	9.2293E-01	212	1.1172E+00	213	1.0866E+00	214	1.1323E+00	215	8.5071E-01	216	8.5391E-01				
217	1.1286E+00	218	1.1053E+00	219	8.9825E-01	220	0.0000E+00	221	9.5813E-01	222	9.5082E-01				
223	9.5584E-01	224	9.5539E-01	225	0.0000E+00	226	9.5584E-01	227	1.2004E+00	228	9.5493E-01				
229	0.0000E+00	230	8.8773E-01	231	1.0998E+00	232	1.1245E+00	233	8.5162E-01	234	8.5528E-01				
235	1.1222E+00	236	1.1040E+00	237	8.8773E-01	238	9.2293E-01	239	9.5584E-01	240	9.5722E-01				
241	1.2004E+00	242	9.4396E-01	243	9.5082E-01	244	9.5722E-01	245	9.3573E-01	246	9.2430E-01				
247	8.9825E-01	248	1.1040E+00	249	1.1282E+00	250	8.5802E-01	251	8.5619E-01	252	1.1282E+00				
253	1.0998E+00	254	1.1172E+00	255	9.0602E-01	256	0.0000E+00	257	9.3573E-01	258	9.5493E-01				
259	9.5813E-01	260	9.5584E-01	261	0.0000E+00	262	9.0830E-01	263	1.1145E+00	264	1.1053E+00				
265	1.1222E+00	266	8.5619E-01	267	8.5802E-01	268	1.1245E+00	269	1.0866E+00	270	1.0902E+00				
271	8.8179E-01	272	9.0830E-01	273	9.2430E-01	274	0.0000E+00	275	9.2293E-01	276	9.0602E-01				
277	8.8179E-01	278	1.1021E+00	279	1.0765E+00	280	1.1286E+00	281	8.5528E-01	282	8.5162E-01				
283	1.1323E+00	284	1.0774E+00	285	1.0720E+00	286	1.1021E+00	287	1.1145E+00	288	8.9825E-01				
289	8.8773E-01	290	1.1172E+00	291	1.0902E+00	292	1.0720E+00	293	1.0706E+00	294	1.1264E+00				
295	8.5391E-01	296	8.5071E-01	297	1.1241E+00	298	1.0861E+00	299	1.0706E+00	300	1.0765E+00				
301	1.1053E+00	302	1.1040E+00	303	1.0998E+00	304	1.0866E+00	305	1.0774E+00	306	1.0861E+00				
307	1.1222E+00	308	8.4842E-01	309	8.7493E-01	310	1.1597E+00	311	1.1222E+00	312	1.1264E+00				
313	1.1286E+00	314	1.1222E+00	315	1.1282E+00	316	1.1245E+00	317	1.1323E+00	318	1.1241E+00				
319	1.1597E+00	320	8.7493E-01	321	8.9413E-01	322	8.7493E-01	323	8.4842E-01	324	8.5391E-01				
325	8.5528E-01	326	8.5619E-01	327	8.5802E-01	328	8.5162E-01	329	8.5071E-01	330	8.7493E-01				
331	8.9413E-01														

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1806E-01	3.3360E-01	1.3624E-01	5.3017E-01
29	1.1761E-01	3.3351E-01	1.3590E-01	5.3059E-01
72	1.1728E-01	3.3383E-01	1.3575E-01	5.3042E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.5494E-02	1.7079E-02	4.9625E-02
29	6.9850E-02	2.1058E-02	6.1208E-02
72	6.7342E-02	1.8397E-02	5.3464E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.85826E+01	1.05071E-05	9.59277E+01	2.07465E-05
	U-236	8.48244E+00	1.77435E-06	8.15553E-01	1.70597E-07
	Pu-238	3.25119E+01	4.57776E-06	7.16978E+00	1.00952E-06
	Pu-239	1.39407E+02	5.71923E-04	2.58636E+02	1.06107E-03
	Pu-240	7.57008E+01	3.04037E-04	1.83639E+00	7.37549E-06
	Pu-241	1.36406E+02	2.94440E-04	2.95036E+02	6.36850E-04
	Pu-242	2.14602E+01	5.00308E-05	1.42903E+00	3.33155E-06
	Xe-135	1.79955E+05	3.76402E-05	0.00000E+00	0.00000E+00
	Sm-149	5.48118E+03	1.45399E-05	0.00000E+00	0.00000E+00
	Total FP	8.85713E+00	3.42459E-04	0.00000E+00	0.00000E+00
29	U-235	4.01916E+01	1.11433E-05	7.87327E+01	2.18289E-05
	U-236	7.98094E+00	1.65156E-06	8.33790E-01	1.72543E-07
	Pu-238	2.65753E+01	4.84698E-06	6.80072E+00	1.24036E-06
	Pu-239	1.11460E+02	7.49420E-04	2.06764E+02	1.39021E-03

Variant 12
State 1

	Pu-240	6.67355E+01	2.94731E-04	1.92394E+00	8.49687E-06
	Pu-241	1.10077E+02	3.42387E-04	2.38389E+02	7.41491E-04
	Pu-242	2.20743E+01	4.69833E-05	1.50609E+00	3.20558E-06
	Xe-135	1.41323E+05	5.11500E-05	0.00000E+00	0.00000E+00
	Sm-149	4.36123E+03	2.14198E-05	0.00000E+00	0.00000E+00
	Total FP	8.60951E+00	3.56577E-04	0.00000E+00	0.00000E+00
72	U-235	4.71927E+01	1.09011E-05	9.31047E+01	2.15064E-05
	U-236	8.10111E+00	1.68140E-06	8.09462E-01	1.68006E-07
	Pu-238	3.14962E+01	4.69848E-06	7.11059E+00	1.06073E-06
	Pu-239	1.35114E+02	6.25556E-04	2.50571E+02	1.16011E-03
	Pu-240	7.52762E+01	3.10147E-04	1.84997E+00	7.62210E-06
	Pu-241	1.32086E+02	3.12299E-04	2.85691E+02	6.75479E-04
	Pu-242	2.13897E+01	4.85333E-05	1.44081E+00	3.26920E-06
	Xe-135	1.73964E+05	4.14434E-05	0.00000E+00	0.00000E+00
	Sm-149	5.31783E+03	1.62683E-05	0.00000E+00	0.00000E+00
	Total FP	8.83949E+00	3.46623E-04	0.00000E+00	0.00000E+00

Variant 12
State 2

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	.8492	1.0010	.0013
10.00	.7576	.8934	.0013
20.00	.6966	.8210	.0012
30.00	.6488	.7634	.0011
40.00	.6045	.7129	.0011
50.00	.5689	.6695	.0010
60.00	.5381	.6344	.0010

Additional data

Burnup = 0 MWd/kgU

Power distribution by pin

1	1.3621E+00	2	1.3143E+00	3	1.2681E+00	4	1.2857E+00	5	1.2265E+00	6	1.2295E+00
7	1.2482E+00	8	1.2203E+00	9	1.2501E+00	10	1.3004E+00	11	1.3621E+00	12	1.3004E+00
13	1.1990E+00	14	1.1413E+00	15	1.0928E+00	16	1.0965E+00	17	1.0980E+00	18	1.1112E+00
19	1.0980E+00	20	1.1134E+00	21	1.1553E+00	22	1.1990E+00	23	1.3143E+00	24	1.2501E+00
25	1.1553E+00	26	1.0803E+00	27	1.0800E+00	28	1.0241E+00	29	9.9145E-01	30	9.9291E-01
31	9.9255E-01	32	1.0440E+00	33	1.0506E+00	34	1.0803E+00	35	1.1413E+00	36	1.2681E+00
37	1.2203E+00	38	1.1134E+00	39	1.0506E+00	40	1.0054E+00	41	9.7969E-01	42	9.2900E-01
43	8.8749E-01	44	9.1541E-01	45	9.3634E-01	46	9.9108E-01	47	1.0054E+00	48	1.0800E+00
49	1.0928E+00	50	1.2857E+00	51	1.2482E+00	52	1.0980E+00	53	1.0440E+00	54	9.9108E-01
55	8.7390E-01	56	8.4451E-01	57	8.1843E-01	58	0.0000E+00	59	8.2798E-01	60	8.4855E-01
61	8.7390E-01	62	9.7969E-01	63	1.0241E+00	64	1.0965E+00	65	1.2265E+00	66	1.2295E+00
67	1.1112E+00	68	9.9255E-01	69	9.3634E-01	70	8.4855E-01	71	0.0000E+00	72	7.7839E-01
73	7.8243E-01	74	7.9382E-01	75	7.9676E-01	76	0.0000E+00	77	8.4451E-01	78	9.2900E-01
79	9.9145E-01	80	1.0980E+00	81	1.2295E+00	82	1.2265E+00	83	1.0980E+00	84	9.9291E-01
85	9.1541E-01	86	8.2798E-01	87	7.9676E-01	88	7.5708E-01	89	7.4900E-01	90	7.4863E-01
91	7.7802E-01	92	7.5708E-01	93	7.7839E-01	94	8.1843E-01	95	8.8749E-01	96	9.9291E-01
97	1.1112E+00	98	1.2482E+00	99	1.2857E+00	100	1.0965E+00	101	9.9145E-01	102	8.8749E-01
103	0.0000E+00	104	7.9382E-01	105	7.7802E-01	106	7.5121E-01	107	0.0000E+00	108	7.3798E-01
109	7.5121E-01	110	7.4900E-01	111	7.8243E-01	112	0.0000E+00	113	9.1541E-01	114	9.9255E-01
115	1.0980E+00	116	1.2203E+00	117	1.2681E+00	118	1.0928E+00	119	1.0241E+00	120	9.2900E-01
121	8.1843E-01	122	7.8243E-01	123	7.4863E-01	124	7.3798E-01	125	7.4900E-01	126	7.8280E-01
127	7.4900E-01	128	0.0000E+00	129	7.4863E-01	130	7.9382E-01	131	8.2798E-01	132	9.3634E-01
133	1.0440E+00	134	1.1134E+00	135	1.2501E+00	136	1.3143E+00	137	1.1413E+00	138	1.0800E+00
139	9.7969E-01	140	8.4451E-01	141	7.7839E-01	142	7.4900E-01	143	0.0000E+00	144	7.8280E-01
145	8.7059E-01	146	8.7059E-01	147	7.8280E-01	148	7.3798E-01	149	7.7802E-01	150	7.9676E-01
151	8.4855E-01	152	9.9108E-01	153	1.0506E+00	154	1.1553E+00	155	1.3004E+00	156	1.3621E+00
157	1.1990E+00	158	1.0803E+00	159	1.0054E+00	160	8.7390E-01	161	0.0000E+00	162	7.5708E-01
163	7.5121E-01	164	7.4900E-01	165	8.7059E-01	166	0.0000E+00	167	8.7059E-01	168	7.4900E-01
169	7.5121E-01	170	7.5708E-01	171	0.0000E+00	172	8.7390E-01	173	1.0054E+00	174	1.0803E+00
175	1.1990E+00	176	1.3621E+00	177	1.3004E+00	178	1.1553E+00	179	1.0506E+00	180	9.9108E-01
181	8.4855E-01	182	7.9676E-01	183	7.7802E-01	184	7.3798E-01	185	7.8280E-01	186	8.7059E-01
187	8.7059E-01	188	7.8280E-01	189	0.0000E+00	190	7.4900E-01	191	7.7839E-01	192	8.4451E-01
193	9.7969E-01	194	1.0800E+00	195	1.1413E+00	196	1.3143E+00	197	1.2501E+00	198	1.1134E+00
199	1.0440E+00	200	9.3634E-01	201	8.2798E-01	202	7.9382E-01	203	7.4863E-01	204	0.0000E+00
205	7.4900E-01	206	7.8280E-01	207	7.4900E-01	208	7.3798E-01	209	7.4863E-01	210	7.8243E-01
211	8.1843E-01	212	9.2900E-01	213	1.0241E+00	214	1.0928E+00	215	1.2681E+00	216	1.2203E+00
217	1.0980E+00	218	9.9255E-01	219	9.1541E-01	220	0.0000E+00	221	7.8243E-01	222	7.4900E-01
223	7.5121E-01	224	7.3798E-01	225	0.0000E+00	226	7.5121E-01	227	7.7802E-01	228	7.9382E-01
229	0.0000E+00	230	8.8749E-01	231	9.9145E-01	232	1.0965E+00	233	1.2857E+00	234	1.2482E+00
235	1.1112E+00	236	9.9291E-01	237	8.8749E-01	238	8.1843E-01	239	7.7839E-01	240	7.5708E-01
241	7.7802E-01	242	7.4863E-01	243	7.4900E-01	244	7.5708E-01	245	7.9676E-01	246	8.2798E-01
247	9.1541E-01	248	9.9291E-01	249	1.0980E+00	250	1.2265E+00	251	1.2295E+00	252	1.0980E+00
253	9.9145E-01	254	9.2900E-01	255	8.4451E-01	256	0.0000E+00	257	7.9676E-01	258	7.9382E-01
259	7.8243E-01	260	7.7839E-01	261	0.0000E+00	262	8.4855E-01	263	9.3634E-01	264	9.9255E-01
265	1.1112E+00	266	1.2295E+00	267	1.2265E+00	268	1.0965E+00	269	1.0241E+00	270	9.7969E-01
271	8.7390E-01	272	8.4855E-01	273	8.2798E-01	274	0.0000E+00	275	8.1843E-01	276	8.4451E-01
277	8.7390E-01	278	9.9108E-01	279	1.0440E+00	280	1.0980E+00	281	1.2482E+00	282	1.2857E+00
283	1.0928E+00	284	1.0800E+00	285	1.0054E+00	286	9.9108E-01	287	9.3634E-01	288	9.1541E-01
289	8.8749E-01	290	9.2900E-01	291	9.7969E-01	292	1.0054E+00	293	1.0506E+00	294	1.1134E+00
295	1.2203E+00	296	1.2681E+00	297	1.1413E+00	298	1.0803E+00	299	1.0506E+00	300	1.0440E+00
301	9.9255E-01	302	9.9291E-01	303	9.9145E-01	304	1.0241E+00	305	1.0800E+00	306	1.0803E+00
307	1.1553E+00	308	1.2501E+00	309	1.3143E+00	310	1.1990E+00	311	1.1553E+00	312	1.1134E+00
313	1.0980E+00	314	1.1112E+00	315	1.0980E+00	316	1.0965E+00	317	1.0928E+00	318	1.1413E+00
319	1.1990E+00	320	1.3004E+00	321	1.3621E+00	322	1.3004E+00	323	1.2501E+00	324	1.2203E+00
325	1.2482E+00	326	1.2295E+00	327	1.2265E+00	328	1.2857E+00	329	1.2681E+00	330	1.3143E+00
331	1.3621E+00										

Variant 12
State 2

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1923E-01	3.3388E-01	1.3585E-01	5.3027E-01
29	1.1131E-01	3.3304E-01	1.3549E-01	5.3147E-01
72	1.0265E-01	3.3412E-01	1.3565E-01	5.3023E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.2770E-02	3.1897E-02	9.1640E-02
29	6.0750E-02	2.5041E-02	7.1928E-02
72	5.4279E-02	2.1444E-02	6.1583E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	2.78863E+01	4.26198E-05	5.32546E+01	8.13912E-05
	U-236	8.75570E+00	0.00000E+00	8.90022E-01	0.00000E+00
	Pu-238	1.75860E+01	0.00000E+00	6.19969E+00	0.00000E+00
	Pu-239	6.69292E+01	1.75511E-03	1.24599E+02	3.26741E-03
	Pu-240	1.00006E+02	1.68489E-04	2.03949E+00	3.43610E-06
	Pu-241	7.05035E+01	1.97152E-05	1.53206E+02	4.28416E-05
	Pu-242	3.19496E+01	0.00000E+00	1.58679E+00	0.00000E+00
	Xe-135	7.99279E+04	3.00934E-05	0.00000E+00	0.00000E+00
	Sm-149	2.50889E+03	7.35737E-06	0.00000E+00	0.00000E+00
	Total FP	1.13177E+04	3.74508E-05	0.00000E+00	0.00000E+00
29	U-235	2.29277E+01	3.26323E-05	4.30521E+01	6.12747E-05
	U-236	8.73930E+00	0.00000E+00	8.93416E-01	0.00000E+00
	Pu-238	1.41077E+01	0.00000E+00	5.96883E+00	0.00000E+00
	Pu-239	5.14454E+01	1.25633E-03	9.56001E+01	2.33461E-03
	Pu-240	9.14400E+01	1.43466E-04	2.05830E+00	3.22939E-06
	Pu-241	5.55951E+01	1.44775E-05	1.21144E+02	3.15470E-05
	Pu-242	3.01917E+01	0.00000E+00	1.60319E+00	0.00000E+00
	Xe-135	5.62815E+04	1.97335E-05	0.00000E+00	0.00000E+00
	Sm-149	1.79626E+03	4.90543E-06	0.00000E+00	0.00000E+00
	Total FP	7.99567E+03	2.46389E-05	0.00000E+00	0.00000E+00
72	U-235	2.00531E+01	2.64055E-05	3.71502E+01	4.89187E-05
	U-236	7.61782E+00	0.00000E+00	8.60913E-01	0.00000E+00
	Pu-238	1.20695E+01	0.00000E+00	5.86899E+00	0.00000E+00
	Pu-239	4.35017E+01	9.82852E-04	8.04770E+01	1.81825E-03
	Pu-240	7.71609E+01	1.12005E-04	2.05406E+00	2.98162E-06
	Pu-241	4.73051E+01	1.13970E-05	1.03266E+02	2.48794E-05
	Pu-242	2.67683E+01	0.00000E+00	1.60290E+00	0.00000E+00
	Xe-135	4.30542E+04	1.39663E-05	0.00000E+00	0.00000E+00
	Sm-149	1.40094E+03	3.53959E-06	0.00000E+00	0.00000E+00
	Total FP	6.14031E+03	1.75059E-05	0.00000E+00	0.00000E+00

Burnup = 10 MWd/kgU

Power distribution by pin

1	1.2960E+00	2	1.2812E+00	3	1.2071E+00	4	1.2116E+00	5	1.1996E+00	6	1.2091E+00
7	1.1996E+00	8	1.1968E+00	9	1.2334E+00	10	1.2610E+00	11	1.2960E+00	12	1.2610E+00
13	1.2211E+00	14	1.1786E+00	15	1.1683E+00	16	1.1321E+00	17	1.1304E+00	18	1.1127E+00
19	1.1037E+00	20	1.1531E+00	21	1.1758E+00	22	1.2211E+00	23	1.2812E+00	24	1.2334E+00
25	1.1758E+00	26	1.1148E+00	27	1.0892E+00	28	1.0410E+00	29	1.0324E+00	30	1.0217E+00
31	1.0295E+00	32	1.0489E+00	33	1.0905E+00	34	1.1148E+00	35	1.1786E+00	36	1.2071E+00
37	1.1968E+00	38	1.1531E+00	39	1.0905E+00	40	1.0274E+00	41	9.8501E-01	42	9.7430E-01
43	8.7955E-01	44	8.8284E-01	45	9.7883E-01	46	9.8872E-01	47	1.0274E+00	48	1.0892E+00
49	1.1683E+00	50	1.2116E+00	51	1.1996E+00	52	1.1037E+00	53	1.0489E+00	54	9.8872E-01
55	8.7749E-01	56	8.3011E-01	57	8.1157E-01	58	0.0000E+00	59	8.3547E-01	60	8.3629E-01
61	8.7749E-01	62	9.8501E-01	63	1.0410E+00	64	1.1321E+00	65	1.1996E+00	66	1.2091E+00
67	1.1127E+00	68	1.0295E+00	69	9.7883E-01	70	8.3629E-01	71	0.0000E+00	72	7.6337E-01
73	7.5596E-01	74	7.5719E-01	75	7.8438E-01	76	0.0000E+00	77	8.3011E-01	78	9.7430E-01
79	1.0324E+00	80	1.1304E+00	81	1.2091E+00	82	1.1996E+00	83	1.1304E+00	84	1.0217E+00
85	8.8284E-01	86	8.3547E-01	87	7.8438E-01	88	7.5884E-01	89	7.6008E-01	90	7.3783E-01
91	7.9798E-01	92	7.5884E-01	93	7.6337E-01	94	8.1157E-01	95	8.7955E-01	96	1.0217E+00
97	1.1127E+00	98	1.1996E+00	99	1.2116E+00	100	1.1321E+00	101	1.0324E+00	102	8.7955E-01
103	0.0000E+00	104	7.5719E-01	105	7.9798E-01	106	7.2959E-01	107	0.0000E+00	108	7.4937E-01
109	7.2959E-01	110	7.6008E-01	111	7.5596E-01	112	0.0000E+00	113	8.8284E-01	114	1.0295E+00
115	1.1037E+00	116	1.1968E+00	117	1.2071E+00	118	1.1683E+00	119	1.0410E+00	120	9.7430E-01
121	8.1157E-01	122	7.5596E-01	123	7.3783E-01	124	7.4937E-01	125	7.4607E-01	126	7.6420E-01

127	7.4607E-01	128	0.0000E+00	129	7.3783E-01	130	7.5719E-01	131	8.3547E-01	132	9.7883E-01
133	1.0489E+00	134	1.1531E+00	135	1.2334E+00	136	1.2812E+00	137	1.1786E+00	138	1.0892E+00
139	9.8501E-01	140	8.3011E-01	141	7.6337E-01	142	7.6008E-01	143	0.0000E+00	144	7.6420E-01
145	8.4824E-01	146	8.4824E-01	147	7.6420E-01	148	7.4937E-01	149	7.9798E-01	150	7.8438E-01
151	8.3629E-01	152	9.8872E-01	153	1.0905E+00	154	1.1758E+00	155	1.2610E+00	156	1.2960E+00
157	1.2211E+00	158	1.1148E+00	159	1.0274E+00	160	8.7749E-01	161	0.0000E+00	162	7.5884E-01
163	7.2959E-01	164	7.4607E-01	165	8.4824E-01	166	0.0000E+00	167	8.4824E-01	168	7.4607E-01
169	7.2959E-01	170	7.5884E-01	171	0.0000E+00	172	8.7749E-01	173	1.0274E+00	174	1.1148E+00
175	1.2211E+00	176	1.2960E+00	177	1.2610E+00	178	1.1758E+00	179	1.0905E+00	180	9.8872E-01
181	8.3629E-01	182	7.8438E-01	183	7.9798E-01	184	7.4937E-01	185	7.6420E-01	186	8.4824E-01
187	8.4824E-01	188	7.6420E-01	189	0.0000E+00	190	7.6008E-01	191	7.6337E-01	192	8.3011E-01
193	9.8501E-01	194	1.0892E+00	195	1.1786E+00	196	1.2812E+00	197	1.2334E+00	198	1.1531E+00
199	1.0489E+00	200	9.7883E-01	201	8.3547E-01	202	7.5719E-01	203	7.3783E-01	204	0.0000E+00
205	7.4607E-01	206	7.6420E-01	207	7.4607E-01	208	7.4937E-01	209	7.3783E-01	210	7.5596E-01
211	8.1157E-01	212	9.7430E-01	213	1.0410E+00	214	1.1683E+00	215	1.2071E+00	216	1.1968E+00
217	1.1037E+00	218	1.0295E+00	219	8.8284E-01	220	0.0000E+00	221	7.5596E-01	222	7.6008E-01
223	7.2959E-01	224	7.4937E-01	225	0.0000E+00	226	7.2959E-01	227	7.9798E-01	228	7.5719E-01
229	0.0000E+00	230	8.7955E-01	231	1.0324E+00	232	1.1321E+00	233	1.2116E+00	234	1.1996E+00
235	1.1127E+00	236	1.0217E+00	237	8.7955E-01	238	8.1157E-01	239	7.6337E-01	240	7.5884E-01
241	7.9798E-01	242	7.3783E-01	243	7.6008E-01	244	7.5884E-01	245	7.8438E-01	246	8.3547E-01
247	8.8284E-01	248	1.0217E+00	249	1.1304E+00	250	1.1996E+00	251	1.2091E+00	252	1.1304E+00
253	1.0324E+00	254	9.7430E-01	255	8.3011E-01	256	0.0000E+00	257	7.8438E-01	258	7.5719E-01
259	7.5596E-01	260	7.6337E-01	261	0.0000E+00	262	8.3629E-01	263	9.7883E-01	264	1.0295E+00
265	1.1127E+00	266	1.2091E+00	267	1.1996E+00	268	1.1321E+00	269	1.0410E+00	270	9.8501E-01
271	8.7749E-01	272	8.3629E-01	273	8.3547E-01	274	0.0000E+00	275	8.1157E-01	276	8.3011E-01
277	8.7749E-01	278	9.8872E-01	279	1.0489E+00	280	1.1037E+00	281	1.1996E+00	282	1.2116E+00
283	1.1683E+00	284	1.0892E+00	285	1.0274E+00	286	9.8872E-01	287	9.7883E-01	288	8.8284E-01
289	8.7955E-01	290	9.7430E-01	291	9.8501E-01	292	1.0274E+00	293	1.0905E+00	294	1.1531E+00
295	1.1968E+00	296	1.2071E+00	297	1.1786E+00	298	1.1148E+00	299	1.0905E+00	300	1.0489E+00
301	1.0295E+00	302	1.0217E+00	303	1.0324E+00	304	1.0410E+00	305	1.0892E+00	306	1.1148E+00
307	1.1758E+00	308	1.2334E+00	309	1.2812E+00	310	1.2211E+00	311	1.1758E+00	312	1.1531E+00
313	1.1037E+00	314	1.1127E+00	315	1.1304E+00	316	1.1321E+00	317	1.1683E+00	318	1.1786E+00
319	1.2211E+00	320	1.2610E+00	321	1.2960E+00	322	1.2610E+00	323	1.2334E+00	324	1.1968E+00
325	1.1996E+00	326	1.2091E+00	327	1.1996E+00	328	1.2116E+00	329	1.2071E+00	330	1.2812E+00
331	1.2960E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.1920E-01	3.3512E-01	1.3608E-01	5.2879E-01
29	1.1193E-01	3.3415E-01	1.3628E-01	5.2957E-01
72	1.0274E-01	3.3329E-01	1.3580E-01	5.3091E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.1557E-02	2.7446E-02	7.8951E-02
29	6.2454E-02	2.3386E-02	6.7272E-02
72	5.3818E-02	1.8828E-02	5.4127E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	2.95857E+01	3.70304E-05	5.67136E+01	7.09844E-05
	U-236	8.38897E+00	4.88902E-07	8.71656E-01	5.07994E-08
	Pu-238	1.88271E+01	4.12063E-08	6.29052E+00	1.37679E-08
	Pu-239	7.47040E+01	1.39796E-03	1.38557E+02	2.59287E-03
	Pu-240	7.03582E+01	2.91996E-04	2.00075E+00	8.30336E-06
	Pu-241	7.67056E+01	1.07461E-04	1.66498E+02	2.33256E-04
	Pu-242	3.21782E+01	3.56849E-06	1.56853E+00	1.73947E-07
	Xe-135	8.72696E+04	4.89182E-05	0.00000E+00	0.00000E+00
	Sm-149	2.73300E+03	1.56667E-05	0.00000E+00	0.00000E+00
	Total FP	1.58526E+01	1.34070E-04	0.00000E+00	0.00000E+00
29	U-235	2.43498E+01	2.90100E-05	4.60151E+01	5.48216E-05
	U-236	8.41448E+00	4.58474E-07	8.91213E-01	4.85589E-08
	Pu-238	1.51918E+01	3.54372E-08	6.06907E+00	1.41570E-08
	Pu-239	5.73280E+01	1.09463E-03	1.06396E+02	2.03154E-03
	Pu-240	6.40258E+01	2.24642E-04	2.05109E+00	7.19649E-06
	Pu-241	6.04958E+01	8.36131E-05	1.31606E+02	1.81897E-04
	Pu-242	2.93657E+01	2.74008E-06	1.61075E+00	1.50298E-07
	Xe-135	6.38933E+04	3.77238E-05	0.00000E+00	0.00000E+00
	Sm-149	2.02699E+03	1.37713E-05	0.00000E+00	0.00000E+00
	Total FP	1.46127E+01	1.05687E-04	0.00000E+00	0.00000E+00

72	U-235	2.10163E+01	2.26682E-05	3.91988E+01	4.22798E-05
	U-236	7.83408E+00	3.89844E-07	8.70235E-01	4.33051E-08
	Pu-238	1.28108E+01	2.43379E-08	5.90983E+00	1.12274E-08
	Pu-239	4.77633E+01	7.86763E-04	8.82512E+01	1.45368E-03
	Pu-240	5.39949E+01	1.86524E-04	2.04170E+00	7.05300E-06
	Pu-241	5.03436E+01	6.09463E-05	1.09817E+02	1.32945E-04
	Pu-242	2.68145E+01	2.45412E-06	1.60534E+00	1.46925E-07
	Xe-135	4.79513E+04	2.36253E-05	0.00000E+00	0.00000E+00
	Sm-149	1.52450E+03	7.89641E-06	0.00000E+00	0.00000E+00
	Total FP	1.11294E+01	7.83346E-05	0.00000E+00	0.00000E+00

Burnup = 20 MWd/kgU

Power distribution by pin

1	1.2808E+00	2	1.2065E+00	3	1.1827E+00	4	1.1872E+00	5	1.1814E+00	6	1.1823E+00
7	1.1827E+00	8	1.1935E+00	9	1.1877E+00	10	1.2226E+00	11	1.2808E+00	12	1.2226E+00
13	1.2589E+00	14	1.2150E+00	15	1.1997E+00	16	1.1756E+00	17	1.1702E+00	18	1.1621E+00
19	1.1576E+00	20	1.1957E+00	21	1.2132E+00	22	1.2589E+00	23	1.2065E+00	24	1.1877E+00
25	1.2132E+00	26	1.1518E+00	27	1.1111E+00	28	1.0694E+00	29	1.0618E+00	30	1.0426E+00
31	1.0372E+00	32	1.0949E+00	33	1.1290E+00	34	1.1518E+00	35	1.2150E+00	36	1.1827E+00
37	1.1935E+00	38	1.1957E+00	39	1.1290E+00	40	1.0591E+00	41	1.0040E+00	42	9.9419E-01
43	8.6566E-01	44	8.5357E-01	45	9.7627E-01	46	1.0099E+00	47	1.0591E+00	48	1.1111E+00
49	1.1997E+00	50	1.1872E+00	51	1.1827E+00	52	1.1576E+00	53	1.0949E+00	54	1.0099E+00
55	8.5536E-01	56	8.0834E-01	57	7.9535E-01	58	0.0000E+00	59	8.0520E-01	60	8.2849E-01
61	8.5536E-01	62	1.0040E+00	63	1.0694E+00	64	1.1756E+00	65	1.1814E+00	66	1.1823E+00
67	1.1621E+00	68	1.0372E+00	69	9.7627E-01	70	8.2849E-01	71	0.0000E+00	72	7.4071E-01
73	7.5146E-01	74	7.3221E-01	75	7.4385E-01	76	0.0000E+00	77	8.0834E-01	78	9.9419E-01
79	1.0618E+00	80	1.1702E+00	81	1.1823E+00	82	1.1814E+00	83	1.1702E+00	84	1.0426E+00
85	8.5357E-01	86	8.0520E-01	87	7.4385E-01	88	7.3489E-01	89	7.2280E-01	90	7.0802E-01
91	8.2491E-01	92	7.3489E-01	93	7.4071E-01	94	7.9535E-01	95	8.6566E-01	96	1.0426E+00
97	1.1621E+00	98	1.1827E+00	99	1.1872E+00	100	1.1756E+00	101	1.0618E+00	102	8.6566E-01
103	0.0000E+00	104	7.3221E-01	105	8.2491E-01	106	7.0354E-01	107	0.0000E+00	108	7.1384E-01
109	7.0354E-01	110	7.2280E-01	111	7.5146E-01	112	0.0000E+00	113	8.5357E-01	114	1.0372E+00
115	1.1576E+00	116	1.1935E+00	117	1.1827E+00	118	1.1997E+00	119	1.0694E+00	120	9.9419E-01
121	7.9535E-01	122	7.5146E-01	123	7.0802E-01	124	7.1384E-01	125	7.2862E-01	126	7.4519E-01
127	7.2862E-01	128	0.0000E+00	129	7.0802E-01	130	7.3221E-01	131	8.0520E-01	132	9.7627E-01
133	1.0949E+00	134	1.1957E+00	135	1.1877E+00	136	1.2065E+00	137	1.2150E+00	138	1.1111E+00
139	1.0040E+00	140	8.0834E-01	141	7.4071E-01	142	7.2280E-01	143	0.0000E+00	144	7.4519E-01
145	8.4148E-01	146	8.4148E-01	147	7.4519E-01	148	7.1384E-01	149	8.2491E-01	150	7.4385E-01
151	8.2849E-01	152	1.0099E+00	153	1.1290E+00	154	1.2132E+00	155	1.2226E+00	156	1.2808E+00
157	1.2589E+00	158	1.1518E+00	159	1.0591E+00	160	8.5536E-01	161	0.0000E+00	162	7.3489E-01
163	7.0354E-01	164	7.2862E-01	165	8.4148E-01	166	0.0000E+00	167	8.4148E-01	168	7.2862E-01
169	7.0354E-01	170	7.3489E-01	171	0.0000E+00	172	8.5536E-01	173	1.0591E+00	174	1.1518E+00
175	1.2589E+00	176	1.2808E+00	177	1.2226E+00	178	1.2132E+00	179	1.1290E+00	180	1.0099E+00
181	8.2849E-01	182	7.4385E-01	183	8.2491E-01	184	7.1384E-01	185	7.4519E-01	186	8.4148E-01
187	8.4148E-01	188	7.4519E-01	189	0.0000E+00	190	7.2280E-01	191	7.4071E-01	192	8.0834E-01
193	1.0040E+00	194	1.1111E+00	195	1.2150E+00	196	1.2065E+00	197	1.1877E+00	198	1.1957E+00
199	1.0949E+00	200	9.7627E-01	201	8.0520E-01	202	7.3221E-01	203	7.0802E-01	204	0.0000E+00
205	7.2862E-01	206	7.4519E-01	207	7.2862E-01	208	7.1384E-01	209	7.0802E-01	210	7.5146E-01
211	7.9535E-01	212	9.9419E-01	213	1.0694E+00	214	1.1997E+00	215	1.1827E+00	216	1.1935E+00
217	1.1576E+00	218	1.0372E+00	219	8.5357E-01	220	0.0000E+00	221	7.5146E-01	222	7.2280E-01
223	7.0354E-01	224	7.1384E-01	225	0.0000E+00	226	7.0354E-01	227	8.2491E-01	228	7.3221E-01
229	0.0000E+00	230	8.6566E-01	231	1.0618E+00	232	1.1756E+00	233	1.1872E+00	234	1.1827E+00
235	1.1621E+00	236	1.0426E+00	237	8.6566E-01	238	7.9535E-01	239	7.4071E-01	240	7.3489E-01
241	8.2491E-01	242	7.0802E-01	243	7.2280E-01	244	7.3489E-01	245	7.4385E-01	246	8.0520E-01
247	8.5357E-01	248	1.0426E+00	249	1.1702E+00	250	1.1814E+00	251	1.1823E+00	252	1.1702E+00
253	1.0618E+00	254	9.9419E-01	255	8.0834E-01	256	0.0000E+00	257	7.4385E-01	258	7.3221E-01
259	7.5146E-01	260	7.4071E-01	261	0.0000E+00	262	8.2849E-01	263	9.7627E-01	264	1.0372E+00
265	1.1621E+00	266	1.1823E+00	267	1.1814E+00	268	1.1756E+00	269	1.0694E+00	270	1.0040E+00
271	8.5536E-01	272	8.2849E-01	273	8.0520E-01	274	0.0000E+00	275	7.9535E-01	276	8.0834E-01
277	8.5536E-01	278	1.0099E+00	279	1.0949E+00	280	1.1576E+00	281	1.1827E+00	282	1.1872E+00
283	1.1997E+00	284	1.1111E+00	285	1.0591E+00	286	1.0099E+00	287	9.7627E-01	288	8.5357E-01
289	8.6566E-01	290	9.9419E-01	291	1.0040E+00	292	1.0591E+00	293	1.1290E+00	294	1.1957E+00
295	1.1935E+00	296	1.1827E+00	297	1.2150E+00	298	1.1518E+00	299	1.1290E+00	300	1.0949E+00
301	1.0372E+00	302	1.0426E+00	303	1.0618E+00	304	1.0694E+00	305	1.1111E+00	306	1.1518E+00
307	1.2132E+00	308	1.1877E+00	309	1.2065E+00	310	1.2589E+00	311	1.2132E+00	312	1.1957E+00
313	1.1576E+00	314	1.1621E+00	315	1.1702E+00	316	1.1756E+00	317	1.1997E+00	318	1.2150E+00
319	1.2589E+00	320	1.2226E+00	321	1.2808E+00	322	1.2226E+00	323	1.1877E+00	324	1.1935E+00
325	1.1827E+00	326	1.1823E+00	327	1.1814E+00	328	1.1872E+00	329	1.1827E+00	330	1.2065E+00
331	1.2808E+00										

Variant 12
State 2

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.2035E-01	3.3461E-01	1.3607E-01	5.2932E-01
29	1.1301E-01	3.3320E-01	1.3614E-01	5.3065E-01
72	1.0283E-01	3.3386E-01	1.3561E-01	5.3053E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	7.0691E-02	2.4694E-02	7.1199E-02
29	6.2001E-02	2.1754E-02	6.2713E-02
72	5.2734E-02	1.6852E-02	4.8542E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.34326E+01	3.30604E-05	6.46105E+01	6.38911E-05
	U-236	8.22541E+00	9.04874E-07	8.61797E-01	9.48058E-08
	Pu-238	2.16415E+01	2.58270E-07	6.49247E+00	7.74814E-08
	Pu-239	8.68818E+01	1.12492E-03	1.61267E+02	2.08803E-03
	Pu-240	6.34544E+01	3.47049E-04	1.97070E+00	1.07783E-05
	Pu-241	8.81594E+01	2.09376E-04	1.91231E+02	4.54168E-04
	Pu-242	3.02253E+01	1.20805E-05	1.54609E+00	6.17944E-07
	Xe-135	1.06602E+05	4.89533E-05	0.00000E+00	0.00000E+00
	Sm-149	3.30212E+03	1.69524E-05	0.00000E+00	0.00000E+00
	Total FP	1.19604E+01	1.93241E-04	0.00000E+00	0.00000E+00
29	U-235	2.56080E+01	2.46948E-05	4.86549E+01	4.69199E-05
	U-236	8.33304E+00	8.54828E-07	8.77583E-01	9.00251E-08
	Pu-238	1.61657E+01	2.04389E-07	6.12398E+00	7.74276E-08
	Pu-239	6.33229E+01	9.33355E-04	1.17255E+02	1.72829E-03
	Pu-240	5.49933E+01	2.54849E-04	2.02598E+00	9.38876E-06
	Pu-241	6.48439E+01	1.56412E-04	1.40978E+02	3.40058E-04
	Pu-242	2.78587E+01	9.16083E-06	1.59206E+00	5.23519E-07
	Xe-135	7.10662E+04	3.80659E-05	0.00000E+00	0.00000E+00
	Sm-149	2.23626E+03	1.50619E-05	0.00000E+00	0.00000E+00
	Total FP	1.06892E+01	1.51737E-04	0.00000E+00	0.00000E+00
72	U-235	2.21973E+01	1.89705E-05	4.16318E+01	3.55798E-05
	U-236	7.38128E+00	6.89008E-07	8.42782E-01	7.86698E-08
	Pu-238	1.36695E+01	1.41049E-07	5.97035E+00	6.16048E-08
	Pu-239	5.39225E+01	6.32038E-04	9.92652E+01	1.16351E-03
	Pu-240	4.79034E+01	2.17625E-04	2.00796E+00	9.12217E-06
	Pu-241	5.50945E+01	1.13501E-04	1.19745E+02	2.46690E-04
	Pu-242	2.44841E+01	7.97639E-06	1.57879E+00	5.14336E-07
	Xe-135	5.41803E+04	2.24397E-05	0.00000E+00	0.00000E+00
	Sm-149	1.73786E+03	8.25606E-06	0.00000E+00	0.00000E+00
	Total FP	8.44636E+00	1.13914E-04	0.00000E+00	0.00000E+00

Burnup = 30 MWd/kgU

Power distribution by pin

1	1.2286E+00	2	1.1882E+00	3	1.1435E+00	4	1.1161E+00	5	1.1046E+00	6	1.1219E+00
7	1.0844E+00	8	1.1099E+00	9	1.1382E+00	10	1.1426E+00	11	1.2286E+00	12	1.1426E+00
13	1.3166E+00	14	1.2791E+00	15	1.2262E+00	16	1.2022E+00	17	1.2195E+00	18	1.2070E+00
19	1.2224E+00	20	1.2517E+00	21	1.2762E+00	22	1.3166E+00	23	1.1882E+00	24	1.1382E+00
25	1.2762E+00	26	1.1950E+00	27	1.1536E+00	28	1.1185E+00	29	1.1074E+00	30	1.1137E+00
31	1.1026E+00	32	1.1233E+00	33	1.1368E+00	34	1.1950E+00	35	1.2791E+00	36	1.1435E+00
37	1.1099E+00	38	1.2517E+00	39	1.1368E+00	40	1.0940E+00	41	1.0353E+00	42	1.0146E+00
43	8.2229E-01	44	8.4153E-01	45	1.0204E+00	46	1.0228E+00	47	1.0940E+00	48	1.1536E+00
49	1.2262E+00	50	1.1161E+00	51	1.0844E+00	52	1.2224E+00	53	1.1233E+00	54	1.0228E+00
55	8.2902E-01	56	8.0883E-01	57	7.9488E-01	58	0.0000E+00	59	7.7901E-01	60	8.0738E-01
61	8.2902E-01	62	1.0353E+00	63	1.1185E+00	64	1.2022E+00	65	1.1046E+00	66	1.1219E+00
67	1.2070E+00	68	1.1026E+00	69	1.0204E+00	70	8.0738E-01	71	0.0000E+00	72	7.4391E-01
73	7.0351E-01	74	7.2035E-01	75	7.5497E-01	76	0.0000E+00	77	8.0883E-01	78	1.0146E+00
79	1.1074E+00	80	1.2195E+00	81	1.1219E+00	82	1.1046E+00	83	1.2195E+00	84	1.1137E+00
85	8.4153E-01	86	7.7901E-01	87	7.5497E-01	88	7.3141E-01	89	6.9005E-01	90	7.0784E-01
91	8.2325E-01	92	7.3141E-01	93	7.4391E-01	94	7.9488E-01	95	8.2229E-01	96	1.1137E+00
97	1.2070E+00	98	1.0844E+00	99	1.1161E+00	100	1.2022E+00	101	1.1074E+00	102	8.2229E-01
103	0.0000E+00	104	7.2035E-01	105	8.2325E-01	106	7.0640E-01	107	0.0000E+00	108	6.9871E-01
109	7.0640E-01	110	6.9005E-01	111	7.0351E-01	112	0.0000E+00	113	8.4153E-01	114	1.1026E+00
115	1.2224E+00	116	1.1099E+00	117	1.1435E+00	118	1.2262E+00	119	1.1185E+00	120	1.0146E+00
121	7.9488E-01	122	7.0351E-01	123	7.0784E-01	124	6.9871E-01	125	7.0736E-01	126	7.3237E-01

127	7.0736E-01	128	0.0000E+00	129	7.0784E-01	130	7.2035E-01	131	7.7901E-01	132	1.0204E+00
133	1.1233E+00	134	1.2517E+00	135	1.1382E+00	136	1.1882E+00	137	1.2791E+00	138	1.1536E+00
139	1.0353E+00	140	8.0883E-01	141	7.4391E-01	142	6.9005E-01	143	0.0000E+00	144	7.3237E-01
145	7.7997E-01	146	7.7997E-01	147	7.3237E-01	148	6.9871E-01	149	8.2325E-01	150	7.5497E-01
151	8.0738E-01	152	1.0228E+00	153	1.1368E+00	154	1.2762E+00	155	1.1426E+00	156	1.2286E+00
157	1.3166E+00	158	1.1950E+00	159	1.0940E+00	160	8.2902E-01	161	0.0000E+00	162	7.3141E-01
163	7.0640E-01	164	7.0736E-01	165	7.7997E-01	166	0.0000E+00	167	7.7997E-01	168	7.0736E-01
169	7.0640E-01	170	7.3141E-01	171	0.0000E+00	172	8.2902E-01	173	1.0940E+00	174	1.1950E+00
175	1.3166E+00	176	1.2286E+00	177	1.1426E+00	178	1.2762E+00	179	1.1368E+00	180	1.0228E+00
181	8.0738E-01	182	7.5497E-01	183	8.2325E-01	184	6.9871E-01	185	7.3237E-01	186	7.7997E-01
187	7.7997E-01	188	7.3237E-01	189	0.0000E+00	190	6.9005E-01	191	7.4391E-01	192	8.0883E-01
193	1.0353E+00	194	1.1536E+00	195	1.2791E+00	196	1.1882E+00	197	1.1382E+00	198	1.2517E+00
199	1.1233E+00	200	1.0204E+00	201	7.7901E-01	202	7.2035E-01	203	7.0784E-01	204	0.0000E+00
205	7.0736E-01	206	7.3237E-01	207	7.0736E-01	208	6.9871E-01	209	7.0784E-01	210	7.0351E-01
211	7.9488E-01	212	1.0146E+00	213	1.1185E+00	214	1.2262E+00	215	1.1435E+00	216	1.1099E+00
217	1.2224E+00	218	1.1026E+00	219	8.4153E-01	220	0.0000E+00	221	7.0351E-01	222	6.9005E-01
223	7.0640E-01	224	6.9871E-01	225	0.0000E+00	226	7.0640E-01	227	8.2325E-01	228	7.2035E-01
229	0.0000E+00	230	8.2229E-01	231	1.1074E+00	232	1.2022E+00	233	1.1161E+00	234	1.0844E+00
235	1.2070E+00	236	1.1137E+00	237	8.2229E-01	238	7.9488E-01	239	7.4391E-01	240	7.3141E-01
241	8.2325E-01	242	7.0784E-01	243	6.9005E-01	244	7.3141E-01	245	7.5497E-01	246	7.7901E-01
247	8.4153E-01	248	1.1137E+00	249	1.2195E+00	250	1.1046E+00	251	1.1219E+00	252	1.2195E+00
253	1.1074E+00	254	1.0146E+00	255	8.0883E-01	256	0.0000E+00	257	7.5497E-01	258	7.2035E-01
259	7.0351E-01	260	7.4391E-01	261	0.0000E+00	262	8.0738E-01	263	1.0204E+00	264	1.1026E+00
265	1.2070E+00	266	1.1219E+00	267	1.1046E+00	268	1.2022E+00	269	1.1185E+00	270	1.0353E+00
271	8.2902E-01	272	8.0738E-01	273	7.7901E-01	274	0.0000E+00	275	7.9488E-01	276	8.0883E-01
277	8.2902E-01	278	1.0228E+00	279	1.1233E+00	280	1.2224E+00	281	1.0844E+00	282	1.1161E+00
283	1.2262E+00	284	1.1536E+00	285	1.0940E+00	286	1.0228E+00	287	1.0204E+00	288	8.4153E-01
289	8.2229E-01	290	1.0146E+00	291	1.0353E+00	292	1.0940E+00	293	1.1368E+00	294	1.2517E+00
295	1.1099E+00	296	1.1435E+00	297	1.2791E+00	298	1.1950E+00	299	1.1368E+00	300	1.1233E+00
301	1.1026E+00	302	1.1137E+00	303	1.1074E+00	304	1.1185E+00	305	1.1536E+00	306	1.1950E+00
307	1.2762E+00	308	1.1382E+00	309	1.1882E+00	310	1.3166E+00	311	1.2762E+00	312	1.2517E+00
313	1.2224E+00	314	1.2070E+00	315	1.2195E+00	316	1.2022E+00	317	1.2262E+00	318	1.2791E+00
319	1.3166E+00	320	1.1426E+00	321	1.2286E+00	322	1.1426E+00	323	1.1382E+00	324	1.1099E+00
325	1.0844E+00	326	1.1219E+00	327	1.1046E+00	328	1.1161E+00	329	1.1435E+00	330	1.1882E+00
331	1.2286E+00										

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.2050E-01	3.3551E-01	1.3616E-01	5.2833E-01
29	1.1421E-01	3.3401E-01	1.3608E-01	5.2991E-01
72	1.0354E-01	3.3379E-01	1.3604E-01	5.3017E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.7405E-02	2.1507E-02	6.2163E-02
29	6.1727E-02	2.0578E-02	5.9465E-02
72	5.2189E-02	1.5382E-02	4.4397E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.59935E+01	2.67191E-05	6.99579E+01	5.19319E-05
	U-236	8.48495E+00	1.29338E-06	8.57649E-01	1.30733E-07
	Pu-238	2.34617E+01	7.93864E-07	6.60686E+00	2.23554E-07
	Pu-239	9.69864E+01	8.62134E-04	1.79818E+02	1.59844E-03
	Pu-240	6.08884E+01	3.54565E-04	1.94934E+00	1.13514E-05
	Pu-241	9.70159E+01	2.78423E-04	2.10283E+02	6.03486E-04
	Pu-242	2.71159E+01	2.29967E-05	1.52992E+00	1.29751E-06
	Xe-135	1.19696E+05	4.43578E-05	0.00000E+00	0.00000E+00
	Sm-149	3.72135E+03	1.63534E-05	0.00000E+00	0.00000E+00
	Total FP	1.02874E+01	2.37455E-04	0.00000E+00	0.00000E+00
29	U-235	2.73378E+01	2.06919E-05	5.22671E+01	3.95608E-05
	U-236	7.74209E+00	1.11086E-06	8.59211E-01	1.23282E-07
	Pu-238	1.73390E+01	6.33960E-07	6.20634E+00	2.26920E-07
	Pu-239	7.05764E+01	8.11799E-04	1.30423E+02	1.50018E-03
	Pu-240	5.26824E+01	2.71133E-04	2.01774E+00	1.03844E-05
	Pu-241	7.09218E+01	2.20950E-04	1.53924E+02	4.79535E-04
	Pu-242	2.60683E+01	1.82483E-05	1.58861E+00	1.11206E-06
	Xe-135	7.87079E+04	3.84298E-05	0.00000E+00	0.00000E+00
	Sm-149	2.45832E+03	1.57551E-05	0.00000E+00	0.00000E+00
	Total FP	9.11383E+00	1.92998E-04	0.00000E+00	0.00000E+00

Variant 12
State 2

72	U-235	2.42250E+01	1.57622E-05	4.57822E+01	2.97885E-05
	U-236	7.88437E+00	1.02339E-06	8.47610E-01	1.10019E-07
	Pu-238	1.51229E+01	4.46565E-07	6.04289E+00	1.78441E-07
	Pu-239	6.13803E+01	5.12382E-04	1.12964E+02	9.42984E-04
	Pu-240	4.54868E+01	2.23332E-04	1.98265E+00	9.73444E-06
	Pu-241	6.17632E+01	1.57077E-04	1.34251E+02	3.41430E-04
	Pu-242	2.38596E+01	1.65536E-05	1.55843E+00	1.08122E-06
	Xe-135	6.33175E+04	2.19383E-05	0.00000E+00	0.00000E+00
	Sm-149	1.99499E+03	8.36019E-06	0.00000E+00	0.00000E+00
	Total FP	7.66048E+00	1.49618E-04	0.00000E+00	0.00000E+00

Burnup = 40 MWd/kgU

Power distribution by pin

1	1.1767E+00	2	1.1369E+00	3	1.1142E+00	4	1.1018E+00	5	1.0755E+00	6	1.0822E+00
7	1.0466E+00	8	1.1132E+00	9	1.1023E+00	10	1.1266E+00	11	1.1767E+00	12	1.1266E+00
13	1.3537E+00	14	1.3010E+00	15	1.2747E+00	16	1.2644E+00	17	1.2308E+00	18	1.2566E+00
19	1.2303E+00	20	1.2706E+00	21	1.2938E+00	22	1.3537E+00	23	1.1369E+00	24	1.1023E+00
25	1.2938E+00	26	1.2185E+00	27	1.1875E+00	28	1.1380E+00	29	1.1085E+00	30	1.1276E+00
31	1.1312E+00	32	1.1380E+00	33	1.1777E+00	34	1.2185E+00	35	1.3010E+00	36	1.1142E+00
37	1.1132E+00	38	1.2706E+00	39	1.1777E+00	40	1.1199E+00	41	1.0383E+00	42	1.0311E+00
43	8.3089E-01	44	8.0405E-01	45	1.0218E+00	46	1.1096E+00	47	1.1199E+00	48	1.1875E+00
49	1.2747E+00	50	1.1018E+00	51	1.0466E+00	52	1.2303E+00	53	1.1380E+00	54	1.1096E+00
55	8.2108E-01	56	7.8083E-01	57	7.4625E-01	58	0.0000E+00	59	7.7618E-01	60	8.0921E-01
61	8.2108E-01	62	1.0383E+00	63	1.1380E+00	64	1.2644E+00	65	1.0755E+00	66	1.0822E+00
67	1.2566E+00	68	1.1312E+00	69	1.0218E+00	70	8.0921E-01	71	0.0000E+00	72	7.1528E-01
73	7.0806E-01	74	7.1116E-01	75	7.2870E-01	76	0.0000E+00	77	7.8083E-01	78	1.0311E+00
79	1.1085E+00	80	1.2308E+00	81	1.0822E+00	82	1.0755E+00	83	1.2308E+00	84	1.1276E+00
85	8.0405E-01	86	7.7618E-01	87	7.2870E-01	88	6.9671E-01	89	6.6935E-01	90	6.8226E-01
91	8.4534E-01	92	6.9671E-01	93	7.1528E-01	94	7.4625E-01	95	8.3089E-01	96	1.1276E+00
97	1.2566E+00	98	1.0466E+00	99	1.1018E+00	100	1.2644E+00	101	1.1085E+00	102	8.3089E-01
103	0.0000E+00	104	7.1116E-01	105	8.4534E-01	106	6.8226E-01	107	0.0000E+00	108	6.9000E-01
109	6.8226E-01	110	6.6935E-01	111	7.0806E-01	112	0.0000E+00	113	8.0405E-01	114	1.1312E+00
115	1.2303E+00	116	1.1132E+00	117	1.1142E+00	118	1.2747E+00	119	1.1380E+00	120	1.0311E+00
121	7.4625E-01	122	7.0806E-01	123	6.8226E-01	124	6.9000E-01	125	7.0496E-01	126	7.2509E-01
127	7.0496E-01	128	0.0000E+00	129	6.8226E-01	130	7.1116E-01	131	7.7618E-01	132	1.0218E+00
133	1.1380E+00	134	1.2706E+00	135	1.1023E+00	136	1.1369E+00	137	1.3010E+00	138	1.1875E+00
139	1.0383E+00	140	7.8083E-01	141	7.1528E-01	142	6.6935E-01	143	0.0000E+00	144	7.2509E-01
145	7.7257E-01	146	7.7257E-01	147	7.2509E-01	148	6.9000E-01	149	8.4534E-01	150	7.2870E-01
151	8.0921E-01	152	1.1096E+00	153	1.1777E+00	154	1.2938E+00	155	1.1266E+00	156	1.1767E+00
157	1.3537E+00	158	1.2185E+00	159	1.1199E+00	160	8.2108E-01	161	0.0000E+00	162	6.9671E-01
163	6.8226E-01	164	7.0496E-01	165	7.7257E-01	166	0.0000E+00	167	7.7257E-01	168	7.0496E-01
169	6.8226E-01	170	6.9671E-01	171	0.0000E+00	172	8.2108E-01	173	1.1199E+00	174	1.2185E+00
175	1.3537E+00	176	1.1767E+00	177	1.1266E+00	178	1.2938E+00	179	1.1777E+00	180	1.1096E+00
181	8.0921E-01	182	7.2870E-01	183	8.4534E-01	184	6.9000E-01	185	7.2509E-01	186	7.7257E-01
187	7.7257E-01	188	7.2509E-01	189	0.0000E+00	190	6.6935E-01	191	7.1528E-01	192	7.8083E-01
193	1.0383E+00	194	1.1875E+00	195	1.3010E+00	196	1.1369E+00	197	1.1023E+00	198	1.2706E+00
199	1.1380E+00	200	1.0218E+00	201	7.7618E-01	202	7.1116E-01	203	6.8226E-01	204	0.0000E+00
205	7.0496E-01	206	7.2509E-01	207	7.0496E-01	208	6.9000E-01	209	6.8226E-01	210	7.0806E-01
211	7.4625E-01	212	1.0311E+00	213	1.1380E+00	214	1.2747E+00	215	1.1142E+00	216	1.1132E+00
217	1.2303E+00	218	1.1312E+00	219	8.0405E-01	220	0.0000E+00	221	7.0806E-01	222	6.6935E-01
223	6.8226E-01	224	6.9000E-01	225	0.0000E+00	226	6.8226E-01	227	8.4534E-01	228	7.1116E-01
229	0.0000E+00	230	8.3089E-01	231	1.1085E+00	232	1.2644E+00	233	1.1018E+00	234	1.0466E+00
235	1.2566E+00	236	1.1276E+00	237	8.3089E-01	238	7.4625E-01	239	7.1528E-01	240	6.9671E-01
241	8.4534E-01	242	6.8226E-01	243	6.6935E-01	244	6.9671E-01	245	7.2870E-01	246	7.7618E-01
247	8.0405E-01	248	1.1276E+00	249	1.2308E+00	250	1.0755E+00	251	1.0822E+00	252	1.2308E+00
253	1.1085E+00	254	1.0311E+00	255	7.8083E-01	256	0.0000E+00	257	7.2870E-01	258	7.1116E-01
259	7.0806E-01	260	7.1528E-01	261	0.0000E+00	262	8.0921E-01	263	1.0218E+00	264	1.1312E+00
265	1.2566E+00	266	1.0822E+00	267	1.0755E+00	268	1.2644E+00	269	1.1380E+00	270	1.0383E+00
271	8.2108E-01	272	8.0921E-01	273	7.7618E-01	274	0.0000E+00	275	7.4625E-01	276	7.8083E-01
277	8.2108E-01	278	1.1096E+00	279	1.1380E+00	280	1.2303E+00	281	1.0466E+00	282	1.1018E+00
283	1.2747E+00	284	1.1875E+00	285	1.1199E+00	286	1.1096E+00	287	1.0218E+00	288	8.0405E-01
289	8.3089E-01	290	1.0311E+00	291	1.0383E+00	292	1.1199E+00	293	1.1777E+00	294	1.2706E+00
295	1.1132E+00	296	1.1142E+00	297	1.3010E+00	298	1.2185E+00	299	1.1777E+00	300	1.1380E+00
301	1.1312E+00	302	1.1276E+00	303	1.1085E+00	304	1.1380E+00	305	1.1875E+00	306	1.2185E+00
307	1.2938E+00	308	1.1023E+00	309	1.1369E+00	310	1.3537E+00	311	1.2938E+00	312	1.2706E+00
313	1.2303E+00	314	1.2566E+00	315	1.2308E+00	316	1.2644E+00	317	1.2747E+00	318	1.3010E+00
319	1.3537E+00	320	1.1266E+00	321	1.1767E+00	322	1.1266E+00	323	1.1023E+00	324	1.1132E+00
325	1.0466E+00	326	1.0822E+00	327	1.0755E+00	328	1.1018E+00	329	1.1142E+00	330	1.1369E+00
331	1.1767E+00										

Variant 12
State 2

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.2140E-01	3.3452E-01	1.3631E-01	5.2917E-01
29	1.1502E-01	3.3321E-01	1.3621E-01	5.3058E-01
72	1.0401E-01	3.3396E-01	1.3581E-01	5.3023E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.5372E-02	1.9119E-02	5.5391E-02
29	6.1635E-02	1.9332E-02	5.5994E-02
72	5.0942E-02	1.3927E-02	4.0293E-02

One-group fuel-averaged microscopic cross-sections and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	3.91938E+01	2.07369E-05	7.65271E+01	4.04894E-05
	U-236	8.29635E+00	1.53184E-06	8.43503E-01	1.55744E-07
	Pu-238	2.57381E+01	1.75384E-06	6.73694E+00	4.59068E-07
	Pu-239	1.08113E+02	6.91394E-04	2.00384E+02	1.28147E-03
	Pu-240	6.41574E+01	3.54168E-04	1.92258E+00	1.06132E-05
	Pu-241	1.06877E+02	3.09603E-04	2.31459E+02	6.70492E-04
	Pu-242	2.52601E+01	3.51188E-05	1.50713E+00	2.09535E-06
	Xe-135	1.34437E+05	4.06783E-05	0.00000E+00	0.00000E+00
	Sm-149	4.11648E+03	1.53334E-05	0.00000E+00	0.00000E+00
	Total FP	9.44276E+00	2.76955E-04	0.00000E+00	0.00000E+00
29	U-235	2.91897E+01	1.64830E-05	5.59807E+01	3.16115E-05
	U-236	7.89627E+00	1.37299E-06	8.59508E-01	1.49450E-07
	Pu-238	1.85597E+01	1.40661E-06	6.28399E+00	4.76253E-07
	Pu-239	7.68919E+01	7.03043E-04	1.42010E+02	1.29844E-03
	Pu-240	5.42875E+01	2.78278E-04	1.99949E+00	1.02494E-05
	Pu-241	7.68240E+01	2.60388E-04	1.66622E+02	5.64752E-04
	Pu-242	2.32681E+01	2.69444E-05	1.57273E+00	1.82122E-06
	Xe-135	8.71224E+04	3.82482E-05	0.00000E+00	0.00000E+00
	Sm-149	2.73266E+03	1.60991E-05	0.00000E+00	0.00000E+00
	Total FP	8.44409E+00	2.35639E-04	0.00000E+00	0.00000E+00
72	U-235	2.58771E+01	1.21617E-05	4.92208E+01	2.31328E-05
	U-236	7.56604E+00	1.19194E-06	8.35561E-01	1.31633E-07
	Pu-238	1.63668E+01	9.85583E-07	6.13239E+00	3.69284E-07
	Pu-239	6.84396E+01	4.21096E-04	1.25868E+02	7.74444E-04
	Pu-240	4.62801E+01	2.18874E-04	1.97158E+00	9.32424E-06
	Pu-241	6.68591E+01	1.75620E-04	1.45093E+02	3.81118E-04
	Pu-242	2.16510E+01	2.48117E-05	1.54823E+00	1.77424E-06
	Xe-135	7.21154E+04	2.08785E-05	0.00000E+00	0.00000E+00
	Sm-149	2.25190E+03	8.15936E-06	0.00000E+00	0.00000E+00
	Total FP	7.00948E+00	1.76099E-04	0.00000E+00	0.00000E+00

Burnup = 50 MWd/kgU

Power distribution by pin

1	1.1489E+00	2	1.1073E+00	3	1.0574E+00	4	1.0414E+00	5	1.0409E+00	6	1.0546E+00
7	1.0321E+00	8	1.0678E+00	9	1.0639E+00	10	1.1012E+00	11	1.1489E+00	12	1.1012E+00
13	1.3935E+00	14	1.3365E+00	15	1.2926E+00	16	1.2882E+00	17	1.2663E+00	18	1.2789E+00
19	1.2855E+00	20	1.3118E+00	21	1.3436E+00	22	1.3935E+00	23	1.1073E+00	24	1.0639E+00
25	1.3436E+00	26	1.2592E+00	27	1.2027E+00	28	1.1517E+00	29	1.1160E+00	30	1.1539E+00
31	1.1539E+00	32	1.1977E+00	33	1.2372E+00	34	1.2592E+00	35	1.3365E+00	36	1.0574E+00
37	1.0678E+00	38	1.3118E+00	39	1.2372E+00	40	1.1616E+00	41	1.1012E+00	42	1.0798E+00
43	8.2318E-01	44	8.0563E-01	45	1.0672E+00	46	1.0990E+00	47	1.1616E+00	48	1.2027E+00
49	1.2926E+00	50	1.0414E+00	51	1.0321E+00	52	1.2855E+00	53	1.1977E+00	54	1.0990E+00
55	8.0179E-01	56	8.0179E-01	57	7.4146E-01	58	0.0000E+00	59	7.3049E-01	60	7.8150E-01
61	8.0179E-01	62	1.1012E+00	63	1.1517E+00	64	1.2882E+00	65	1.0409E+00	66	1.0546E+00
67	1.2789E+00	68	1.1539E+00	69	1.0672E+00	70	7.8150E-01	71	0.0000E+00	72	6.9265E-01
73	6.9046E-01	74	6.9869E-01	75	7.0033E-01	76	0.0000E+00	77	8.0179E-01	78	1.0798E+00
79	1.1160E+00	80	1.2663E+00	81	1.0546E+00	82	1.0409E+00	83	1.2663E+00	84	1.1539E+00
85	8.0563E-01	86	7.3049E-01	87	7.0033E-01	88	6.7785E-01	89	6.6523E-01	90	6.5372E-01
91	8.2976E-01	92	6.7785E-01	93	6.9265E-01	94	7.4146E-01	95	8.2318E-01	96	1.1539E+00
97	1.2789E+00	98	1.0321E+00	99	1.0414E+00	100	1.2882E+00	101	1.1160E+00	102	8.2318E-01
103	0.0000E+00	104	6.9869E-01	105	8.2976E-01	106	6.3781E-01	107	0.0000E+00	108	6.5920E-01
109	6.3781E-01	110	6.6523E-01	111	6.9046E-01	112	0.0000E+00	113	8.0563E-01	114	1.1539E+00
115	1.2855E+00	116	1.0678E+00	117	1.0574E+00	118	1.2926E+00	119	1.1517E+00	120	1.0798E+00
121	7.4146E-01	122	6.9046E-01	123	6.5372E-01	124	6.5920E-01	125	6.7949E-01	126	6.8333E-01

127 6.7949E-01 128 0.0000E+00 129 6.5372E-01 130 6.9869E-01 131 7.3049E-01 132 1.0672E+00
133 1.1977E+00 134 1.3118E+00 135 1.0639E+00 136 1.1073E+00 137 1.3365E+00 138 1.2027E+00
139 1.1012E+00 140 8.0179E-01 141 6.9265E-01 142 6.6523E-01 143 0.0000E+00 144 6.8333E-01
145 7.5188E-01 146 7.5188E-01 147 6.8333E-01 148 6.5920E-01 149 8.2976E-01 150 7.0033E-01
151 7.8150E-01 152 1.0990E+00 153 1.2372E+00 154 1.3436E+00 155 1.1012E+00 156 1.1489E+00
157 1.3935E+00 158 1.2592E+00 159 1.1616E+00 160 8.0179E-01 161 0.0000E+00 162 6.7785E-01
163 6.3781E-01 164 6.7949E-01 165 7.5188E-01 166 0.0000E+00 167 7.5188E-01 168 6.7949E-01
169 6.3781E-01 170 6.7785E-01 171 0.0000E+00 172 8.0179E-01 173 1.1616E+00 174 1.2592E+00
175 1.3935E+00 176 1.1489E+00 177 1.1012E+00 178 1.3436E+00 179 1.2372E+00 180 1.0990E+00
181 7.8150E-01 182 7.0033E-01 183 8.2976E-01 184 6.5920E-01 185 6.8333E-01 186 7.5188E-01
187 7.5188E-01 188 6.8333E-01 189 0.0000E+00 190 6.6523E-01 191 6.9265E-01 192 8.0179E-01
193 1.1012E+00 194 1.2027E+00 195 1.3365E+00 196 1.1073E+00 197 1.0639E+00 198 1.3118E+00
199 1.1977E+00 200 1.0672E+00 201 7.3049E-01 202 6.9869E-01 203 6.5372E-01 204 0.0000E+00
205 6.7949E-01 206 6.8333E-01 207 6.7949E-01 208 6.5920E-01 209 6.5372E-01 210 6.9046E-01
211 7.4146E-01 212 1.0798E+00 213 1.1517E+00 214 1.2926E+00 215 1.0574E+00 216 1.0678E+00
217 1.2855E+00 218 1.1539E+00 219 8.0563E-01 220 0.0000E+00 221 6.9046E-01 222 6.6523E-01
223 6.3781E-01 224 6.5920E-01 225 0.0000E+00 226 6.3781E-01 227 8.2976E-01 228 6.9869E-01
229 0.0000E+00 230 8.2318E-01 231 1.1160E+00 232 1.2882E+00 233 1.0414E+00 234 1.0321E+00
235 1.2789E+00 236 1.1539E+00 237 8.2318E-01 238 7.4146E-01 239 6.9265E-01 240 6.7785E-01
241 8.2976E-01 242 6.5372E-01 243 6.6523E-01 244 6.7785E-01 245 7.0033E-01 246 7.3049E-01
247 8.0563E-01 248 1.1539E+00 249 1.2663E+00 250 1.0409E+00 251 1.0546E+00 252 1.2663E+00
253 1.1160E+00 254 1.0798E+00 255 8.0179E-01 256 0.0000E+00 257 7.0033E-01 258 6.9869E-01
259 6.9046E-01 260 6.9265E-01 261 0.0000E+00 262 7.8150E-01 263 1.0672E+00 264 1.1539E+00
265 1.2789E+00 266 1.0546E+00 267 1.0409E+00 268 1.2882E+00 269 1.1517E+00 270 1.1012E+00
271 8.0179E-01 272 7.8150E-01 273 7.3049E-01 274 0.0000E+00 275 7.4146E-01 276 8.0179E-01
277 8.0179E-01 278 1.0990E+00 279 1.1977E+00 280 1.2855E+00 281 1.0321E+00 282 1.0414E+00
283 1.2926E+00 284 1.2027E+00 285 1.1616E+00 286 1.0990E+00 287 1.0672E+00 288 8.0563E-01
289 8.2318E-01 290 1.0798E+00 291 1.1012E+00 292 1.1616E+00 293 1.2372E+00 294 1.3118E+00
295 1.0678E+00 296 1.0574E+00 297 1.3365E+00 298 1.2592E+00 299 1.2372E+00 300 1.1977E+00
301 1.1539E+00 302 1.1539E+00 303 1.1160E+00 304 1.1517E+00 305 1.2027E+00 306 1.2592E+00
307 1.3436E+00 308 1.0639E+00 309 1.1073E+00 310 1.3935E+00 311 1.3436E+00 312 1.3118E+00
313 1.2855E+00 314 1.2789E+00 315 1.2663E+00 316 1.2882E+00 317 1.2926E+00 318 1.3365E+00
319 1.3935E+00 320 1.1012E+00 321 1.1489E+00 322 1.1012E+00 323 1.0639E+00 324 1.0678E+00
325 1.0321E+00 326 1.0546E+00 327 1.0409E+00 328 1.0414E+00 329 1.0574E+00 330 1.1073E+00
331 1.1489E+00

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.2367E-01	3.3383E-01	1.3615E-01	5.3002E-01
29	1.1552E-01	3.3459E-01	1.3596E-01	5.2945E-01
72	1.0381E-01	3.3320E-01	1.3583E-01	5.3097E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.3164E-02	1.7349E-02	5.0351E-02
29	6.1512E-02	1.8554E-02	5.3821E-02
72	5.0013E-02	1.2659E-02	3.6681E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.18467E+01	1.50692E-05	8.20258E+01	2.95378E-05
	U-236	7.81123E+00	1.63006E-06	8.13936E-01	1.69853E-07
	Pu-238	2.75659E+01	3.03739E-06	6.86443E+00	7.56367E-07
	Pu-239	1.20541E+02	6.10527E-04	2.22841E+02	1.12866E-03
	Pu-240	6.54032E+01	3.23159E-04	1.88697E+00	9.32359E-06
	Pu-241	1.16109E+02	3.08377E-04	2.51032E+02	6.66724E-04
	Pu-242	2.20396E+01	4.32763E-05	1.47438E+00	2.89505E-06
	Xe-135	1.46758E+05	3.75328E-05	0.00000E+00	0.00000E+00
	Sm-149	4.46359E+03	1.43579E-05	0.00000E+00	0.00000E+00
	Total FP	8.65722E+00	3.06663E-04	0.00000E+00	0.00000E+00
29	U-235	3.14991E+01	1.27276E-05	6.08187E+01	2.45745E-05
	U-236	7.23845E+00	1.40940E-06	8.35715E-01	1.62722E-07
	Pu-238	2.03113E+01	2.57900E-06	6.39577E+00	8.12094E-07
	Pu-239	8.49959E+01	6.48632E-04	1.57105E+02	1.19892E-03
	Pu-240	5.50789E+01	2.65471E-04	1.98566E+00	9.57057E-06
	Pu-241	8.36636E+01	2.79438E-04	1.81305E+02	6.05562E-04
	Pu-242	2.15150E+01	3.55145E-05	1.56044E+00	2.57580E-06
	Xe-135	9.88197E+04	3.91654E-05	0.00000E+00	0.00000E+00
	Sm-149	3.07644E+03	1.65200E-05	0.00000E+00	0.00000E+00
	Total FP	7.82677E+00	2.70799E-04	0.00000E+00	0.00000E+00

72	U-235	2.76046E+01	8.77274E-06	5.27469E+01	1.67630E-05
	U-236	7.46821E+00	1.30378E-06	8.28049E-01	1.44558E-07
	Pu-238	1.74562E+01	1.69010E-06	6.21058E+00	6.01308E-07
	Pu-239	7.38705E+01	3.55920E-04	1.35887E+02	6.54724E-04
	Pu-240	5.05250E+01	2.12713E-04	1.95275E+00	8.22120E-06
	Pu-241	7.26654E+01	1.75054E-04	1.57413E+02	3.79216E-04
	Pu-242	1.88036E+01	3.00859E-05	1.53147E+00	2.45036E-06
	Xe-135	7.93097E+04	1.93442E-05	0.00000E+00	0.00000E+00
	Sm-149	2.45501E+03	7.62886E-06	0.00000E+00	0.00000E+00
	Total FP	6.62947E+00	1.99187E-04	0.00000E+00	0.00000E+00

Burnup = 60 MWd/kgU

Power distribution by pin

1	1.1112E+00	2	1.1089E+00	3	1.0532E+00	4	1.0271E+00	5	1.0213E+00	6	1.0010E+00
7	9.9925E-01	8	1.0323E+00	9	1.0746E+00	10	1.1141E+00	11	1.1112E+00	12	1.1141E+00
13	1.4133E+00	14	1.3466E+00	15	1.3182E+00	16	1.2730E+00	17	1.2979E+00	18	1.2834E+00
19	1.3153E+00	20	1.3368E+00	21	1.3681E+00	22	1.4133E+00	23	1.1089E+00	24	1.0746E+00
25	1.3681E+00	26	1.2973E+00	27	1.2324E+00	28	1.2063E+00	29	1.1529E+00	30	1.1210E+00
31	1.1744E+00	32	1.1941E+00	33	1.2411E+00	34	1.2973E+00	35	1.3466E+00	36	1.0532E+00
37	1.0323E+00	38	1.3368E+00	39	1.2411E+00	40	1.1738E+00	41	1.1054E+00	42	1.0671E+00
43	8.0439E-01	44	8.0265E-01	45	1.0654E+00	46	1.1471E+00	47	1.1738E+00	48	1.2324E+00
49	1.3182E+00	50	1.0271E+00	51	9.9925E-01	52	1.3153E+00	53	1.1941E+00	54	1.1471E+00
55	7.9047E-01	56	7.5509E-01	57	7.3074E-01	58	0.0000E+00	59	7.3306E-01	60	7.6205E-01
61	7.9047E-01	62	1.1054E+00	63	1.2063E+00	64	1.2730E+00	65	1.0213E+00	66	1.0010E+00
67	1.2834E+00	68	1.1744E+00	69	1.0654E+00	70	7.6205E-01	71	0.0000E+00	72	7.0696E-01
73	6.6868E-01	74	6.8608E-01	75	7.1566E-01	76	0.0000E+00	77	7.5509E-01	78	1.0671E+00
79	1.1529E+00	80	1.2979E+00	81	1.0010E+00	82	1.0213E+00	83	1.2979E+00	84	1.1210E+00
85	8.0265E-01	86	7.3306E-01	87	7.1566E-01	88	6.7796E-01	89	6.3620E-01	90	6.6288E-01
91	8.5021E-01	92	6.7796E-01	93	7.0696E-01	94	7.3074E-01	95	8.0439E-01	96	1.1210E+00
97	1.2834E+00	98	9.9925E-01	99	1.0271E+00	100	1.2730E+00	101	1.1529E+00	102	8.0439E-01
103	0.0000E+00	104	6.8608E-01	105	8.5021E-01	106	6.6462E-01	107	0.0000E+00	108	6.4490E-01
109	6.6462E-01	110	6.3620E-01	111	6.6868E-01	112	0.0000E+00	113	8.0265E-01	114	1.1744E+00
115	1.3153E+00	116	1.0323E+00	117	1.0532E+00	118	1.3182E+00	119	1.2063E+00	120	1.0671E+00
121	7.3074E-01	122	6.6868E-01	123	6.6288E-01	124	6.4490E-01	125	6.4432E-01	126	6.6520E-01
127	6.4432E-01	128	0.0000E+00	129	6.6288E-01	130	6.8608E-01	131	7.3306E-01	132	1.0654E+00
133	1.1941E+00	134	1.3368E+00	135	1.0746E+00	136	1.1089E+00	137	1.3466E+00	138	1.2324E+00
139	1.1054E+00	140	7.5509E-01	141	7.0696E-01	142	6.3620E-01	143	0.0000E+00	144	6.6520E-01
145	7.2378E-01	146	7.2378E-01	147	6.6520E-01	148	6.4490E-01	149	8.5021E-01	150	7.1566E-01
151	7.6205E-01	152	1.1471E+00	153	1.2411E+00	154	1.3681E+00	155	1.1141E+00	156	1.1112E+00
157	1.4133E+00	158	1.2973E+00	159	1.1738E+00	160	7.9047E-01	161	0.0000E+00	162	6.7796E-01
163	6.6462E-01	164	6.4432E-01	165	7.2378E-01	166	0.0000E+00	167	7.2378E-01	168	6.4432E-01
169	6.6462E-01	170	6.7796E-01	171	0.0000E+00	172	7.9047E-01	173	1.1738E+00	174	1.2973E+00
175	1.4133E+00	176	1.1112E+00	177	1.1141E+00	178	1.3681E+00	179	1.2411E+00	180	1.1471E+00
181	7.6205E-01	182	7.1566E-01	183	8.5021E-01	184	6.4490E-01	185	6.6520E-01	186	7.2378E-01
187	7.2378E-01	188	6.6520E-01	189	0.0000E+00	190	6.3620E-01	191	7.0696E-01	192	7.5509E-01
193	1.1054E+00	194	1.2324E+00	195	1.3466E+00	196	1.1089E+00	197	1.0746E+00	198	1.3368E+00
199	1.1941E+00	200	1.0654E+00	201	7.3306E-01	202	6.8608E-01	203	6.6288E-01	204	0.0000E+00
205	6.4432E-01	206	6.6520E-01	207	6.4432E-01	208	6.4490E-01	209	6.6288E-01	210	6.6868E-01
211	7.3074E-01	212	1.0671E+00	213	1.2063E+00	214	1.3182E+00	215	1.0532E+00	216	1.0323E+00
217	1.3153E+00	218	1.1744E+00	219	8.0265E-01	220	0.0000E+00	221	6.6868E-01	222	6.3620E-01
223	6.6462E-01	224	6.4490E-01	225	0.0000E+00	226	6.6462E-01	227	8.5021E-01	228	6.8608E-01
229	0.0000E+00	230	8.0439E-01	231	1.1529E+00	232	1.2730E+00	233	1.0271E+00	234	9.9925E-01
235	1.2834E+00	236	1.1210E+00	237	8.0439E-01	238	7.3074E-01	239	7.0696E-01	240	6.7796E-01
241	8.5021E-01	242	6.6288E-01	243	6.3620E-01	244	6.7796E-01	245	7.1566E-01	246	7.3306E-01
247	8.0265E-01	248	1.1210E+00	249	1.2979E+00	250	1.0213E+00	251	1.0010E+00	252	1.2979E+00
253	1.1529E+00	254	1.0671E+00	255	7.5509E-01	256	0.0000E+00	257	7.1566E-01	258	6.8608E-01
259	6.6868E-01	260	7.0696E-01	261	0.0000E+00	262	7.6205E-01	263	1.0654E+00	264	1.1744E+00
265	1.2834E+00	266	1.0010E+00	267	1.0213E+00	268	1.2730E+00	269	1.2063E+00	270	1.1054E+00
271	7.9047E-01	272	7.6205E-01	273	7.3306E-01	274	0.0000E+00	275	7.3074E-01	276	7.5509E-01
277	7.9047E-01	278	1.1471E+00	279	1.1941E+00	280	1.3153E+00	281	9.9925E-01	282	1.0271E+00
283	1.3182E+00	284	1.2324E+00	285	1.1738E+00	286	1.1471E+00	287	1.0654E+00	288	8.0265E-01
289	8.0439E-01	290	1.0671E+00	291	1.1054E+00	292	1.1738E+00	293	1.2411E+00	294	1.3368E+00
295	1.0323E+00	296	1.0532E+00	297	1.3466E+00	298	1.2973E+00	299	1.2411E+00	300	1.1941E+00
301	1.1744E+00	302	1.1210E+00	303	1.1529E+00	304	1.2063E+00	305	1.2324E+00	306	1.2973E+00
307	1.3681E+00	308	1.0746E+00	309	1.1089E+00	310	1.4133E+00	311	1.3681E+00	312	1.3368E+00
313	1.3153E+00	314	1.2834E+00	315	1.2979E+00	316	1.2730E+00	317	1.3182E+00	318	1.3466E+00
319	1.4133E+00	320	1.1141E+00	321	1.1112E+00	322	1.1141E+00	323	1.0746E+00	324	1.0323E+00
325	9.9925E-01	326	1.0010E+00	327	1.0213E+00	328	1.0271E+00	329	1.0532E+00	330	1.1089E+00
331	1.1112E+00										

Variant 12
State 2

Pin	Cell Flux	Fuel/Cell	Clad/Cell	Moderator/Cell
1	1.2424E-01	3.3468E-01	1.3553E-01	5.2979E-01
29	1.1711E-01	3.3612E-01	1.3599E-01	5.2789E-01
72	1.0387E-01	3.3369E-01	1.3630E-01	5.3001E-01

One-group cell-averaged macroscopic cross-sections:

Pin No.	Absorption	Fission	Nu*Fission
1	6.2721E-02	1.5954E-02	4.6343E-02
29	6.0875E-02	1.7431E-02	5.0625E-02
72	4.9281E-02	1.2034E-02	3.4898E-02

One-group fuel-averaged microscopic cross-sections
and reaction rates for selected nuclides:

Pin No.	Isotope	Absorption		Nu*Fission	
		Cross-Section (barns)	Reaction Rate (1/sec-cm**3)	Cross-Section (barns)	Reaction Rate (1/sec-cm**3)
1	U-235	4.50877E+01	1.02951E-05	8.87401E+01	2.02624E-05
	U-236	8.17491E+00	1.80539E-06	8.23786E-01	1.81929E-07
	Pu-238	2.99445E+01	4.45141E-06	7.00085E+00	1.04071E-06
	Pu-239	1.28870E+02	5.58178E-04	2.38833E+02	1.03447E-03
	Pu-240	7.47644E+01	3.17022E-04	1.88198E+00	7.98011E-06
	Pu-241	1.25321E+02	2.85598E-04	2.71186E+02	6.18014E-04
	Pu-242	2.08082E+01	5.12160E-05	1.46920E+00	3.61620E-06
	Xe-135	1.63960E+05	3.62070E-05	0.00000E+00	0.00000E+00
	Sm-149	5.03020E+03	1.40877E-05	0.00000E+00	0.00000E+00
	Total FP	8.40545E+00	3.43119E-04	0.00000E+00	0.00000E+00
29	U-235	3.31105E+01	9.21209E-06	6.42293E+01	1.78701E-05
	U-236	7.32872E+00	1.52189E-06	8.35766E-01	1.73556E-07
	Pu-238	2.14816E+01	3.93166E-06	6.46988E+00	1.18414E-06
	Pu-239	8.99206E+01	6.06707E-04	1.66405E+02	1.12276E-03
	Pu-240	6.02212E+01	2.66891E-04	1.98476E+00	8.79611E-06
	Pu-241	8.85455E+01	2.76377E-04	1.91828E+02	5.98751E-04
	Pu-242	1.88617E+01	4.02858E-05	1.55784E+00	3.32732E-06
	Xe-135	1.07463E+05	3.90307E-05	0.00000E+00	0.00000E+00
	Sm-149	3.31651E+03	1.63457E-05	0.00000E+00	0.00000E+00
	Total FP	7.37607E+00	3.06560E-04	0.00000E+00	0.00000E+00
72	U-235	2.97122E+01	6.07648E-06	5.72462E+01	1.17075E-05
	U-236	7.01089E+00	1.28832E-06	8.16313E-01	1.50005E-07
	Pu-238	1.91072E+01	2.52359E-06	6.32015E+00	8.34736E-07
	Pu-239	8.20446E+01	3.36309E-04	1.51120E+02	6.19455E-04
	Pu-240	5.31265E+01	1.93795E-04	1.96030E+00	7.15079E-06
	Pu-241	7.95287E+01	1.66480E-04	1.72246E+02	3.60567E-04
	Pu-242	1.74673E+01	3.50900E-05	1.53591E+00	3.08549E-06
	Xe-135	9.19278E+04	1.93895E-05	0.00000E+00	0.00000E+00
	Sm-149	2.87155E+03	7.77760E-06	0.00000E+00	0.00000E+00
	Total FP	6.24692E+00	2.16880E-04	0.00000E+00	0.00000E+00

VARIANT 12, STATE 3

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0744	1.2654	.0013
10.00	.9558	1.1294	.0015
20.00	.8923	1.0521	.0014
30.00	.8365	.9879	.0012
40.00	.7886	.9321	.0011
50.00	.7516	.8876	.0012
60.00	.7183	.8500	.0011

VARIANT 12, STATE 4

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0603	1.2493	.0018
10.00	.9294	1.0949	.0012
20.00	.8638	1.0161	.0011
30.00	.8057	.9503	.0012
40.00	.7570	.8936	.0011
50.00	.7152	.8455	.0011
60.00	.6844	.8089	.0010

VARIANT 12, STATE 5

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.0773	1.2704	.0015
10.00	.9412	1.1106	.0013
20.00	.8750	1.0324	.0014
30.00	.8193	.9663	.0012
40.00	.7706	.9097	.0013
50.00	.7282	.8608	.0012
60.00	.6936	.8209	.0011

VARIANT 12, STATE 6

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1981	1.3415	.0013
10.00	1.0418	1.1643	.0012
20.00	.9606	1.0752	.0013
30.00	.8916	.9986	.0011
40.00	.8342	.9329	.0012
50.00	.7801	.8747	.0010
60.00	.7363	.8251	.0010

Burnup (MWd/kgU)	k-eff	k-0	1 sigma
.00	1.1702	1.3123	.0005

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34. W. Danker, U.S. Department of Energy, NN-62, 1000 Independence Avenue SW, Washington, DC 20585
35. Dr. Alexandre Ermolaev; Balakovo Nuclear Power Plant, Saratov Region, Balakovo-26, Russia, 413866
36. T. Gould, Lawrence Livermore National Laboratory, P.O. Box 808, MS-L186, Livermore, CA 94551
37. L. Jardine, Lawrence Livermore National Laboratory, P.O. Box 808, MS-L166, Livermore, CA 94551
38. Dr. Alexander Kalashnikov, Institute of Physics and Power Engineering, 1 Bondarenko Square, Obninsk, Kaluga Region, Russia 249020
39. R. W. Lee, Office of Nuclear Reactor Regulation, MS O10B3, U.S. Nuclear Regulatory Commission, Washington DC 20555-0001
40. R. Martin, Office of Nuclear Reactor Regulation, MS O10B3, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001

41. S. Nesbit, Duke/Cogema/Stone & Webster, 400 South Tryon Street, WC-32G, P.O. Box 1004, Charlotte, NC 28202
42. Nagao Ogawa; Director and General Manager; Plant Engineering Department; Nuclear Power Engineering Corporation; Shuwa-Kamiyacho Building, 2F; 3-13, 4-Chome Toranomon; Minato-Ku, Tokyo 105-0001, Japan
43–47. Dr. Alexander Pavlovitchev, Russian Research Center "Kurchatov Institute," Institute of Nuclear Reactors, VVER Division, VVER Physics Department, 123182, Kurchatov Square, 1, Moscow, Russia
48. J. Thompson, Office of Fissile Materials Disposition, U.S. Department of Energy, NN-61, 1000 Independence Avenue SW, Washington, DC 20585
49. F. Trumble, Westinghouse Savannah River Company, Building 730R, Room 3402, WSRC, Aiken, SC 29808
50. Boris E. Volkov; Head of Division; EDO Gidropress; 21 Ordzhonikidze Street; Podolsk, Moscow District, Russia 142103
51. V. Bilovsky, Transnuclear, 4 Skyline Dr., Hawthorne, NY 10532