

# **A VVER-1000 LEU and MOX Assembly Computational Benchmark**

Specification and Results

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NUCLEAR ENERGY AGENCY  
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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## FOREWORD

The NEA Nuclear Science Committee has an Expert Group that deals with the status and trends of reactor physics, fuel performance, and fuel cycle issues related to the disposition of weapons-grade plutonium as mixed-oxide fuel. The objectives of the group are to provide NEA Member countries with up-to-date information on, and develop consensus regarding, core and fuel cycle issues associated with weapons-grade plutonium disposition in thermal water reactors (PWR, BWR, VVER-1000 and CANDU) and fast reactors (BN-600). These issues concern core physics, fuel performance and reliability, and the capability and flexibility of thermal water reactors and fast reactors to dispose of weapons-grade plutonium in standard fuel cycles.

The activities of the NEA Expert Group on Reactor-based Plutonium Disposition are carried out in close co-operation with the NEA Working Party on Physics of Plutonium Fuels and Innovative Fuel Cycles (WPPR), sometimes jointly. An eminent part of these activities include benchmark studies. At the time of preparation of the report the following benchmarks were completed or in progress:

- VENUS-2 MOX Core Benchmarks – carried out jointly with the WPPR (completed);
- VVER-1000 LEU and MOX Benchmark – (completed, and the object of this report);
- KRITZ-2 Benchmarks – carried out jointly with the WPPR (in progress);
- Hollow and Solid MOX Fuel Behaviour Benchmark (in progress).

This report describes the detailed results of a benchmark study investigating the physics of a VVER-1000 reactor using low-enriched uranium (LEU) and MOX fuel. It contributes to the computer code certification process and to the verification of calculation methods used in the Russian Federation.

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## TABLE OF CONTENTS

<b>FOREWORD</b> .....	3
<b>CONTRIBUTORS</b> .....	4
<b>EXECUTIVE SUMMARY</b> .....	9
<i>Chapter 1. INTRODUCTION</i> .....	11
<i>Chapter 2. BENCHMARK MODEL</i> .....	13
<i>Chapter 3. PARTICIPANTS, CODES, AND DATA</i> .....	17
<i>Chapter 4. RESULTS OF BENCHMARK CALCULATIONS</i> .....	21
4.1. <i>Calculations methods</i> .....	22
4.2. <i>Effective multiplication factor</i> .....	23
4.3. <i>Fission rate distributions</i> .....	24
4.4. <i>Isotopic concentrations</i> .....	24
<i>Chapter 5. CONCLUSIONS</i> .....	25
<i>Appendix A. BENCHMARK SPECIFICATION</i> .....	117
<i>Appendix B. CALCULATIONAL DETAILS PROVIDED BY THE PARTICIPANTS</i> .....	127
<i>Appendix C. ADDITIONAL RESULTS</i> .....	145
<i>List of figures</i>	
Figure 2.1. UGD assembly configuration.....	14
Figure 2.2. MOXGD assembly configuration .....	15
Figure 1. UGD Variant $K_{inf}$ vs burnup.....	30
Figure 2. MOXGD Variant $K_{inf}$ vs burnup .....	72
Figure A.1. Cartogram of the Uniform LEU fuel assembly with 12 Gd BA rods.....	124
Figure A.2. Cartogram of the Profiled MOX fuel assembly with 12 Gd BA rods .....	125
Figure A.3. Cell numeration in the fuel assemblies to presenting fission rate distribution .....	126
Figure B.1. WIMS8A. Calculation scheme for the VVER benchmarks .....	135
Figure B.2. WIMS8A. Explicit heterogeneous representation of the geometry, with the CACTUS module of WIMS. ....	136

*List of tables*

Table 2.1. Calculations States.....	14
Table 3.1. Participants, basic library and computer codes used .....	19
Table 1. UGD Variant. $K_{inf}$ . Abs. deviation from Mean Value .....	29
Table 2. UGD. Assembly Average Isotopic Composition. $^{235}\text{U}$ , atoms/barn*cm .....	31
Table 3. UGD. Assembly Average Isotopic Composition. $^{236}\text{U}$ , atoms/barn*cm .....	32
Table 4. UGD. Assembly Average Isotopic Composition. $^{238}\text{U}$ , atoms/barn*cm .....	33
Table 5. UGD. Assembly Average Isotopic Composition. $^{239}\text{Pu}$ , atoms/barn*cm .....	34
Table 6. UGD. Assembly Average Isotopic Composition. $^{240}\text{Pu}$ , atoms/barn*cm .....	35
Table 7. UGD. Assembly Average Isotopic Composition. $^{241}\text{Pu}$ , atoms/barn*cm .....	36
Table 8. UGD. Assembly Average Isotopic Composition. $^{242}\text{Pu}$ , atoms/barn*cm .....	37
Table 9. UGD. Assembly Average Isotopic Composition. $^{135}\text{Xe}$ , atoms/barn*cm.....	38
Table 10. UGD. Assembly Average Isotopic Composition. $^{149}\text{Sm}$ , atoms/barn*cm (codes with equilibrium concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	39
Table 11. UGD. Assembly Average Isotopic Composition. $^{149}\text{Sm}$ , atoms/barn*cm (codes with zero concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	40
Table 12. UGD. Assembly Average Isotopic Composition. $^{155}\text{Gd}$ , atoms/barn*cm .....	41
Table 13. UGD. Assembly Average Isotopic Composition. $^{157}\text{Gd}$ , atoms/barn*cm .....	42
Table 14. UGD. Assembly Average Isotopic Composition Deviation from Average Value, %. Burnup=40 MWd/kgHM.....	43
Table 15. UGD. Isotopic Composition in Cell 1. $^{235}\text{U}$ , atoms/barn*cm .....	44
Table 16. UGD. Isotopic Composition in Cell 1. $^{236}\text{U}$ , atoms/barn*cm .....	45
Table 17. UGD. Isotopic Composition in Cell 1. $^{238}\text{U}$ , atoms/barn*cm .....	46
Table 18. UGD. Isotopic Composition in Cell 1. $^{239}\text{Pu}$ , atoms/barn*cm.....	47
Table 19. UGD. Isotopic Composition in Cell 1. $^{240}\text{Pu}$ , atoms/barn*cm.....	48
Table 20. UGD. Isotopic Composition in Cell 1. $^{241}\text{Pu}$ , atoms/barn*cm.....	49
Table 21. UGD. Isotopic Composition in Cell 1. $^{242}\text{Pu}$ , atoms/barn*cm.....	50
Table 22. UGD. Isotopic Composition in Cell 1. $^{135}\text{Xe}$ , atoms/barn*cm .....	51
Table 23. UGD. Isotopic Composition in Cell 1. $^{149}\text{Sm}$ , atoms/barn*cm (codes with equilibrium concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	52
Table 24. UGD. Isotopic Composition in Cell 1. $^{149}\text{Sm}$ , atoms/barn*cm (codes with zero concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	53
Table 25. UGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM.....	54
Table 26. UGD. Isotopic Composition in Cell 24. $^{235}\text{U}$ , atoms/barn*cm .....	55
Table 27. UGD. Isotopic Composition in Cell 24. $^{236}\text{U}$ , atoms/barn*cm .....	56
Table 28. UGD. Isotopic Composition in Cell 24. $^{238}\text{U}$ , atoms/barn*cm .....	57
Table 29. UGD. Isotopic Composition in Cell 24. $^{239}\text{Pu}$ , atoms/barn*cm.....	58
Table 30. UGD. Isotopic Composition in Cell 24. $^{240}\text{Pu}$ , atoms/barn*cm.....	59
Table 31. UGD. Isotopic Composition in Cell 24. $^{241}\text{Pu}$ , atoms/barn*cm.....	60
Table 32. UGD. Isotopic Composition in Cell 24. $^{242}\text{Pu}$ , atoms/barn*cm.....	61
Table 33. UGD. Isotopic Composition in Cell 24. $^{135}\text{Xe}$ , atoms/barn*cm .....	62
Table 34. UGD. Isotopic Composition in Cell 24. $^{149}\text{Sm}$ , atoms/barn*cm (codes with equilibrium concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	63
Table 35. UGD. Isotopic Composition in Cell 24. $^{149}\text{Sm}$ , atoms/barn*cm (codes with zero concentration of $^{149}\text{Sm}$ at 0MWd/kgHM) .....	64
Table 36. UGD. Isotopic Composition in Cell 24. $^{155}\text{Gd}$ , atoms/barn*cm .....	65
Table 37. UGD. Isotopic Composition in Cell 24. $^{157}\text{Gd}$ , atoms/barn*cm .....	66
Table 38. UGD. Isotopic Composition in Cell 24 Deviation from Average Value, %. Burnup=40 MWd/kgHM.....	67

Table 39. UGD. Isotopic Composition in Cell 24 vs radius, burnup=40 MWd/kgHM. <sup>235</sup> U, atoms/barn*cm .....	68
Table 40. UGD. Isotopic Composition in Cell 24 vs radius, burnup=40 MWd/kgHM. <sup>239</sup> Pu, atoms/barn*cm .....	68
Table 41. UGD. Isotopic Composition in Cell 24 vs radius, burnup=2 MWd/kgHM. <sup>155</sup> Gd, atoms/barn*cm .....	69
Table 42. UGD. Isotopic Composition in Cell 24 vs radius, burnup=2 MWd/kgHM. <sup>157</sup> Gd, atoms/barn*cm .....	69
Table 43. UGD. Reactivity Effects, 100*(K <sub>init</sub> -K <sub>fin</sub> ) .....	70
Table 44. MOXGD Variant. K <sub>inf</sub> . Abs. deviation from Mean Value .....	71
Table 45. MOXGD. Assembly Average Isotopic Composition. <sup>235</sup> U, atoms/barn*cm .....	73
Table 46. MOXGD. Assembly Average Isotopic Composition. <sup>236</sup> U, atoms/barn*cm .....	74
Table 47. MOXGD. Assembly Average Isotopic Composition. <sup>238</sup> U, atoms/barn*cm .....	75
Table 48. MOXGD. Assembly Average Isotopic Composition. <sup>239</sup> Pu, atoms/barn*cm .....	76
Table 49. MOXGD. Assembly Average Isotopic Composition. <sup>240</sup> Pu, atoms/barn*cm .....	77
Table 50. MOXGD. Assembly Average Isotopic Composition. <sup>241</sup> Pu, atoms/barn*cm .....	78
Table 51. MOXGD. Assembly Average Isotopic Composition. <sup>242</sup> Pu, atoms/barn*cm .....	79
Table 52. MOXGD. Assembly Average Isotopic Composition. <sup>135</sup> Xe, atoms/barn*cm .....	80
Table 53. MOXGD. Assembly Average Isotopic Composition. <sup>149</sup> Sm, atoms/barn*cm (codes with equilibrium concentration of <sup>149</sup> Sm at 0MWd/kgHM), .....	81
Table 54. MOXGD. Assembly Average Isotopic Composition. <sup>149</sup> Sm, atoms/barn*cm (codes with zero concentration of <sup>149</sup> Sm at 0MWd/kgHM), .....	82
Table 55. MOXGD. Assembly Average Isotopic Composition. <sup>155</sup> Gd, atoms/barn*cm .....	83
Table 56. MOXGD. Assembly Average Isotopic Composition. <sup>157</sup> Gd, atoms/barn*cm .....	84
Table 57. MOXGD. Assembly Average Isotopic Composition Deviation from Average Value, %. Burnup=40 MWd/kgHM .....	85
Table 58. MOXGD. Isotopic Composition in Cell 1. <sup>235</sup> U, atoms/barn*cm .....	86
Table 59. MOXGD. Isotopic Composition in Cell 1. <sup>236</sup> U, atoms/barn*cm .....	87
Table 60. MOXGD. Isotopic Composition in Cell 1. <sup>238</sup> U, atoms/barn*cm .....	88
Table 61. MOXGD. Isotopic Composition in Cell 1. <sup>239</sup> Pu, atoms/barn*cm .....	89
Table 62. MOXGD. Isotopic Composition in Cell 1. <sup>240</sup> Pu, atoms/barn*cm .....	90
Table 63. MOXGD. Isotopic Composition in Cell 1. <sup>241</sup> Pu, atoms/barn*cm .....	91
Table 64. MOXGD. Isotopic Composition in Cell 1. <sup>242</sup> Pu, atoms/barn*cm .....	92
Table 65. MOXGD. Isotopic Composition in Cell 1. <sup>135</sup> Xe, atoms/barn*cm .....	93
Table 66. MOXGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm (codes with equilibrium concentration of <sup>149</sup> Sm at 0MWd/kgHM) .....	94
Table 67. MOXGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm (codes with zero concentration of <sup>149</sup> Sm at 0MWd/kgHM) .....	95
Table 68. MOXGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM .....	96
Table 69. MOXGD. Isotopic Composition in Cell 24. <sup>235</sup> U, atoms/barn*cm .....	97
Table 70. MOXGD. Isotopic Composition in Cell 24. <sup>236</sup> U, atoms/barn*cm .....	98
Table 71. MOXGD. Isotopic Composition in Cell 24. <sup>238</sup> U, atoms/barn*cm .....	99
Table 72. MOXGD. Isotopic Composition in Cell 24. <sup>239</sup> Pu, atoms/barn*cm .....	100
Table 73. MOXGD. Isotopic Composition in Cell 24. <sup>240</sup> Pu, atoms/barn*cm .....	101
Table 74. MOXGD. Isotopic Composition in Cell 24. <sup>241</sup> Pu, atoms/barn*cm .....	102
Table 75. MOXGD. Isotopic Composition in Cell 24. <sup>242</sup> Pu, atoms/barn*cm .....	103
Table 76. MOXGD. Isotopic Composition in Cell 24. <sup>135</sup> Xe, atoms/barn*cm .....	104
Table 77. MOXGD. Isotopic Composition in Cell 24. <sup>149</sup> Sm, atoms/barn*cm (codes with equilibrium concentration of <sup>149</sup> Sm at 0MWd/kgHM) .....	105

Table 78. MOXGD. Isotopic Composition in Cell 24. $^{149}\text{Sm}$ , atoms/barn*cm (codes with zero concentration of $^{149}\text{Sm}$ at 0MWd/kgHM), .....	106
Table 79. MOXGD. Isotopic Composition in Cell 24. $^{155}\text{Gd}$ , atoms/barn*cm.....	107
Table 80. MOXGD. Isotopic Composition in Cell 24. $^{157}\text{Gd}$ , atoms/barn*cm.....	108
Table 81. MOXGD. Isotopic Composition in Cell 24 Deviation from Average Value, %. Burnup=40 MWd/kgHM.....	109
Table 82. MOXGD. Isotopic Composition in Cell 24 vs radius, burnup=40 MWd/kgHM. $^{235}\text{U}$ , atoms/barn*cm .....	110
Table 83. MOXGD. Isotopic Composition in Cell 24 vs radius, burnup=40 MWd/kgHM. $^{239}\text{Pu}$ , atoms/barn*cm .....	110
Table 84. MOXGD. Isotopic Composition in Cell 24 vs radius, burnup=2 MWd/kgHM. $^{155}\text{Gd}$ , atoms/barn*cm .....	111
Table 85. MOXGD. Isotopic Composition in Cell 24 vs radius, burnup=2 MWd/kgHM. $^{157}\text{Gd}$ , atoms/barn*cm .....	111
Table 86. MOXGD Reactivity Effects, $100*(K_{\text{init}}-K_{\text{fin}})$ .....	112
Table 87. UGD Variant. Fission Rates Distribution. Max. R.M.S. over all the pins (%) and Corresponding Pin N versus burnup.....	113
Table 88. UGD Variant. Fission Rates Distribution. Max. R.M.S. over all the pins (%) and Corresponding Pin N for different states.....	114
Table 89. MOXGD Variant. Fission Rates Distribution. Max. R.M.S. over all the pins (%) and Corresponding Pin N versus burnup.....	115
Table 90. MOXGD Variant. Fission Rates Distribution. Max. R.M.S. over all the pins (%) and Corresponding Pin N for different states.....	116
Table A.1. Material description.....	119
Table A.2. Description of cell types geometry .....	120
Table A.3. State parameters.....	121
Table A.4. Set of calculation variants.....	123
Table C.1. UGD Variant. $K_{\text{inf}}$ States S1, S2, S3, S4, S5. Burnup=0, 20, 40 MWd/kgHM...	147
Table C.2. MOXGD Variant. $K_{\text{inf}}$ States S1, S2, S3, S4, S5. Burnup=0, 20, 40 MWd/kgHM.....	148
Table C.3. UGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0 MWd/kgHM.....	149
Table C.4. MOXGD Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0 MWd/kgHM.....	152



## EXECUTIVE SUMMARY

The United States and Russian Federation have each declared significant quantities of weapons-grade (WG) plutonium to be surplus to their defence needs. Under a mutual agreement, both countries are working towards a plan for the final disposition of the material with one option being the conversion of the material to mixed-oxide (MOX) fuel for nuclear reactors. The current agreement calls for the disposition of approximately 34 tonnes of WG plutonium by each country over the next 25 years. The experience with MOX fuel in these two countries is relatively small compared with that accumulated in European countries and Japan. For this reason an international Experts Group has been established at the OECD/NEA to facilitate the sharing of existing information and experience in the physics and fuel behaviour of MOX fuel as it relates to the disposition of weapons-grade plutonium. The Experts Group deals with the status and trends of reactor physics, fuel performance and fuel cycle issues related to the disposition of weapons-grade plutonium as mixed oxide fuel.

In Russia the WG MOX fuel will be used in both fast (BN-600) and light water reactors (VVER-1000). Recent work in Russia has focused on the certification of the calculational codes and the design of MOX fuel assemblies and core configurations. The Expert's group has performed several benchmarking efforts to help in the code certification process by providing experimental data and by sponsoring benchmarking exercises that provide useful verification of the Russian calculational methods. The VVER-1000 MOX Assembly Computational Benchmark is one such benchmarking activity performed by the Expert's Group.

The benchmark model consists of two different assemblies that are typical of the advanced designs that are under active development in Russia for the VVER-1000 reactors. In particular, these assemblies are similar to the designs that are expected to be used in the plutonium disposition mission. The benchmark exercise consists of two assembly types: a uniform LEU fuel assembly with 12 U/Gd rods (UGD variant) and a profiled MOX fuel assembly with 12 U/Gd rods (MOXGD variant). The benchmark calls depletion calculations to a burnup of 40 MWd/kgHM along with several branch calculations at various other states. The requested results include  $k_{inf}$  values, pin power distributions, and isotopic concentrations.

The participants of the benchmark included five institutions submitting six different solutions. The participants include the Russian Research Center "Kurchatov Institute" (RRC-KI) using the MCU and TVS-M codes, Belgonucléaire, Belgium using WIMS8A, Oak Ridge National Laboratory (ORNL), USA using the HELIOS code, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, Germany using MCNP4B, and KFKI Atomic Energy Research Institute, Hungary using the MULTICELL code. The data libraries utilised by the participants include ENDF/B-VI, JEF-2.2, and MCUDAT-2.1, a compilation of cross section data used with MCU and TVS-M at the RRC-KI.

A comparison of the results was performed and in most cases excellent agreement was observed. The  $k_{inf}$  values versus burnup showed a maximum deviation of 0.004  $\delta k$  for the uranium assembly and a slightly larger value of 0.007  $\delta k$  for the MOX assembly. A few trends for the codes were observed in that the WIMS8A results slightly overestimated  $k_{inf}$  at high burnups while TVS-M and MULTICELL underestimated  $k_{inf}$  at high burnups in comparison with the average value. Using the

branch calculations, several reactivity effects were compared and generally show good agreement. A summary of the results is given below:

- Discrepancies for reactivity effects are approximately the same both for UGD and MOXGD variants and are somewhat increased at high burnup.
- The R.M.S. (root-mean-square) difference for  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  poisoning effect is  $\sim 5\% \delta k$ .
- Deviations in boron effect are smaller and equal to 2-2.5%  $\delta k$ .
- The R.M.S. difference for fuel temperature effect is 5-7%  $\delta k$  for all the burnup points with exception of the UGD variant in zero burnup point, where the R.M.S. difference is 8.7%  $\delta k$ .
- Deviations of the total temperature effect have a tendency to increase with burnup; at high burnups the deviations are 6%  $\delta k$  for UGD and 7%  $\delta k$  for MOXGD variants.

The results of comparison of pin-by-pin power distributions computed by various codes show very good agreement. The discrepancies do not exceed 2% for UGD and 3% for MOXGD variants. The benchmark problem has demonstrated that the codes and data represented by the participants can be used to compute constant results for both the UGD and MOXGD assembly designs.

The verification of spectral codes using benchmarks such as the one described above, is only a part of overall verification of the whole code package for VVERs calculations. Additional parts of this package (codes for core coarse-mesh and fine-mesh calculation) must be verified as well. Work along these lines should be continued and benchmarking efforts should be extended to the whole-core methods involving fuel cycle and kinetics calculations. Further, it should be emphasised that verification on the base of calculational benchmarks does not eliminate the necessity of comparing with the results obtained at MOX fuelled experimental facilities.

## *Chapter 1*

### **INTRODUCTION**

The United States and Russian Federation have each declared significant quantities of weapons-grade (WG) plutonium to be surplus to their defence needs. Under a mutual agreement, both countries are working towards a plan for the final disposition of the material with one option being the conversion of the material to mixed-oxide (MOX) fuel for nuclear reactors. The current agreement calls for the disposition of approximately 34 tonnes of WG plutonium by each country over the next twenty-five years. The experience with MOX fuel in these two countries is relatively small compared with that accumulated in European countries and Japan.

For this reason an international Experts Group has been established at the OECD/NEA to facilitate the sharing of existing information and experience in the physics and fuel behaviour of MOX fuel as it relates to the disposition of weapons-grade plutonium. The Experts Group deals with the status and trends of reactor physics, fuel performance and fuel cycle issues related to the disposition of weapons-grade plutonium as mixed oxide fuel. Its objectives are to provide up-to-date information and develop a consensus regarding core and fuel cycle issues with weapons-grade plutonium disposition in thermal water reactors (PWR, BWR, VVER-1000, and CANDU) and fast reactors (BN-600). The topics covered include core physics, fuel performance and reliability, thermal water reactor and fast reactor fuel designs, fuel management approaches for maximising weapons-grade plutonium disposition rates, and fuel cycle flexibility. The Experts Group also aims to provide advice to the nuclear community on the scientific and technical developments needed to meet requirements (*e.g.* data, methods and validation experiments) for implementing weapons-grade plutonium disposition approaches. In this regard, activities are closely co-ordinated with other NEA groups such as the Working Party on Physics of Plutonium Fuels and Innovative Fuel Cycles. A summary of recent activities of the Experts Group was recently presented at an International Meeting [1].

In Russia the WG MOX fuel will be used in both fast (BN-600) and light water reactors (VVER-1000). Recent work in Russia has focused on the certification of the calculational codes and the design of MOX fuel assemblies and core configurations. The Expert's group has performed several benchmarking efforts to help in the code certification process by providing experimental data and by sponsoring benchmarking exercises that provide useful verification of the Russian calculational methods. While these Russian codes and data have been certified for LEU-based fuel, the certification for MOX fuel is required because of the essential differences between reactors fuelled with MOX:

- Reduced worth of the control rods, boric acid and burnable poisons.
- Reduced effective fraction of delayed neutrons.
- Reduced moderator temperature reactivity coefficient at the end of fuel cycle.
- Increased pin power peaking factor at the boundary between MOX and UOX FAs which makes it necessary to use fuel rods with different contents of plutonium in fuel assembly.

- Increased quantity of fission neutrons.
- Increased neutron flux sensitivity to local changes of moderator/fuel ratio.

The design process in Russia has studied several different MOX fuel assembly configurations and has converged on a design that has a graded configuration that utilises uranium/gadolinium fuel pins to provide an effective means of introducing burnable absorbers into the MOX assemblies. In 1999 a calculational benchmark based on this prevailing concept was formulated in Kurchatov Institute. This is standard problem for VVER-1000 core physics in which two assemblies are considered:

- Uniform LEU fuel assembly with 12 U/Gd rods (UGD variant).
- Profiled MOX fuel assembly with 12 U/Gd rods (MOXGD variant).

This benchmark was proposed to OECD/NEA Experts Group on Reactor Based Plutonium Disposition to be calculated in year 2000. The primary motivations of the VVER-MOX Benchmark are:

- It provides a well-defined standard problem for VVER-1000 core physics calculations.
- The VVER-1000 assembly design with U/Gd rods is a very recent development that corresponds to the VVER-1000 core configuration where first MOX FAs will be installed.
- A comparison of the LEU and MOX fuel assembly properties during irradiation period is essential for understanding the changes in the behaviour of the reactor core.
- Comparisons of calculational results of the complex VVER-1000 MOX assembly with U/Gd pins will provide a good indication of the adequacy of the current computational methods.

A discussion of the benchmark model is given in Chapter 2 and the details of the participants, codes and data are presented in Chapter 3. In Chapter 4 the results of the benchmark are discussed and Chapter 5 provides conclusions.

- [1] D'Hondt, P., J. Gehin, M. Kalugin, B.C. Na, E. Sartori, W. Wiesenack: Reactor Based Plutonium Disposition – Physics and Fuel Behaviour Benchmark Studies of an OECD/NEA Experts Group, Proc. GLOBAL-2001 Conference “Back End of the Fuel Cycle: From Research to Solutions”, Palais des Congrès, Paris, 9-13 September 2001.

## Chapter 2

### BENCHMARK MODEL

The benchmark model consists of two different assemblies that are typical of the advanced designs that are under active development in Russia for the VVER-1000 reactors. In particular, these assemblies are similar to the designs that are expected to be used in the plutonium disposition mission. The detailed benchmark specifications, as used by the participants, are given in Appendix A. An overview of the benchmark model will be discussed in this chapter.

The benchmark exercise consists of two assembly types:

- Uniform LEU fuel assembly with 12 U/Gd rods (UGD variant).
- Profiled MOX fuel assembly with 12 U/Gd rods (MOXGD variant).

The VVER-1000 assemblies are hexagonal in design and consist of one central tube, 312 fuel pin locations (12 of which are U/Gd rods), and 18 guide tubes. The clad and structural material are composed of a Zr-Nb alloy. The UGD assembly is shown in Figure 2.1 and consists of fuel rods with 3.7 wt.% enrichment. The 12 U/Gd pins have a  $^{235}\text{U}$  enrichment of 3.6 wt.% and a  $\text{Gd}_2\text{O}_3$  content of 4.0 wt.%. The MOXGD assembly is shown in Figure 2.2 and contains fuel rods with three different plutonium loadings. The central region contains MOX pins with 4.2 wt.% fissile plutonium (consisting of 93 wt.%  $^{239}\text{Pu}$ ), two rings of fuel rods with 3.0 wt.% fissile plutonium, and an outer ring of fuel rods with 2.0 wt.% fissile plutonium. The 12 U/Gd rods are in the same locations as in the UGD assembly configuration and have the same design.

Several calculational states were included in the benchmark exercise. These states, listed in Table 2.1 cover the operational states and cold conditions. Burnup calculations are performed with the S1 state with a power density of 108 MWt/m<sup>3</sup> to a burnup of 40 MWd/kgHM with a sufficient number of burnup steps to provide accurate results, particularly during the burn out of the Gd absorber. At specified burnup points, branch calculations are performed for states S2-S5 using the isotopic compositions from the burnup calculation. The parameters that are requested include:

State S1. Parameters versus burnup (0, 2, 4, 6, 8, 10, 12, 14, 15, 20, 40 MWd/kgHM):

$k_{\text{inf}}$ ;

fuel isotopic composition;

pin by pin fission rate distribution.

States S2-S5. with isotopic composition at burnup points 0, 20, 40 MWd/kgHM:

$k_{\text{inf}}$  ;

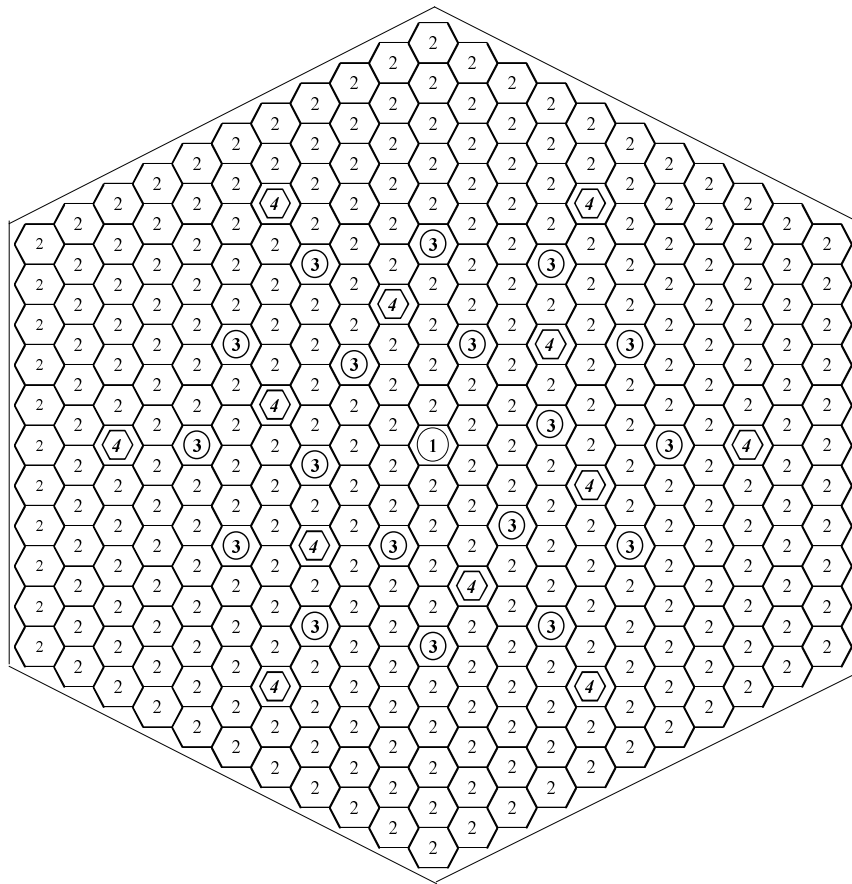
pin by pin fission rate distribution.

**Table 2.1. Calculation States**

State	Description	Fuel temp., K	Non-fuel temp., K	<sup>135</sup> Xe, <sup>149</sup> Sm
S1	Operating poisoned state	1027	575	Eq.*
S2	Operating non-poisoned state	1027	575	0.0
S3	Hot state	575	575	0.0
S4	Hot state without boron acid	575	575	0.0
S5	Cold state	300	300	0.0

\* Eq. Indicates equilibrium <sup>135</sup>Xe and <sup>149</sup>Sm concentrations.

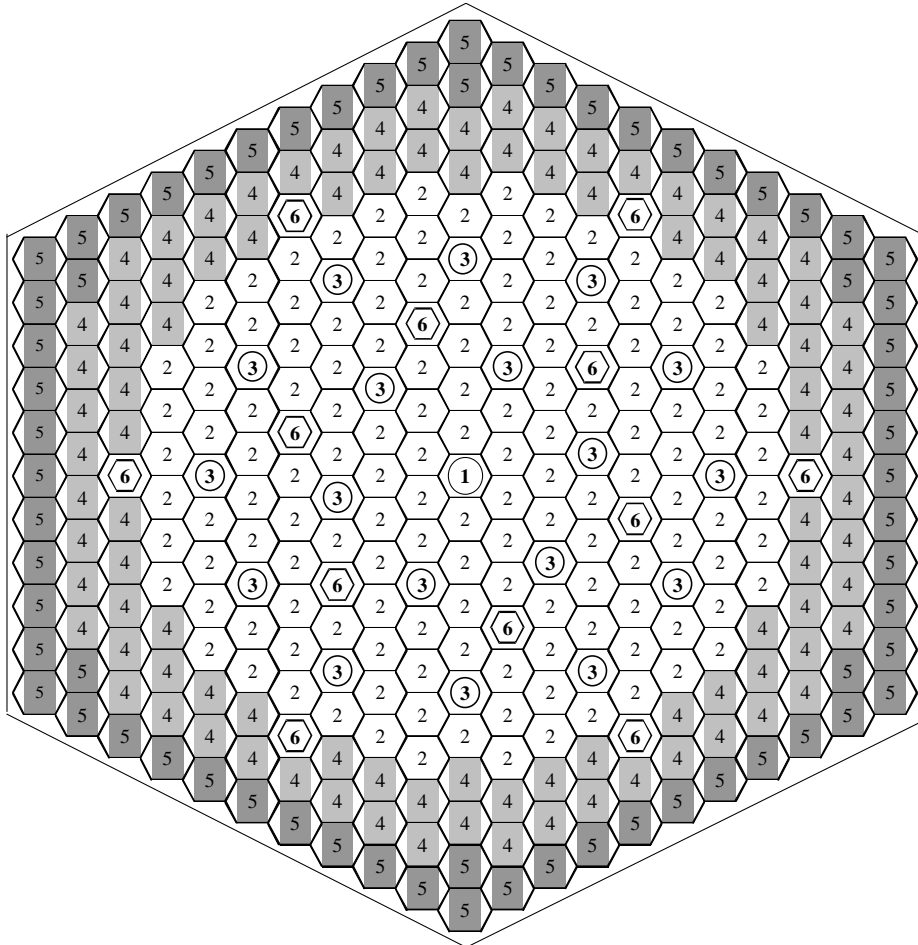
**Figure 2.1. UGD assembly configuration**



Cell types:

1. Central tube cell.
2. Fuel cell (with U1, 3.7 wt.% LEU).
3. Guide tube cell.
4. Fuel cell (with GD1, 3.6 wt.% LEU with 4.0 wt.% Gd<sub>2</sub>O<sub>3</sub>).

**Figure 2.2. MOXGD assembly configuration**



Cell types:

1. Central tube cell.
2. Fuel cell (with PU3, 4.2 wt.% Pu).
3. Guide tube cell.
4. Fuel cell (with PU2, 3.0 wt.% Pu).
5. Fuel cell (with PU1, 2.0 wt.% Pu).
6. Fuel cell (with GD1, 3.6 wt.% LEU with 4.0 wt.% Gd<sub>2</sub>O<sub>3</sub>).





### *Chapter 3*

#### **PARTICIPANTS, CODES, AND DATA**

A total of six solutions were received from five countries with each participant using different methods and data combinations. Two of the solutions are based on continuous energy Monte Carlo methods, while the remaining solutions are based on collision probability (or similar) methods. The submitted solutions cover several data libraries. The complete list of participants, basic libraries and codes used are presented below and summarised in Table 3.1. Computational details provided by the participants can be found in Appendix B.

##### ***RRC-KI, Russian Federation***

- Participants: M. Kalugin and D. Shkarovsky.
- Basic Library: MCUDAT-2.1.
- Code: MCU.
- Remarks: MCU is a continuous energy Monte Carlo code.

##### ***RRC-KI, Russian Federation***

- Participants: V. Sidorenko and A. Lazarenko.
- Basic Library: MCUDAT-2.1.
- Code: TVS-M.
- Remarks: Same basic library as MCU, calculational method similar to collision probability method.

##### ***Belgonucléaire, Belgium***

- Participants: B. Lance and P. Brusselaers.
- Basic Library: JEF-2.2.
- Code: WIMS8A.
- Remarks: none.

***ORNL, USA***

- Participant: J.C. Gehin.
- Basic Library: ENDF/B-VI.
- Code: HELIOS 1.4.
- Remarks: none.

***GRS, Germany***

- Participant: W. Zwermann.
- Basic Library: JEF-2.2 and ENDF/B-VI.
- Code: MCNP4B.
- Remarks:  $^1\text{H}$ ,  $^{16}\text{O}$ ,  $^{\text{nat}}\text{Zr}$ ,  $^{152}\text{Gd}$ : ENDF/B-VI.4, all other materials: JEF-2.2.

***KFKI, Hungary***

- Participant: Cs. Maráczy.
- Basic Library: ENDF/B-VI.
- Code: MULTICELL.
- Remarks: none.

**Table 3.1. Participants, basic library and computer codes used**

<b>Institution</b>	<b>Library used</b>	<b>Codes used</b>
<b>KI (Russian Federation)</b> M. Kalugin D. Shkarovsky	MCUDAT-2.1	MCU
<b>KI (Russian Federation)</b> V. Sidorenko A. Lazarenko	48-group library with 24 thermal groups (with boundary energy of 0.625 eV). For resonance nuclides (Th, U, Pu) files of resonance parameters are also available giving a possibility to obtain cross sections for any point in energy region of resolved resonances above 0.625 eV. The data library is obtained from the same source as MCUDAT-2.1.	TVS-M
<b>Belgonucléaire s.a. (Belgium)</b> B. Lance P. Brusselaers	WIMS97 library based on JEF-2.2, composed of 172 energy groups	WIMS8A
<b>ORNL (USA)</b> J.C. Gehin	ENDF/B-VI with adjustments to the $^{238}\text{U}$ absorption cross section (The $^{238}\text{U}$ resonance integral has been reduced by 3.4% to match integral experiments).	HELIOS (verion 1.4)
<b>Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH (Germany)</b> W. Zwermann	Point data generated by IKE Stuttgart with NJOY: $^1\text{H}$ , $^{16}\text{O}$ , $^{\text{nat}}\text{Zr}$ , $^{152}\text{Gd}$ : ENDF/B-VI.4 all other materials: JEF-2.2 (no depletion calculation).	MCNP-4B
<b>KFKI Atomic Energy Research Institute (Hungary)</b> Cs. Maráczy	ENDF/B-VI	MULTICELL



## Chapter 4

### RESULTS OF BENCHMARK CALCULATIONS

As outlined in Chapter 3, six participants of this benchmark exercise provided six distinct solutions. Because this benchmark is computational in nature, all calculation parameters are compared to the average value of the solutions. The average solution therefore represents a sort of “consensus” solution to the benchmark problem and will provide a reasonable means to show the level of agreement among the solutions and to identify outliers. Also note that the solutions were obtained with the calculational tools and data available at the participating institutions in 2000. In this chapter, comparisons of the calculated quantities are compared and discussed.

The participants’ results and the comparison of results are presented in Tables 1-90 and Tables C.1 - C.4. The  $k_{\text{inf}}$  values versus burnup are presented in Table 1, Figure 1 and Table 44, Figure 2 for variants UGD and MOXGD respectively. Assembly average isotopic composition versus burnup as well as isotopic composition in the corner cell 1 and fuel-gadolinium cell 24 (see Figure A.3) are presented in Tables 2-37 and 45-80 for variants UGD and MOXGD respectively. Isotopic compositions in five fuel-gadolinium pin radial zones are presented in Tables 39-42 and 82-85 respectively. Tables 43 and 86 contain the data on reactivity effects calculated with various codes. The following reactivity effects at burnup points 0, 20, 40 MWd/kg are shown in these tables:

- $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  poisoning;
- Soluble boron effect;
- Fuel temperature (Doppler) effect;
- Total temperature effect.

The fission rate distribution results are summarised in Tables 87-90. The comparison of results (maximum values of the root mean squares and deviations from mean) is given in Tables 14, 25, 38, 44, 57, 68, 81. The tables in Appendix C present values obtained by six codes (including MCNP) for  $k_{\text{inf}}$  and fission rate distributions in zero burnup point.

In the tables the following definitions and symbols are used:

*Relative Root Mean Square (R.M.S):*

$$R.M.S. = 100\% * \frac{1}{\bar{x}} * \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{(N-1)}}$$

*Absolute Root Mean Square ( $\Delta$ ):*

$$\Delta = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{(N-1)}}$$

*Relative Deviation from mean value:*

$$\text{Relative Deviation} = 100\% * \frac{x_i - \bar{x}}{\bar{x}}$$

*Absolute deviation from mean value:*

$$\text{Absolute Deviation} = x_i - \bar{x}$$

where

$i$  code number,  $i=1,N$

$N$  total number of codes used to obtain the parameter (in this report  $N=5$ , except for tables on fission rate distributions and reactivity effects that include the results obtained by means of MCNP-4B, where  $N=6$  in corresponding rows and columns).

$x_i$  value of parameter obtained by code  $i$ ,  $\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$  - mean values of parameter

#### **4.1. Calculational methods**

Four of the submitted solutions are based on deterministic methods. The RRC-KI calculations performed with the two-dimensional lattice code TVS-M is based on the so-called “method of passing through probability”, which is similar to collision probability methods commonly used in other codes. The TVS-M library contains 48 energy groups with 24 thermal groups and the data is based on a standard formulation used at the RRC-KI known as MCUDAT-2.1. MCUDAT-2.1 has been derived from several sources and is described in more detail in Appendix B. The ORNL calculations were performed with the HELIOS fuel assembly analysis code version 1.4. The HELIOS methods are based on collision probability with current coupling. The calculations were performed with 190 energy groups (62 thermal groups) with the data based on ENDF/B-VI. Note that in the production HELIOS library that the  $^{238}\text{U}$  resonance integral has been adjusted to match critical experiments. The Belgonucléaire calculations were performed with WIMS8A using the method of characteristics. The cross section library (WIMS97) is based on JEF-2.2 and consists of 172 energy groups. The KFKI Atomic Energy Research Institute provided results using the MULTICELL collision probability code. The MULTICELL cross sections are based on ENDF/B-VI and use 70 energy groups (35 thermal groups).

Two solutions based on Monte Carlo calculations were submitted. One of these solutions was provided by the RRC-KI using the MCU Monte Carlo code. MCU uses a continuous energy formulation and uses the MCUDAT-2.1 cross section data, as previously discussed above in regards to the TVS-M code. Burnup calculations were performed using MCU in combination with a standard burnup code using 39 actinides and 165 fission products. The MCU  $k_{\text{inf}}$  results were performed with a sufficient number of particle histories such that the statistical uncertainty is less than 0.1% (one standard deviation). The other Monte Carlo solution was submitted by GRS using MCNP4B with  $^1\text{H}$ ,

$^{16}\text{O}$ ,  $^{\text{nat}}\text{Zr}$ ,  $^{152}\text{Gd}$  cross sections from ENDF/B-VI.4 all other materials from JEF-2.2. The MCNP calculations were performed for fresh fuel conditions and used 1,000,000 particle histories.

More details of the codes, methods, and data libraries were provided by the benchmark participants and are given in Appendix B.

#### 4.2. Effective multiplication factor

The benchmark specification called for depletion calculation of two VVER-1000 fuel assemblies (UGD and MOXGD) were being in the working state S1. Additionally, for some burnup points calculation of several alternate states is required.

The  $k_{\text{inf}}$  values versus burnup obtained by various codes are presented in Table 1, Figure 1 and Table 44, Figure 2 for variants UGD and MOXGD respectively. The results show generally good agreement, but it should be noted that:

- All the codes give very similar behaviour of  $k_{\text{inf}}$  vs. burnup for both UGD and MOXGD variants.
- The results for the UGD variant demonstrate very good agreement among all of the submitted solutions with a maximum difference of 0.004  $\delta k$  at high burnup. The WIMS8A slightly underestimates  $k_{\text{inf}}$  at the beginning of burnup in comparison with the other solutions while TVS-M and MULTICELL slightly underestimate  $k_{\text{inf}}$  values at the higher burnups (0.004  $\delta k$  in comparison to the mean value).
- The results for the MOXGD variant show slightly larger discrepancies in  $k_{\text{inf}}$  with deviations exceeding 0.007  $\delta k$  at high burnup. Similar to the UGD results, WIMS8A underestimates  $k_{\text{inf}}$  relatively to mean value at the beginning of burnup (0.007  $\delta k$ ), and TVS-M and MULTICELL underestimate  $k_{\text{inf}}$  values at the higher burnups (~0.007  $\delta k$  relatively to mean value).

Results of separate state calculations (for specific states see Table 2.1) obtained for several burnup points are given in Tables C.1 and C.2. These results show that the maximum differences between codes are observed at high burnups and for some states the deviations are as large as ~1.5% in case of uranium assembly and up to ~2.5% in case of MOX assembly.

The multiplication factors for fuel assembly variants were used to compute various reactivity effects. Corresponding results obtained with six codes are presented in Tables 43, 86 and show generally good agreement with a few exceptions:

- Discrepancies for reactivity effects are approximately the same both for UGD and MOXGD variants and are somewhat increased at high burnup.
- The R.M.S. difference for  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  poisoning effect is ~5%  $\delta k$ .
- Deviations in boron effect are smaller and equal to 2-2.5%  $\delta k$ .
- The R.M.S. difference for fuel temperature effect is 5-7%  $\delta k$  for all the burnup points with exception of the UGD variant in zero burnup point, where the R.M.S. difference is 8.7%  $\delta k$ .

- Deviations of the total temperature effect have a tendency to increase with burnup; at high burnups the deviations are 6%  $\delta k$  for UGD and 7%  $\delta k$  for MOXGD variants.

#### 4.3. Fission rate distributions

The results of comparison of pin-by-pin power distributions computed by various codes are shown in Tables 87-90. Comparison results are presented for state S1 burnup points 0, 2, 4, 6, 8, 10, 12, 14, 15, 20, 40 MWd/kgHM, and for other states S2-S5 for three burnup points (0, 20 and 40 MWd/kgHM) The tables make it possible to conclude that pin-by-pin fission rate distribution calculations show very good agreement. The discrepancies do not exceed 2% for UGD and 3% for MOXGD variants.

For UGD variant at the beginning of burnup, the pin with maximum deviation is uranium-gadolinium pin and is located at pin location 24 (see Figure A.3). At the end of burnup pin with maximum deviation is uranium pin number 1 at the corner of the system. For MOXGD variant at the beginning of burnup pin with maximum deviation is uranium pin number 1 at the corner of the assembly and at the end of burnup pin with maximum deviation is uranium-gadolinium pin number 35.

#### 4.4. Isotopic concentrations

Assembly average isotopic composition versus burnup as well as isotopic composition in the corner cell 1 and fuel-gadolinium cell 24 (see Figure A.3) are presented in Tables 2-38 and 45-81 for variants UGD and MOXGD respectively. For assembly average isotopic composition the R.M.S. deviation is ~2% for  $^{235}\text{U}$  and 3.4% for  $^{239}\text{Pu}$ . For  $^{149}\text{Sm}$  the R.M.S. deviation is approximately 7%.

Isotopic compositions in five fuel-gadolinium pin radial zones for burnup point 2 MWd/kgHM are presented in Tables 39-42 and 82-85 respectively. The radial distribution of the Pu and Gd isotopes in the fuel-gadolinium pin shows very good agreement. For  $^{239}\text{Pu}$  the R.M.S. deviation is 5% in inner zone when the MULTICELL results are not included in the comparison and about 11% with the MULTICELL results are included. The  $^{155}\text{Gd}$  R.M.S. deviation is 2% in the outer zone.



## *Chapter 5*

### **CONCLUSIONS**

The VVER-MOX Computational Benchmark Results were analysed. Five participants have submitted results with burnup calculations and one with only BOL results. The codes use a variety of different methods and nuclear data. A comparison of the results shows rather good agreement among the various codes.

All codes give very similar trends in  $k_{inf}$  versus burnup, but TVS-M and MULTICELL codes have a tendency to underestimate somewhat a  $k_{inf}$  at the end of burnup relative to the other tree codes. Pin-by-pin fission rate distribution calculations show very good agreement with the discrepancy not exceeding 2% for UGD and 3% for MOXGD variants.

The verification of spectral codes using benchmarks such as the one described above, is only a part of overall verification of the whole code package for VVERs calculations. Additional parts of this package (codes for core coarse-mesh and fine-mesh calculation) must be verified as well. Work along these lines should be continued and benchmarking efforts should be extended to the whole-core methods involving fuel cycle and kinetics calculations. Further, it should be emphasised that verification on the base of calculational benchmarks does not eliminate the necessity of comparing with the results obtained at MOX fuelled experimental facilities.



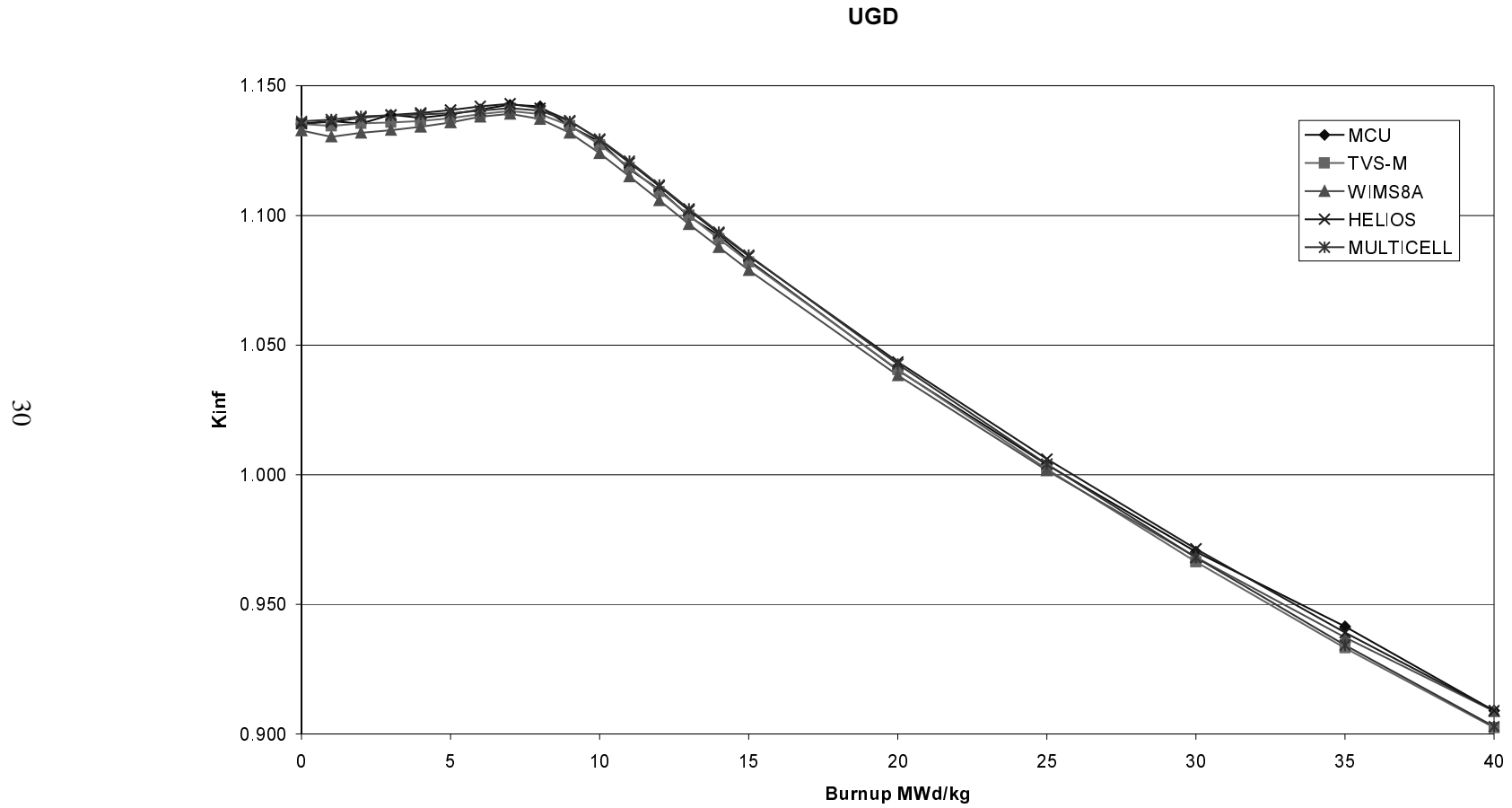
# **TABLES**



**Table 1. UGD Variant.  $K_{inf}$ . Abs. Deviation from Mean Value**

Burnup MWd/kgHM	$K_{inf}$					Mean	$\Delta$	Abs. Deviation from Mean (K-mean)				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.1353	1.1353	1.1328	1.1355	1.1363	1.1350	0.001	0.000	0.000	-0.002	0.000	0.001
1	1.1364	1.1345	1.1303	1.1361	1.1370	1.1349	0.002	0.002	0.000	-0.005	0.001	0.002
2	1.1354	1.1355	1.1318	1.1377	1.1382	1.1357	0.002	0.000	0.000	-0.004	0.002	0.002
3	1.1388	1.1359	1.1330	1.1387	1.1386	1.1370	0.002	0.002	-0.001	-0.004	0.002	0.002
4	1.1377	1.1365	1.1341	1.1395	1.1389	1.1373	0.002	0.000	-0.001	-0.003	0.002	0.002
5	1.1390	1.1375	1.1358	1.1407	1.1394	1.1385	0.002	0.001	-0.001	-0.003	0.002	0.001
6	1.1408	1.1390	1.1380	1.1421	1.1404	1.1401	0.001	0.001	-0.001	-0.002	0.002	0.000
7	1.1427	1.1403	1.1392	1.1430	1.1414	1.1413	0.001	0.001	-0.001	-0.002	0.002	0.000
8	1.1421	1.1390	1.1371	1.1414	1.1404	1.1400	0.002	0.002	-0.001	-0.003	0.001	0.000
9	1.1344	1.1346	1.1318	1.1365	1.1363	1.1347	0.002	0.000	0.000	-0.003	0.002	0.002
10	1.1284	1.1273	1.1240	1.1291	1.1295	1.1277	0.002	0.001	0.000	-0.004	0.001	0.002
11	1.1178	1.1185	1.1150	1.1203	1.1209	1.1185	0.002	-0.001	0.000	-0.003	0.002	0.002
12	1.1099	1.1092	1.1058	1.1112	1.1117	1.1096	0.002	0.000	0.000	-0.004	0.002	0.002
13	1.0996	1.1000	1.0966	1.1020	1.1025	1.1002	0.002	-0.001	0.000	-0.004	0.002	0.002
14	1.0923	1.0910	1.0877	1.0931	1.0935	1.0915	0.002	0.001	-0.001	-0.004	0.002	0.002
15	1.0827	1.0821	1.0790	1.0843	1.0846	1.0825	0.002	0.000	0.000	-0.004	0.002	0.002
20	1.0403	1.0405	1.0383	1.0435	1.0427	1.0411	0.002	-0.001	-0.001	-0.003	0.002	0.002
25	1.0039	1.0022	1.0017	1.0061	1.0041	1.0036	0.002	0.000	-0.001	-0.002	0.003	0.001
30	0.9703	0.9665	0.9681	0.9714	0.9681	0.9689	0.002	0.001	-0.002	-0.001	0.003	-0.001
35	0.9415	0.9332	0.9372	0.9391	0.9343	0.9371	0.004	0.004	-0.004	0.000	0.002	-0.003
40	0.9091	0.9025	0.9088	0.9091	0.9029	0.9065	0.004	0.003	-0.004	0.002	0.003	-0.004

Figure 1. UGD Variant.  $K_{inf}$  vs Burnup



**Table 2. UGD. Assembly Average Isotopic Composition. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value, 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.595E-04	2.596E-04	2.596E-04	2.596E-04	2.596E-04	2.596E-04	0.02	-0.04	0.01	0.01	0.01	0.00
1	2.512E-04	2.513E-04	2.514E-04	2.514E-04	2.514E-04	2.513E-04	0.03	-0.05	0.00	0.01	0.01	0.03
2	2.432E-04	2.434E-04	2.434E-04	2.434E-04	2.434E-04	2.434E-04	0.03	-0.06	0.00	0.03	0.02	0.01
3	2.356E-04	2.357E-04	2.358E-04	2.358E-04	2.358E-04	2.357E-04	0.04	-0.07	-0.01	0.04	0.02	0.03
4	2.281E-04	2.283E-04	2.284E-04	2.284E-04	2.284E-04	2.283E-04	0.05	-0.08	-0.02	0.05	0.02	0.03
5	2.209E-04	2.211E-04	2.213E-04	2.212E-04	2.212E-04	2.212E-04	0.06	-0.09	-0.03	0.08	0.03	0.02
6	2.140E-04	2.141E-04	2.144E-04	2.143E-04	2.143E-04	2.142E-04	0.08	-0.11	-0.04	0.10	0.02	0.04
7	2.072E-04	2.074E-04	2.077E-04	2.075E-04	2.076E-04	2.075E-04	0.10	-0.13	-0.06	0.12	0.02	0.05
8	2.006E-04	2.008E-04	2.012E-04	2.010E-04	2.010E-04	2.009E-04	0.11	-0.15	-0.07	0.15	0.03	0.04
9	1.942E-04	1.944E-04	1.949E-04	1.946E-04	1.946E-04	1.946E-04	0.13	-0.16	-0.08	0.19	0.03	0.02
10	1.880E-04	1.882E-04	1.888E-04	1.884E-04	1.884E-04	1.884E-04	0.15	-0.18	-0.10	0.22	0.03	0.02
11	1.819E-04	1.821E-04	1.828E-04	1.824E-04	1.824E-04	1.823E-04	0.18	-0.21	-0.12	0.26	0.03	0.04
12	1.760E-04	1.762E-04	1.770E-04	1.765E-04	1.765E-04	1.765E-04	0.20	-0.23	-0.13	0.30	0.03	0.03
13	1.703E-04	1.705E-04	1.713E-04	1.708E-04	1.708E-04	1.707E-04	0.23	-0.26	-0.16	0.34	0.03	0.04
14	1.647E-04	1.649E-04	1.658E-04	1.652E-04	1.652E-04	1.652E-04	0.26	-0.28	-0.18	0.40	0.04	0.02
15	1.593E-04	1.594E-04	1.605E-04	1.598E-04	1.598E-04	1.598E-04	0.29	-0.31	-0.20	0.45	0.04	0.03
20	1.341E-04	1.343E-04	1.358E-04	1.348E-04	1.346E-04	1.347E-04	0.48	-0.45	-0.30	0.79	0.04	-0.08
25	1.121E-04	1.123E-04	1.142E-04	1.129E-04	1.126E-04	1.128E-04	0.74	-0.64	-0.44	1.24	0.03	-0.20
30	9.294E-05	9.319E-05	9.548E-05	9.379E-05	9.342E-05	9.376E-05	1.08	-0.88	-0.61	1.83	0.03	-0.37
35	7.636E-05	7.665E-05	7.926E-05	7.730E-05	7.680E-05	7.728E-05	1.50	-1.18	-0.81	2.57	0.03	-0.61
40	6.223E-05	6.248E-05	6.534E-05	6.317E-05	6.254E-05	6.315E-05	2.01	-1.46	-1.07	3.47	0.03	-0.97

**Table 3. UGD. Assembly Average Isotopic Composition. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value, 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.538E-06	1.533E-06	1.519E-06	1.562E-06	1.525E-06	1.535E-06	1.09	0.18	-0.16	-1.09	1.75	-0.68
2	3.013E-06	3.000E-06	2.973E-06	3.058E-06	2.986E-06	3.006E-06	1.09	0.23	-0.19	-1.10	1.73	-0.67
3	4.427E-06	4.407E-06	4.366E-06	4.493E-06	4.389E-06	4.417E-06	1.10	0.24	-0.21	-1.14	1.74	-0.62
4	5.787E-06	5.759E-06	5.704E-06	5.873E-06	5.737E-06	5.772E-06	1.11	0.26	-0.22	-1.18	1.75	-0.60
5	7.095E-06	7.059E-06	6.989E-06	7.201E-06	7.036E-06	7.076E-06	1.12	0.27	-0.24	-1.23	1.76	-0.57
6	8.355E-06	8.312E-06	8.227E-06	8.481E-06	8.288E-06	8.333E-06	1.14	0.27	-0.24	-1.27	1.78	-0.53
7	9.570E-06	9.520E-06	9.419E-06	9.716E-06	9.495E-06	9.544E-06	1.16	0.27	-0.25	-1.31	1.80	-0.51
8	1.074E-05	1.069E-05	1.057E-05	1.091E-05	1.066E-05	1.071E-05	1.17	0.28	-0.25	-1.35	1.82	-0.50
9	1.188E-05	1.181E-05	1.168E-05	1.206E-05	1.179E-05	1.184E-05	1.19	0.27	-0.26	-1.39	1.83	-0.45
10	1.297E-05	1.290E-05	1.275E-05	1.318E-05	1.288E-05	1.294E-05	1.21	0.28	-0.27	-1.43	1.85	-0.43
11	1.403E-05	1.395E-05	1.379E-05	1.426E-05	1.393E-05	1.399E-05	1.23	0.30	-0.27	-1.47	1.88	-0.44
12	1.506E-05	1.497E-05	1.479E-05	1.530E-05	1.495E-05	1.501E-05	1.25	0.30	-0.27	-1.51	1.90	-0.42
13	1.605E-05	1.596E-05	1.575E-05	1.631E-05	1.593E-05	1.600E-05	1.27	0.31	-0.27	-1.54	1.93	-0.43
14	1.701E-05	1.691E-05	1.669E-05	1.728E-05	1.688E-05	1.695E-05	1.29	0.32	-0.27	-1.58	1.95	-0.43
15	1.793E-05	1.783E-05	1.759E-05	1.823E-05	1.780E-05	1.787E-05	1.31	0.32	-0.27	-1.62	1.98	-0.42
20	2.209E-05	2.195E-05	2.161E-05	2.249E-05	2.193E-05	2.202E-05	1.43	0.36	-0.28	-1.82	2.13	-0.39
25	2.555E-05	2.538E-05	2.494E-05	2.603E-05	2.534E-05	2.545E-05	1.55	0.40	-0.28	-2.00	2.29	-0.42
30	2.836E-05	2.816E-05	2.762E-05	2.892E-05	2.810E-05	2.823E-05	1.67	0.46	-0.26	-2.17	2.44	-0.47
35	3.060E-05	3.036E-05	2.973E-05	3.123E-05	3.025E-05	3.043E-05	1.80	0.56	-0.23	-2.32	2.60	-0.60
40	3.230E-05	3.203E-05	3.131E-05	3.299E-05	3.186E-05	3.210E-05	1.91	0.62	-0.21	-2.44	2.77	-0.74



**Table 4. UGD. Assembly Average Isotopic Composition. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value, 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	6.676E-03	6.678E-03	6.679E-03	6.679E-03	6.679E-03	6.678E-03	0.02	-0.04	0.01	0.01	0.01	0.01
1	6.670E-03	6.674E-03	6.674E-03	6.674E-03	6.674E-03	6.673E-03	0.03	-0.05	0.01	0.01	0.01	0.01
2	6.667E-03	6.669E-03	6.669E-03	6.669E-03	6.669E-03	6.669E-03	0.02	-0.03	0.01	0.01	0.01	0.01
3	6.661E-03	6.665E-03	6.664E-03	6.665E-03	6.665E-03	6.664E-03	0.03	-0.05	0.01	0.01	0.01	0.02
4	6.657E-03	6.660E-03	6.659E-03	6.660E-03	6.660E-03	6.659E-03	0.02	-0.03	0.01	0.00	0.01	0.01
5	6.652E-03	6.655E-03	6.655E-03	6.656E-03	6.655E-03	6.654E-03	0.02	-0.04	0.01	0.00	0.02	0.01
6	6.648E-03	6.651E-03	6.650E-03	6.651E-03	6.651E-03	6.650E-03	0.02	-0.03	0.01	0.00	0.02	0.01
7	6.643E-03	6.646E-03	6.645E-03	6.647E-03	6.646E-03	6.645E-03	0.02	-0.04	0.01	0.00	0.02	0.01
8	6.638E-03	6.641E-03	6.640E-03	6.642E-03	6.642E-03	6.641E-03	0.03	-0.04	0.01	-0.01	0.02	0.02
9	6.633E-03	6.637E-03	6.636E-03	6.637E-03	6.637E-03	6.636E-03	0.02	-0.04	0.01	-0.01	0.02	0.02
10	6.629E-03	6.632E-03	6.631E-03	6.633E-03	6.632E-03	6.631E-03	0.02	-0.04	0.01	-0.01	0.02	0.01
11	6.624E-03	6.627E-03	6.626E-03	6.628E-03	6.627E-03	6.626E-03	0.02	-0.04	0.01	-0.01	0.02	0.01
12	6.619E-03	6.622E-03	6.621E-03	6.623E-03	6.623E-03	6.622E-03	0.03	-0.04	0.01	-0.01	0.02	0.02
13	6.614E-03	6.618E-03	6.616E-03	6.618E-03	6.618E-03	6.617E-03	0.03	-0.04	0.01	-0.01	0.02	0.02
14	6.609E-03	6.613E-03	6.611E-03	6.614E-03	6.613E-03	6.612E-03	0.03	-0.05	0.01	-0.01	0.03	0.02
15	6.604E-03	6.608E-03	6.606E-03	6.609E-03	6.608E-03	6.607E-03	0.03	-0.04	0.01	-0.02	0.03	0.02
20	6.578E-03	6.582E-03	6.580E-03	6.584E-03	6.583E-03	6.581E-03	0.03	-0.05	0.01	-0.02	0.03	0.02
25	6.552E-03	6.556E-03	6.553E-03	6.557E-03	6.557E-03	6.555E-03	0.04	-0.05	0.01	-0.03	0.04	0.03
30	6.524E-03	6.528E-03	6.525E-03	6.530E-03	6.530E-03	6.527E-03	0.04	-0.05	0.01	-0.04	0.04	0.04
35	6.495E-03	6.500E-03	6.496E-03	6.502E-03	6.502E-03	6.499E-03	0.05	-0.06	0.01	-0.05	0.04	0.05
40	6.465E-03	6.470E-03	6.465E-03	6.472E-03	6.472E-03	6.469E-03	0.05	-0.06	0.01	-0.05	0.05	0.05

**Table 5. UGD. Assembly Average Isotopic Composition. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value, 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	3.403E-06	3.412E-06	3.492E-06	3.383E-06	3.391E-06	3.416E-06	1.29	-0.38	-0.12	2.22	-0.99	-0.74
2	6.992E-06	6.989E-06	7.164E-06	6.861E-06	6.948E-06	6.991E-06	1.58	0.02	-0.03	2.48	-1.86	-0.62
3	1.024E-05	1.022E-05	1.048E-05	9.994E-06	1.016E-05	1.022E-05	1.70	0.23	0.03	2.53	-2.20	-0.58
4	1.320E-05	1.315E-05	1.348E-05	1.282E-05	1.306E-05	1.314E-05	1.80	0.43	0.08	2.54	-2.43	-0.62
5	1.586E-05	1.581E-05	1.620E-05	1.539E-05	1.570E-05	1.579E-05	1.85	0.46	0.14	2.56	-2.58	-0.58
6	1.829E-05	1.823E-05	1.867E-05	1.771E-05	1.809E-05	1.820E-05	1.91	0.50	0.20	2.58	-2.70	-0.59
7	2.050E-05	2.044E-05	2.092E-05	1.982E-05	2.027E-05	2.039E-05	1.96	0.56	0.25	2.59	-2.81	-0.58
8	2.252E-05	2.245E-05	2.297E-05	2.173E-05	2.225E-05	2.238E-05	2.00	0.61	0.29	2.61	-2.91	-0.60
9	2.437E-05	2.429E-05	2.485E-05	2.349E-05	2.406E-05	2.421E-05	2.05	0.67	0.32	2.64	-2.99	-0.63
10	2.608E-05	2.598E-05	2.659E-05	2.510E-05	2.571E-05	2.589E-05	2.10	0.72	0.36	2.68	-3.06	-0.70
11	2.765E-05	2.755E-05	2.819E-05	2.658E-05	2.724E-05	2.744E-05	2.15	0.77	0.38	2.72	-3.14	-0.73
12	2.912E-05	2.899E-05	2.968E-05	2.795E-05	2.865E-05	2.888E-05	2.20	0.83	0.40	2.77	-3.21	-0.79
13	3.047E-05	3.034E-05	3.106E-05	2.922E-05	2.995E-05	3.021E-05	2.25	0.87	0.43	2.82	-3.27	-0.85
14	3.171E-05	3.158E-05	3.234E-05	3.039E-05	3.116E-05	3.144E-05	2.30	0.88	0.45	2.87	-3.33	-0.88
15	3.287E-05	3.273E-05	3.353E-05	3.148E-05	3.227E-05	3.258E-05	2.34	0.91	0.48	2.93	-3.38	-0.94
20	3.750E-05	3.731E-05	3.831E-05	3.579E-05	3.666E-05	3.712E-05	2.54	1.03	0.54	3.22	-3.56	-1.23
25	4.061E-05	4.043E-05	4.162E-05	3.870E-05	3.958E-05	4.019E-05	2.75	1.04	0.60	3.57	-3.71	-1.51
30	4.265E-05	4.251E-05	4.390E-05	4.062E-05	4.145E-05	4.222E-05	2.96	1.00	0.67	3.97	-3.80	-1.83
35	4.385E-05	4.385E-05	4.545E-05	4.185E-05	4.260E-05	4.352E-05	3.16	0.76	0.77	4.43	-3.84	-2.12
40	4.444E-05	4.469E-05	4.649E-05	4.260E-05	4.324E-05	4.429E-05	3.38	0.33	0.90	4.95	-3.81	-2.37

**Table 6. UGD. Assembly Average Isotopic Composition. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	6.285E-08	6.331E-08	6.491E-08	6.010E-08	5.980E-08	6.219E-08	3.52	1.06	1.80	4.36	-3.37	-3.85
2	2.505E-07	2.516E-07	2.592E-07	2.446E-07	2.444E-07	2.500E-07	2.43	0.18	0.61	3.65	-2.18	-2.25
3	5.302E-07	5.330E-07	5.481E-07	5.202E-07	5.216E-07	5.306E-07	2.11	-0.08	0.45	3.29	-1.97	-1.70
4	8.781E-07	8.835E-07	9.056E-07	8.615E-07	8.663E-07	8.790E-07	1.97	-0.10	0.51	3.03	-1.99	-1.44
5	1.277E-06	1.286E-06	1.313E-06	1.251E-06	1.261E-06	1.278E-06	1.90	-0.07	0.66	2.80	-2.10	-1.29
6	1.715E-06	1.728E-06	1.758E-06	1.675E-06	1.695E-06	1.714E-06	1.85	0.05	0.80	2.57	-2.29	-1.13
7	2.182E-06	2.201E-06	2.231E-06	2.125E-06	2.157E-06	2.179E-06	1.85	0.14	0.98	2.37	-2.47	-1.02
8	2.671E-06	2.697E-06	2.724E-06	2.595E-06	2.642E-06	2.666E-06	1.88	0.21	1.17	2.19	-2.67	-0.89
9	3.177E-06	3.212E-06	3.233E-06	3.078E-06	3.143E-06	3.168E-06	1.93	0.27	1.37	2.03	-2.86	-0.80
10	3.696E-06	3.741E-06	3.752E-06	3.570E-06	3.658E-06	3.683E-06	1.99	0.34	1.55	1.87	-3.07	-0.69
11	4.223E-06	4.280E-06	4.280E-06	4.070E-06	4.183E-06	4.207E-06	2.07	0.37	1.74	1.74	-3.27	-0.58
12	4.758E-06	4.829E-06	4.814E-06	4.574E-06	4.716E-06	4.738E-06	2.16	0.42	1.92	1.60	-3.48	-0.47
13	5.298E-06	5.384E-06	5.352E-06	5.080E-06	5.254E-06	5.274E-06	2.26	0.47	2.10	1.48	-3.68	-0.37
14	5.843E-06	5.944E-06	5.892E-06	5.587E-06	5.796E-06	5.813E-06	2.37	0.53	2.27	1.36	-3.88	-0.28
15	6.393E-06	6.508E-06	6.432E-06	6.094E-06	6.340E-06	6.353E-06	2.48	0.62	2.43	1.24	-4.08	-0.21
20	9.109E-06	9.293E-06	9.109E-06	8.578E-06	9.031E-06	9.024E-06	2.96	0.95	2.98	0.94	-4.94	0.08
25	1.173E-05	1.200E-05	1.166E-05	1.093E-05	1.163E-05	1.159E-05	3.43	1.19	3.55	0.60	-5.70	0.35
30	1.416E-05	1.455E-05	1.402E-05	1.309E-05	1.405E-05	1.398E-05	3.85	1.34	4.13	0.34	-6.32	0.52
35	1.642E-05	1.690E-05	1.617E-05	1.504E-05	1.626E-05	1.616E-05	4.24	1.61	4.60	0.08	-6.91	0.62
40	1.828E-05	1.902E-05	1.809E-05	1.676E-05	1.823E-05	1.808E-05	4.52	1.14	5.20	0.07	-7.26	0.85

**Table 7. UGD. Assembly Average Isotopic Composition. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	3.013E-09	2.940E-09	3.268E-09	2.991E-09	2.873E-09	3.017E-09	4.98	-0.13	-2.54	8.31	-0.86	-4.77
2	2.448E-08	2.371E-08	2.661E-08	2.517E-08	2.421E-08	2.484E-08	4.52	-1.43	-4.53	7.15	1.33	-2.52
3	7.743E-08	7.458E-08	8.378E-08	8.014E-08	7.717E-08	7.862E-08	4.44	-1.52	-5.14	6.57	1.93	-1.84
4	1.675E-07	1.611E-07	1.809E-07	1.741E-07	1.676E-07	1.702E-07	4.41	-1.60	-5.36	6.25	2.26	-1.55
5	2.962E-07	2.844E-07	3.189E-07	3.082E-07	2.964E-07	3.008E-07	4.38	-1.53	-5.48	6.02	2.46	-1.47
6	4.598E-07	4.426E-07	4.959E-07	4.807E-07	4.617E-07	4.681E-07	4.39	-1.78	-5.45	5.92	2.69	-1.38
7	6.573E-07	6.327E-07	7.081E-07	6.881E-07	6.599E-07	6.692E-07	4.37	-1.79	-5.45	5.81	2.82	-1.39
8	8.842E-07	8.511E-07	9.517E-07	9.264E-07	8.870E-07	9.001E-07	4.37	-1.76	-5.44	5.74	2.92	-1.46
9	1.137E-06	1.095E-06	1.223E-06	1.192E-06	1.139E-06	1.157E-06	4.38	-1.77	-5.41	5.71	3.03	-1.56
10	1.412E-06	1.360E-06	1.519E-06	1.482E-06	1.414E-06	1.437E-06	4.37	-1.75	-5.39	5.68	3.08	-1.63
11	1.709E-06	1.645E-06	1.836E-06	1.792E-06	1.707E-06	1.738E-06	4.37	-1.67	-5.36	5.66	3.13	-1.77
12	2.021E-06	1.946E-06	2.171E-06	2.120E-06	2.017E-06	2.055E-06	4.37	-1.64	-5.32	5.65	3.16	-1.86
13	2.349E-06	2.261E-06	2.521E-06	2.463E-06	2.341E-06	2.387E-06	4.36	-1.59	-5.29	5.63	3.17	-1.92
14	2.689E-06	2.587E-06	2.884E-06	2.816E-06	2.675E-06	2.730E-06	4.34	-1.52	-5.25	5.62	3.16	-2.02
15	3.035E-06	2.922E-06	3.255E-06	3.179E-06	3.017E-06	3.081E-06	4.34	-1.52	-5.19	5.64	3.15	-2.09
20	4.841E-06	4.679E-06	5.175E-06	5.055E-06	4.808E-06	4.912E-06	4.07	-1.45	-4.73	5.37	2.92	-2.11
25	6.618E-06	6.403E-06	7.070E-06	6.876E-06	6.554E-06	6.704E-06	3.98	-1.28	-4.50	5.46	2.56	-2.24
30	8.261E-06	7.991E-06	8.821E-06	8.528E-06	8.151E-06	8.350E-06	3.93	-1.07	-4.30	5.64	2.12	-2.39
35	9.661E-06	9.399E-06	1.037E-05	9.961E-06	9.552E-06	9.789E-06	3.94	-1.31	-3.99	5.97	1.76	-2.42
40	1.097E-05	1.061E-05	1.171E-05	1.117E-05	1.074E-05	1.104E-05	3.91	-0.66	-3.88	6.09	1.15	-2.70

**Table 8. UGD. Assembly Average Isotopic Composition. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.959E-11	1.904E-11	1.902E-11	1.723E-11	1.644E-11	1.826E-11	7.40	7.26	4.24	4.14	-5.66	-9.98
2	3.268E-10	3.162E-10	3.201E-10	3.025E-10	2.891E-10	3.109E-10	4.86	5.11	1.68	2.94	-2.71	-7.02
3	1.579E-09	1.524E-09	1.545E-09	1.482E-09	1.417E-09	1.509E-09	4.15	4.63	0.95	2.37	-1.82	-6.13
4	4.649E-09	4.472E-09	4.532E-09	4.381E-09	4.189E-09	4.445E-09	3.89	4.60	0.63	1.96	-1.43	-5.75
5	1.047E-08	1.004E-08	1.016E-08	9.876E-09	9.434E-09	9.997E-09	3.82	4.70	0.48	1.66	-1.21	-5.63
6	1.989E-08	1.909E-08	1.928E-08	1.881E-08	1.795E-08	1.900E-08	3.74	4.68	0.45	1.45	-1.03	-5.55
7	3.371E-08	3.238E-08	3.264E-08	3.194E-08	3.044E-08	3.222E-08	3.69	4.60	0.49	1.31	-0.87	-5.53
8	5.263E-08	5.059E-08	5.092E-08	4.993E-08	4.752E-08	5.032E-08	3.68	4.59	0.53	1.20	-0.76	-5.56
9	7.726E-08	7.431E-08	7.469E-08	7.337E-08	6.973E-08	7.387E-08	3.69	4.59	0.59	1.10	-0.68	-5.61
10	1.082E-07	1.041E-07	1.044E-07	1.027E-07	9.752E-08	1.034E-07	3.72	4.62	0.65	1.02	-0.63	-5.68
11	1.458E-07	1.403E-07	1.406E-07	1.385E-07	1.313E-07	1.393E-07	3.75	4.65	0.73	0.96	-0.60	-5.74
12	1.905E-07	1.834E-07	1.836E-07	1.809E-07	1.713E-07	1.819E-07	3.81	4.71	0.82	0.90	-0.59	-5.85
13	2.426E-07	2.337E-07	2.336E-07	2.303E-07	2.179E-07	2.316E-07	3.86	4.74	0.91	0.85	-0.59	-5.92
14	3.026E-07	2.915E-07	2.909E-07	2.868E-07	2.712E-07	2.886E-07	3.93	4.85	1.00	0.79	-0.61	-6.03
15	3.707E-07	3.568E-07	3.556E-07	3.507E-07	3.314E-07	3.530E-07	4.02	5.00	1.07	0.72	-0.67	-6.13
20	8.307E-07	8.015E-07	7.919E-07	7.809E-07	7.383E-07	7.887E-07	4.27	5.33	1.62	0.42	-0.98	-6.39
25	1.489E-06	1.441E-06	1.413E-06	1.391E-06	1.316E-06	1.410E-06	4.54	5.58	2.24	0.20	-1.35	-6.66
30	2.331E-06	2.262E-06	2.201E-06	2.160E-06	2.045E-06	2.200E-06	4.90	5.96	2.82	0.06	-1.81	-7.03
35	3.334E-06	3.239E-06	3.132E-06	3.061E-06	2.896E-06	3.132E-06	5.37	6.45	3.41	-0.01	-2.29	-7.55
40	4.459E-06	4.347E-06	4.178E-06	4.063E-06	3.839E-06	4.177E-06	5.81	6.74	4.06	0.03	-2.73	-8.09

**Table 9. UGD. Assembly Average Isotopic Composition. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	3.021E-09	2.951E-09	3.042E-09	2.979E-09	3.061E-09	3.011E-09	1.50	0.34	-1.98	1.04	-1.06	1.67
2	3.044E-09	2.976E-09	3.068E-09	3.007E-09	3.092E-09	3.037E-09	1.53	0.23	-2.03	1.00	-1.00	1.80
3	3.065E-09	2.990E-09	3.083E-09	3.025E-09	3.110E-09	3.055E-09	1.55	0.35	-2.10	0.93	-0.98	1.81
4	3.070E-09	2.997E-09	3.090E-09	3.035E-09	3.121E-09	3.063E-09	1.57	0.24	-2.13	0.89	-0.90	1.90
5	3.071E-09	2.997E-09	3.089E-09	3.038E-09	3.123E-09	3.064E-09	1.57	0.23	-2.17	0.84	-0.84	1.94
6	3.065E-09	2.991E-09	3.083E-09	3.035E-09	3.119E-09	3.059E-09	1.59	0.21	-2.21	0.80	-0.78	1.97
7	3.060E-09	2.981E-09	3.073E-09	3.028E-09	3.110E-09	3.050E-09	1.60	0.30	-2.27	0.75	-0.74	1.96
8	3.048E-09	2.971E-09	3.064E-09	3.020E-09	3.098E-09	3.040E-09	1.57	0.24	-2.27	0.78	-0.66	1.90
9	3.041E-09	2.962E-09	3.056E-09	3.014E-09	3.088E-09	3.032E-09	1.56	0.29	-2.30	0.79	-0.61	1.84
10	3.032E-09	2.955E-09	3.050E-09	3.007E-09	3.079E-09	3.025E-09	1.55	0.26	-2.31	0.83	-0.57	1.80
11	3.024E-09	2.947E-09	3.044E-09	3.003E-09	3.070E-09	3.018E-09	1.54	0.22	-2.33	0.86	-0.49	1.74
12	3.016E-09	2.939E-09	3.037E-09	2.996E-09	3.062E-09	3.010E-09	1.55	0.20	-2.36	0.89	-0.46	1.73
13	3.005E-09	2.930E-09	3.029E-09	2.989E-09	3.053E-09	3.001E-09	1.56	0.13	-2.39	0.94	-0.41	1.72
14	2.995E-09	2.919E-09	3.021E-09	2.981E-09	3.043E-09	2.992E-09	1.57	0.10	-2.42	0.98	-0.37	1.71
15	2.985E-09	2.908E-09	3.012E-09	2.971E-09	3.031E-09	2.982E-09	1.58	0.12	-2.47	1.02	-0.34	1.66
20	2.921E-09	2.840E-09	2.956E-09	2.921E-09	2.964E-09	2.920E-09	1.68	0.02	-2.74	1.22	0.01	1.49
25	2.839E-09	2.760E-09	2.888E-09	2.850E-09	2.880E-09	2.843E-09	1.78	-0.15	-2.92	1.57	0.22	1.29
30	2.753E-09	2.675E-09	2.815E-09	2.770E-09	2.789E-09	2.760E-09	1.92	-0.27	-3.11	1.97	0.36	1.04
35	2.656E-09	2.588E-09	2.741E-09	2.688E-09	2.695E-09	2.674E-09	2.12	-0.67	-3.19	2.51	0.55	0.80
40	2.581E-09	2.505E-09	2.669E-09	2.608E-09	2.604E-09	2.593E-09	2.28	-0.48	-3.40	2.92	0.55	0.41

**Table 10. UGD. Assembly Average Isotopic Composition.  $^{149}\text{Sm}$ , atoms/barn\*cm  
(codes with equilibrium concentration of  $^{149}\text{Sm}$  at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. $^{149}\text{Sm}$ , atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	2.452E-08	2.480E-08	2.466E-08	0.80	-0.57	0.57
1	2.411E-08	2.426E-08	2.418E-08	0.44	-0.31	0.31
2	2.423E-08	2.527E-08	2.475E-08	2.98	-2.11	2.11
3	2.448E-08	2.588E-08	2.518E-08	3.92	-2.77	2.77
4	2.480E-08	2.636E-08	2.558E-08	4.31	-3.05	3.05
5	2.513E-08	2.675E-08	2.594E-08	4.39	-3.11	3.11
6	2.546E-08	2.711E-08	2.628E-08	4.44	-3.14	3.14
7	2.577E-08	2.749E-08	2.663E-08	4.57	-3.23	3.23
8	2.609E-08	2.790E-08	2.699E-08	4.76	-3.36	3.36
9	2.640E-08	2.832E-08	2.736E-08	4.96	-3.51	3.51
10	2.672E-08	2.874E-08	2.773E-08	5.16	-3.65	3.65
11	2.702E-08	2.917E-08	2.809E-08	5.40	-3.82	3.82
12	2.730E-08	2.955E-08	2.843E-08	5.60	-3.96	3.96
13	2.755E-08	2.991E-08	2.873E-08	5.78	-4.09	4.09
14	2.778E-08	3.023E-08	2.900E-08	5.96	-4.21	4.21
15	2.798E-08	3.052E-08	2.925E-08	6.12	-4.33	4.33
20	2.864E-08	3.162E-08	3.013E-08	7.00	-4.95	4.95
25	2.884E-08	3.209E-08	3.047E-08	7.55	-5.34	5.34
30	2.873E-08	3.216E-08	3.044E-08	7.96	-5.63	5.63
35	2.841E-08	3.195E-08	3.018E-08	8.28	-5.85	5.85
40	2.799E-08	3.158E-08	2.978E-08	8.51	-6.02	6.02

**Table 11. UGD. Assembly Average Isotopic Composition. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	2.220E-08	2.084E-08	2.174E-08	2.159E-08	3.20	2.81	-3.48	0.67
2	2.437E-08	2.304E-08	2.403E-08	2.381E-08	2.90	2.34	-3.25	0.91
3	2.530E-08	2.411E-08	2.514E-08	2.485E-08	2.59	1.80	-2.97	1.17
4	2.586E-08	2.488E-08	2.597E-08	2.557E-08	2.33	1.12	-2.68	1.56
5	2.627E-08	2.546E-08	2.660E-08	2.611E-08	2.24	0.62	-2.49	1.87
6	2.659E-08	2.595E-08	2.710E-08	2.655E-08	2.17	0.15	-2.24	2.09
7	2.690E-08	2.643E-08	2.756E-08	2.696E-08	2.11	-0.24	-1.99	2.22
8	2.722E-08	2.692E-08	2.801E-08	2.738E-08	2.06	-0.59	-1.70	2.30
9	2.753E-08	2.741E-08	2.848E-08	2.781E-08	2.11	-0.99	-1.43	2.42
10	2.785E-08	2.790E-08	2.894E-08	2.823E-08	2.18	-1.34	-1.17	2.51
11	2.814E-08	2.838E-08	2.940E-08	2.864E-08	2.33	-1.73	-0.92	2.65
12	2.840E-08	2.882E-08	2.984E-08	2.902E-08	2.56	-2.15	-0.68	2.83
13	2.858E-08	2.924E-08	3.024E-08	2.935E-08	2.85	-2.64	-0.39	3.03
14	2.883E-08	2.962E-08	3.061E-08	2.969E-08	3.01	-2.89	-0.22	3.11
15	2.905E-08	2.997E-08	3.094E-08	2.999E-08	3.15	-3.11	-0.06	3.18
20	2.967E-08	3.130E-08	3.212E-08	3.103E-08	4.02	-4.39	0.87	3.51
25	2.969E-08	3.202E-08	3.264E-08	3.145E-08	4.94	-5.59	1.81	3.78
30	2.929E-08	3.233E-08	3.269E-08	3.144E-08	5.94	-6.83	2.84	3.98
35	2.872E-08	3.237E-08	3.241E-08	3.116E-08	6.80	-7.85	3.86	4.00
40	2.830E-08	3.223E-08	3.194E-08	3.082E-08	7.10	-8.18	4.56	3.62



**Table 12. UGD. Assembly Average Isotopic Composition. <sup>155</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>155</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.158E-06	2.159E-06	2.159E-06	2.159E-06	2.159E-06	2.159E-06	0.02	-0.04	0.01	0.01	0.01	0.00
1	1.917E-06	1.927E-06	1.916E-06	1.915E-06	1.928E-06	1.921E-06	0.34	-0.20	0.36	-0.24	-0.30	0.39
2	1.622E-06	1.641E-06	1.620E-06	1.622E-06	1.650E-06	1.631E-06	0.84	-0.55	0.63	-0.70	-0.55	1.16
3	1.299E-06	1.328E-06	1.300E-06	1.307E-06	1.346E-06	1.316E-06	1.55	-1.29	0.92	-1.22	-0.69	2.28
4	9.768E-07	1.016E-06	9.823E-07	9.942E-07	1.042E-06	1.002E-06	2.67	-2.53	1.35	-1.99	-0.80	3.97
5	6.788E-07	7.221E-07	6.853E-07	7.020E-07	7.567E-07	7.090E-07	4.44	-4.25	1.85	-3.34	-0.99	6.73
6	4.197E-07	4.617E-07	4.257E-07	4.459E-07	5.018E-07	4.509E-07	7.30	-6.93	2.38	-5.60	-1.13	11.28
7	2.168E-07	2.507E-07	2.241E-07	2.430E-07	2.905E-07	2.450E-07	11.79	-11.50	2.31	-8.53	-0.83	18.56
8	9.232E-08	1.109E-07	9.825E-08	1.107E-07	1.400E-07	1.104E-07	16.64	-16.40	0.45	-11.03	0.21	26.77
9	3.361E-08	4.137E-08	3.762E-08	4.372E-08	5.698E-08	4.266E-08	20.81	-21.21	-3.03	-11.82	2.49	33.57
10	1.198E-08	1.444E-08	1.394E-08	1.641E-08	2.116E-08	1.558E-08	22.40	-23.11	-7.37	-10.57	5.27	35.78
11	4.850E-09	5.599E-09	5.838E-09	6.711E-09	8.183E-09	6.236E-09	20.45	-22.23	-10.22	-6.39	7.62	31.22
12	2.664E-09	2.915E-09	3.240E-09	3.486E-09	3.915E-09	3.244E-09	15.05	-17.88	-10.14	-0.13	7.46	20.68
13	2.036E-09	2.120E-09	2.430E-09	2.447E-09	2.568E-09	2.320E-09	9.89	-12.25	-8.64	4.74	5.46	10.69
14	1.824E-09	1.880E-09	2.182E-09	2.117E-09	2.150E-09	2.031E-09	8.16	-10.17	-7.41	7.44	4.27	5.88
15	1.763E-09	1.801E-09	2.107E-09	2.014E-09	2.020E-09	1.941E-09	7.74	-9.17	-7.20	8.56	3.75	4.06
20	1.703E-09	1.698E-09	2.091E-09	1.974E-09	1.947E-09	1.883E-09	9.29	-9.56	-9.80	11.08	4.86	3.41
25	1.585E-09	1.614E-09	2.117E-09	1.992E-09	1.931E-09	1.848E-09	12.81	-14.23	-12.66	14.57	7.82	4.50
30	1.512E-09	1.527E-09	2.153E-09	2.021E-09	1.916E-09	1.826E-09	15.99	-17.20	-16.35	17.92	10.70	4.94
35	1.401E-09	1.441E-09	2.195E-09	2.059E-09	1.900E-09	1.799E-09	20.08	-22.15	-19.93	22.02	14.46	5.60
40	1.329E-09	1.356E-09	2.241E-09	2.105E-09	1.883E-09	1.783E-09	23.67	-25.47	-23.93	25.72	18.06	5.63

**Table 13. UGD. Assembly Average Isotopic Composition. <sup>157</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Assembly Average Isotopic Composition. <sup>157</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.267E-06	2.269E-06	2.269E-06	2.269E-06	2.269E-06	2.268E-06	0.03	-0.04	0.01	0.01	0.00	0.03
1	1.566E-06	1.592E-06	1.578E-06	1.583E-06	1.605E-06	1.585E-06	0.92	-1.17	0.44	-0.42	-0.13	1.28
2	1.031E-06	1.062E-06	1.037E-06	1.052E-06	1.092E-06	1.055E-06	2.29	-2.29	0.70	-1.64	-0.30	3.54
3	6.251E-07	6.599E-07	6.279E-07	6.473E-07	6.961E-07	6.513E-07	4.43	-4.02	1.32	-3.59	-0.60	6.88
4	3.313E-07	3.639E-07	3.323E-07	3.528E-07	4.004E-07	3.561E-07	7.96	-6.97	2.18	-6.71	-0.93	12.43
5	1.399E-07	1.630E-07	1.396E-07	1.566E-07	1.940E-07	1.586E-07	14.05	-11.82	2.78	-11.98	-1.27	22.30
6	3.894E-08	4.957E-08	3.943E-08	4.862E-08	6.942E-08	4.920E-08	25.10	-20.85	0.77	-19.85	-1.18	41.11
7	6.878E-09	8.658E-09	7.602E-09	9.704E-09	1.552E-08	9.672E-09	35.56	-28.89	-10.49	-21.40	0.33	60.46
8	2.684E-09	2.498E-09	3.150E-09	3.149E-09	3.997E-09	3.096E-09	18.73	-13.30	-19.30	1.76	1.73	29.12
9	2.300E-09	1.989E-09	2.762E-09	2.569E-09	2.876E-09	2.499E-09	14.37	-7.96	-20.43	10.51	2.80	15.07
10	2.301E-09	1.873E-09	2.691E-09	2.478E-09	2.712E-09	2.411E-09	14.29	-4.56	-22.32	11.62	2.79	12.48
11	2.236E-09	1.836E-09	2.692E-09	2.471E-09	2.672E-09	2.381E-09	14.96	-6.09	-22.92	13.05	3.76	12.20
12	2.185E-09	1.827E-09	2.720E-09	2.483E-09	2.678E-09	2.378E-09	15.72	-8.14	-23.20	14.36	4.39	12.60
13	2.297E-09	1.826E-09	2.756E-09	2.508E-09	2.700E-09	2.417E-09	15.58	-4.98	-24.48	14.02	3.75	11.69
14	2.282E-09	1.827E-09	2.795E-09	2.538E-09	2.727E-09	2.434E-09	16.16	-6.23	-24.93	14.83	4.28	12.05
15	2.276E-09	1.828E-09	2.833E-09	2.569E-09	2.754E-09	2.452E-09	16.69	-7.16	-25.45	15.53	4.76	12.32
20	2.315E-09	1.821E-09	3.015E-09	2.706E-09	2.885E-09	2.548E-09	19.01	-9.16	-28.53	18.32	6.17	13.21
25	2.362E-09	1.802E-09	3.188E-09	2.855E-09	3.013E-09	2.644E-09	21.27	-10.65	-31.84	20.58	7.96	13.95
30	2.360E-09	1.774E-09	3.363E-09	3.010E-09	3.150E-09	2.731E-09	23.92	-13.60	-35.06	23.14	10.18	15.33
35	2.279E-09	1.741E-09	3.550E-09	3.179E-09	3.303E-09	2.810E-09	27.29	-18.90	-38.06	26.33	13.10	17.53
40	2.277E-09	1.706E-09	3.756E-09	3.367E-09	3.480E-09	2.917E-09	30.17	-21.95	-41.51	28.75	15.42	19.29

**Table 14. UGD. Assembly Average Isotopic Composition Deviation from Average Value, %. Burnup=40 MWd/kgHM**

	UGD. Assembly Average Isotopic Composition Deviation from Average Value, %. Burnup=40 MWd/kgHM								
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> U	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm
MCU	-1.46	0.62	-0.06	0.33	1.14	-0.66	6.74	-0.48	-6.93
TVS-M	-1.07	-0.21	0.01	0.90	5.20	-3.88	4.06	-3.40	-7.95
WIMS8A	3.47	-2.44	-0.05	4.95	0.07	6.09	0.03	2.92	6.00
HELIOS	0.03	2.77	0.05	-3.81	-7.26	1.15	-2.73	0.55	3.84
MULTICELL	-0.97	-0.74	0.05	-2.37	0.85	-2.70	-8.09	0.41	5.04
R.M.S. %	2.01	1.91	0.05	3.38	4.52	3.91	5.81	2.28	6.84

**Table 15. UGD. Isotopic Composition in Cell 1. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	8.626E-04	8.626E-04	8.626E-04	8.626E-04	8.626E-04	8.626E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	8.311E-04	8.315E-04	8.318E-04	8.311E-04	8.303E-04	8.312E-04	0.07	-0.01	0.04	0.08	-0.01	-0.10
2	8.008E-04	8.018E-04	8.026E-04	8.010E-04	7.997E-04	8.012E-04	0.13	-0.05	0.08	0.17	-0.02	-0.18
3	7.723E-04	7.735E-04	7.747E-04	7.724E-04	7.705E-04	7.727E-04	0.20	-0.05	0.10	0.26	-0.03	-0.28
4	7.451E-04	7.464E-04	7.481E-04	7.451E-04	7.428E-04	7.455E-04	0.26	-0.05	0.12	0.35	-0.05	-0.36
5	7.188E-04	7.204E-04	7.226E-04	7.190E-04	7.163E-04	7.194E-04	0.32	-0.09	0.14	0.44	-0.06	-0.44
6	6.938E-04	6.956E-04	6.983E-04	6.940E-04	6.910E-04	6.945E-04	0.38	-0.11	0.15	0.54	-0.07	-0.51
7	6.698E-04	6.717E-04	6.749E-04	6.701E-04	6.669E-04	6.707E-04	0.44	-0.13	0.16	0.63	-0.09	-0.56
8	6.468E-04	6.488E-04	6.525E-04	6.470E-04	6.437E-04	6.478E-04	0.50	-0.15	0.16	0.73	-0.12	-0.63
9	6.245E-04	6.267E-04	6.308E-04	6.248E-04	6.214E-04	6.256E-04	0.55	-0.18	0.17	0.83	-0.14	-0.68
10	6.026E-04	6.053E-04	6.099E-04	6.033E-04	5.999E-04	6.042E-04	0.62	-0.26	0.18	0.94	-0.15	-0.71
11	5.817E-04	5.845E-04	5.896E-04	5.824E-04	5.791E-04	5.835E-04	0.67	-0.30	0.18	1.05	-0.18	-0.75
12	5.613E-04	5.644E-04	5.699E-04	5.622E-04	5.588E-04	5.633E-04	0.74	-0.36	0.19	1.16	-0.20	-0.80
13	5.415E-04	5.448E-04	5.507E-04	5.425E-04	5.392E-04	5.437E-04	0.80	-0.41	0.19	1.28	-0.22	-0.83
14	5.225E-04	5.257E-04	5.321E-04	5.234E-04	5.201E-04	5.248E-04	0.87	-0.43	0.18	1.39	-0.25	-0.89
15	5.039E-04	5.072E-04	5.140E-04	5.049E-04	5.015E-04	5.063E-04	0.94	-0.47	0.18	1.52	-0.28	-0.95
20	4.186E-04	4.224E-04	4.310E-04	4.197E-04	4.162E-04	4.216E-04	1.36	-0.71	0.19	2.24	-0.44	-1.28
25	3.453E-04	3.490E-04	3.592E-04	3.462E-04	3.425E-04	3.484E-04	1.84	-0.90	0.15	3.08	-0.63	-1.70
30	2.824E-04	2.858E-04	2.972E-04	2.832E-04	2.791E-04	2.855E-04	2.43	-1.09	0.09	4.08	-0.83	-2.25
35	2.278E-04	2.319E-04	2.441E-04	2.294E-04	2.252E-04	2.317E-04	3.17	-1.68	0.09	5.36	-0.97	-2.80
40	1.816E-04	1.864E-04	1.990E-04	1.842E-04	1.797E-04	1.862E-04	4.08	-2.45	0.11	6.89	-1.07	-3.47

**Table 16. UGD. Isotopic Composition in Cell 1. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	5.718E-06	5.642E-06	5.544E-06	5.813E-06	5.838E-06	5.711E-06	2.13	0.12	-1.21	-2.92	1.79	2.22
2	1.120E-05	1.100E-05	1.080E-05	1.132E-05	1.136E-05	1.114E-05	2.10	0.57	-1.26	-2.98	1.67	2.01
3	1.632E-05	1.608E-05	1.580E-05	1.655E-05	1.660E-05	1.627E-05	2.07	0.31	-1.16	-2.92	1.75	2.03
4	2.120E-05	2.092E-05	2.054E-05	2.153E-05	2.156E-05	2.115E-05	2.04	0.24	-1.09	-2.89	1.80	1.94
5	2.588E-05	2.553E-05	2.505E-05	2.627E-05	2.626E-05	2.580E-05	2.01	0.32	-1.05	-2.89	1.82	1.79
6	3.033E-05	2.992E-05	2.935E-05	3.078E-05	3.074E-05	3.022E-05	1.99	0.35	-1.01	-2.90	1.85	1.71
7	3.457E-05	3.411E-05	3.344E-05	3.509E-05	3.499E-05	3.444E-05	1.97	0.38	-0.96	-2.89	1.88	1.60
8	3.860E-05	3.811E-05	3.736E-05	3.921E-05	3.904E-05	3.846E-05	1.95	0.35	-0.91	-2.87	1.93	1.50
9	4.250E-05	4.195E-05	4.111E-05	4.315E-05	4.291E-05	4.233E-05	1.93	0.41	-0.88	-2.87	1.96	1.38
10	4.626E-05	4.564E-05	4.472E-05	4.695E-05	4.662E-05	4.604E-05	1.92	0.48	-0.86	-2.87	1.99	1.26
11	4.988E-05	4.920E-05	4.819E-05	5.061E-05	5.018E-05	4.961E-05	1.91	0.54	-0.84	-2.87	2.02	1.15
12	5.337E-05	5.262E-05	5.153E-05	5.414E-05	5.362E-05	5.306E-05	1.91	0.59	-0.82	-2.88	2.04	1.06
13	5.670E-05	5.593E-05	5.475E-05	5.755E-05	5.693E-05	5.637E-05	1.90	0.58	-0.79	-2.87	2.08	0.99
14	5.990E-05	5.912E-05	5.786E-05	6.083E-05	6.012E-05	5.956E-05	1.90	0.56	-0.75	-2.86	2.12	0.93
15	6.295E-05	6.219E-05	6.085E-05	6.399E-05	6.319E-05	6.263E-05	1.89	0.50	-0.71	-2.84	2.17	0.89
20	7.672E-05	7.586E-05	7.417E-05	7.812E-05	7.685E-05	7.634E-05	1.91	0.49	-0.64	-2.85	2.33	0.66
25	8.781E-05	8.703E-05	8.502E-05	8.967E-05	8.790E-05	8.748E-05	1.92	0.37	-0.52	-2.82	2.49	0.48
30	9.651E-05	9.594E-05	9.366E-05	9.888E-05	9.659E-05	9.632E-05	1.94	0.20	-0.39	-2.76	2.66	0.29
35	1.034E-04	1.028E-04	1.003E-04	1.060E-04	1.031E-04	1.031E-04	1.96	0.27	-0.30	-2.72	2.78	-0.02
40	1.086E-04	1.079E-04	1.052E-04	1.112E-04	1.077E-04	1.081E-04	1.99	0.45	-0.24	-2.69	2.87	-0.38

**Table 17. UGD. Isotopic Composition in Cell 1. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value, 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.217E-02	2.217E-02	2.217E-02	2.217E-02	2.217E-02	2.217E-02	0.00	0.00	0.00	0.00	0.00	0.00
1	2.215E-02	2.215E-02	2.215E-02	2.215E-02	2.215E-02	2.215E-02	0.01	-0.01	0.01	0.00	0.01	-0.01
2	2.214E-02	2.214E-02	2.214E-02	2.214E-02	2.214E-02	2.214E-02	0.01	0.01	0.00	-0.01	0.00	0.01
3	2.212E-02	2.212E-02	2.212E-02	2.212E-02	2.212E-02	2.212E-02	0.00	0.00	0.00	0.00	0.00	0.00
4	2.210E-02	2.211E-02	2.210E-02	2.211E-02	2.210E-02	2.210E-02	0.01	-0.01	0.01	0.00	0.01	-0.01
5	2.209E-02	2.209E-02	2.209E-02	2.209E-02	2.209E-02	2.209E-02	0.00	0.00	0.00	-0.01	0.00	0.00
6	2.207E-02	2.207E-02	2.207E-02	2.207E-02	2.207E-02	2.207E-02	0.01	-0.01	0.01	0.00	0.01	-0.01
7	2.205E-02	2.206E-02	2.206E-02	2.206E-02	2.205E-02	2.205E-02	0.02	-0.02	0.02	0.00	0.01	-0.02
8	2.204E-02	2.204E-02	2.204E-02	2.204E-02	2.204E-02	2.204E-02	0.01	0.00	0.01	-0.01	0.00	0.00
9	2.202E-02	2.203E-02	2.202E-02	2.203E-02	2.202E-02	2.202E-02	0.01	-0.01	0.01	0.00	0.01	-0.01
10	2.201E-02	2.201E-02	2.201E-02	2.201E-02	2.201E-02	2.201E-02	0.01	0.00	0.00	-0.01	0.00	0.00
11	2.199E-02	2.199E-02	2.199E-02	2.199E-02	2.199E-02	2.199E-02	0.01	-0.01	0.01	-0.01	0.00	-0.01
12	2.197E-02	2.198E-02	2.197E-02	2.198E-02	2.197E-02	2.197E-02	0.01	-0.01	0.02	0.00	0.01	-0.01
13	2.196E-02	2.196E-02	2.196E-02	2.196E-02	2.196E-02	2.196E-02	0.01	0.00	0.01	-0.01	0.00	0.00
14	2.194E-02	2.194E-02	2.194E-02	2.194E-02	2.194E-02	2.194E-02	0.01	-0.01	0.01	-0.01	0.01	-0.01
15	2.192E-02	2.193E-02	2.192E-02	2.193E-02	2.192E-02	2.192E-02	0.02	-0.01	0.02	0.00	0.01	-0.01
20	2.183E-02	2.184E-02	2.184E-02	2.184E-02	2.184E-02	2.184E-02	0.02	-0.03	0.02	-0.01	0.01	0.01
25	2.174E-02	2.175E-02	2.174E-02	2.175E-02	2.175E-02	2.175E-02	0.02	-0.03	0.03	-0.01	0.01	0.01
30	2.164E-02	2.166E-02	2.165E-02	2.166E-02	2.166E-02	2.165E-02	0.04	-0.06	0.03	-0.01	0.01	0.03
35	2.154E-02	2.156E-02	2.155E-02	2.156E-02	2.156E-02	2.155E-02	0.04	-0.07	0.04	-0.01	0.01	0.03
40	2.144E-02	2.146E-02	2.145E-02	2.146E-02	2.146E-02	2.145E-02	0.04	-0.06	0.04	-0.01	0.01	0.03

**Table 18. UGD. Isotopic Composition in Cell 1. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.213E-05	1.175E-05	1.196E-05	1.193E-05	1.214E-05	1.198E-05	1.36	1.25	-1.95	-0.18	-0.46	1.34
2	2.467E-05	2.391E-05	2.438E-05	2.401E-05	2.463E-05	2.432E-05	1.43	1.44	-1.68	0.23	-1.27	1.28
3	3.569E-05	3.478E-05	3.544E-05	3.474E-05	3.568E-05	3.527E-05	1.35	1.20	-1.39	0.50	-1.49	1.18
4	4.587E-05	4.452E-05	4.535E-05	4.431E-05	4.550E-05	4.511E-05	1.48	1.68	-1.31	0.54	-1.78	0.86
5	5.485E-05	5.329E-05	5.427E-05	5.287E-05	5.425E-05	5.391E-05	1.49	1.75	-1.14	0.67	-1.92	0.64
6	6.274E-05	6.121E-05	6.231E-05	6.056E-05	6.207E-05	6.178E-05	1.42	1.55	-0.92	0.86	-1.97	0.47
7	7.006E-05	6.838E-05	6.959E-05	6.749E-05	6.908E-05	6.892E-05	1.47	1.65	-0.79	0.98	-2.08	0.23
8	7.678E-05	7.487E-05	7.621E-05	7.375E-05	7.538E-05	7.540E-05	1.56	1.83	-0.70	1.08	-2.19	-0.02
9	8.288E-05	8.080E-05	8.226E-05	7.943E-05	8.107E-05	8.129E-05	1.65	1.96	-0.60	1.19	-2.28	-0.27
10	8.833E-05	8.622E-05	8.781E-05	8.461E-05	8.624E-05	8.664E-05	1.70	1.95	-0.49	1.35	-2.34	-0.46
11	9.346E-05	9.120E-05	9.292E-05	8.936E-05	9.095E-05	9.158E-05	1.80	2.05	-0.41	1.47	-2.43	-0.69
12	9.804E-05	9.579E-05	9.765E-05	9.371E-05	9.527E-05	9.609E-05	1.85	2.03	-0.31	1.62	-2.48	-0.85
13	1.024E-04	1.000E-04	1.020E-04	9.770E-05	9.922E-05	1.003E-04	1.95	2.12	-0.25	1.74	-2.56	-1.05
14	1.063E-04	1.039E-04	1.060E-04	1.014E-04	1.028E-04	1.041E-04	2.03	2.13	-0.16	1.88	-2.61	-1.24
15	1.101E-04	1.075E-04	1.098E-04	1.047E-04	1.062E-04	1.077E-04	2.14	2.26	-0.15	1.97	-2.72	-1.36
20	1.252E-04	1.215E-04	1.245E-04	1.178E-04	1.189E-04	1.216E-04	2.70	2.96	-0.05	2.42	-3.10	-2.22
25	1.343E-04	1.308E-04	1.345E-04	1.263E-04	1.269E-04	1.306E-04	3.01	2.86	0.19	3.04	-3.28	-2.81
30	1.388E-04	1.368E-04	1.412E-04	1.316E-04	1.318E-04	1.361E-04	3.14	2.02	0.56	3.82	-3.27	-3.13
35	1.412E-04	1.406E-04	1.457E-04	1.348E-04	1.345E-04	1.394E-04	3.39	1.32	0.89	4.54	-3.25	-3.49
40	1.429E-04	1.429E-04	1.486E-04	1.367E-04	1.358E-04	1.414E-04	3.70	1.08	1.06	5.11	-3.30	-3.95

**Table 19. UGD. Isotopic Composition in Cell 1. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	2.485E-07	2.397E-07	2.447E-07	2.375E-07	2.467E-07	2.434E-07	1.92	2.09	-1.53	0.54	-2.44	1.35
2	9.845E-07	9.461E-07	9.695E-07	9.561E-07	9.936E-07	9.699E-07	2.02	1.50	-2.46	-0.05	-1.43	2.44
3	2.029E-06	1.989E-06	2.032E-06	2.012E-06	2.090E-06	2.030E-06	1.85	-0.07	-2.05	0.07	-0.89	2.94
4	3.299E-06	3.270E-06	3.327E-06	3.300E-06	3.424E-06	3.324E-06	1.79	-0.75	-1.62	0.08	-0.72	3.01
5	4.802E-06	4.723E-06	4.782E-06	4.746E-06	4.921E-06	4.795E-06	1.61	0.15	-1.50	-0.27	-1.02	2.63
6	6.395E-06	6.298E-06	6.346E-06	6.299E-06	6.528E-06	6.373E-06	1.50	0.34	-1.18	-0.43	-1.17	2.43
7	8.107E-06	7.960E-06	7.985E-06	7.923E-06	8.208E-06	8.037E-06	1.47	0.88	-0.95	-0.64	-1.41	2.13
8	9.824E-06	9.687E-06	9.676E-06	9.595E-06	9.938E-06	9.744E-06	1.40	0.82	-0.59	-0.70	-1.53	1.99
9	1.162E-05	1.146E-05	1.141E-05	1.130E-05	1.170E-05	1.150E-05	1.41	1.06	-0.30	-0.80	-1.72	1.76
10	1.346E-05	1.328E-05	1.317E-05	1.303E-05	1.349E-05	1.328E-05	1.47	1.32	-0.04	-0.90	-1.92	1.55
11	1.529E-05	1.513E-05	1.495E-05	1.477E-05	1.530E-05	1.509E-05	1.50	1.34	0.27	-0.93	-2.08	1.41
12	1.716E-05	1.700E-05	1.674E-05	1.653E-05	1.713E-05	1.691E-05	1.60	1.46	0.53	-0.99	-2.29	1.29
13	1.899E-05	1.890E-05	1.855E-05	1.828E-05	1.896E-05	1.874E-05	1.64	1.36	0.85	-0.98	-2.42	1.20
14	2.087E-05	2.080E-05	2.037E-05	2.003E-05	2.080E-05	2.057E-05	1.76	1.44	1.09	-1.01	-2.62	1.10
15	2.272E-05	2.271E-05	2.218E-05	2.178E-05	2.263E-05	2.240E-05	1.85	1.41	1.37	-1.00	-2.79	1.01
20	3.185E-05	3.209E-05	3.111E-05	3.022E-05	3.154E-05	3.136E-05	2.34	1.55	2.32	-0.80	-3.64	0.56
25	3.996E-05	4.110E-05	3.955E-05	3.804E-05	3.989E-05	3.971E-05	2.77	0.63	3.51	-0.40	-4.20	0.45
30	4.797E-05	4.950E-05	4.731E-05	4.508E-05	4.745E-05	4.746E-05	3.35	1.08	4.29	-0.32	-5.02	-0.02
35	5.505E-05	5.713E-05	5.428E-05	5.125E-05	5.413E-05	5.437E-05	3.88	1.25	5.07	-0.16	-5.73	-0.44
40	6.024E-05	6.392E-05	6.045E-05	5.657E-05	5.987E-05	6.021E-05	4.33	0.05	6.17	0.40	-6.05	-0.57



**Table 20. UGD. Isotopic Composition in Cell 1. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWD/kgHM	UGD. Isotopic Composition in Cell 1. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.224E-08	1.140E-08	1.263E-08	1.224E-08	1.268E-08	1.224E-08	4.19	0.01	-6.85	3.20	0.04	3.61
2	1.005E-07	9.126E-08	1.020E-07	1.017E-07	1.050E-07	1.001E-07	5.20	0.41	-8.82	1.92	1.58	4.91
3	3.117E-07	2.845E-07	3.180E-07	3.196E-07	3.286E-07	3.125E-07	5.36	-0.26	-8.95	1.77	2.28	5.15
4	6.704E-07	6.093E-07	6.799E-07	6.860E-07	7.016E-07	6.694E-07	5.30	0.15	-8.99	1.56	2.47	4.81
5	1.142E-06	1.066E-06	1.187E-06	1.201E-06	1.221E-06	1.163E-06	5.30	-1.85	-8.36	2.05	3.21	4.94
6	1.763E-06	1.646E-06	1.829E-06	1.853E-06	1.874E-06	1.793E-06	5.14	-1.68	-8.20	2.02	3.34	4.51
7	2.472E-06	2.335E-06	2.590E-06	2.627E-06	2.642E-06	2.533E-06	5.10	-2.41	-7.83	2.24	3.69	4.30
8	3.315E-06	3.118E-06	3.453E-06	3.505E-06	3.507E-06	3.380E-06	4.91	-1.91	-7.75	2.17	3.72	3.77
9	4.245E-06	3.982E-06	4.405E-06	4.474E-06	4.453E-06	4.312E-06	4.75	-1.55	-7.65	2.16	3.77	3.28
10	5.247E-06	4.917E-06	5.433E-06	5.521E-06	5.470E-06	5.318E-06	4.64	-1.33	-7.54	2.18	3.82	2.87
11	6.339E-06	5.911E-06	6.527E-06	6.634E-06	6.545E-06	6.391E-06	4.52	-0.82	-7.51	2.13	3.80	2.40
12	7.463E-06	6.957E-06	7.676E-06	7.802E-06	7.670E-06	7.514E-06	4.45	-0.67	-7.41	2.16	3.84	2.08
13	8.670E-06	8.043E-06	8.869E-06	9.012E-06	8.834E-06	8.686E-06	4.37	-0.18	-7.40	2.11	3.76	1.71
14	9.835E-06	9.161E-06	1.010E-05	1.026E-05	1.003E-05	9.876E-06	4.32	-0.41	-7.23	2.23	3.84	1.56
15	1.106E-05	1.030E-05	1.135E-05	1.152E-05	1.124E-05	1.109E-05	4.26	-0.31	-7.13	2.29	3.83	1.31
20	1.758E-05	1.622E-05	1.775E-05	1.797E-05	1.747E-05	1.740E-05	3.94	1.06	-6.79	2.01	3.30	0.42
25	2.405E-05	2.188E-05	2.394E-05	2.406E-05	2.334E-05	2.345E-05	3.96	2.54	-6.71	2.07	2.59	-0.49
30	2.909E-05	2.699E-05	2.956E-05	2.944E-05	2.854E-05	2.872E-05	3.65	1.27	-6.04	2.92	2.49	-0.64
35	3.340E-05	3.142E-05	3.446E-05	3.398E-05	3.294E-05	3.324E-05	3.52	0.48	-5.48	3.67	2.22	-0.90
40	3.761E-05	3.516E-05	3.861E-05	3.769E-05	3.655E-05	3.712E-05	3.55	1.31	-5.29	4.00	1.52	-1.54

**Table 21. UGD. Isotopic Composition in Cell 1. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	8.714E-11	8.207E-11	8.132E-11	8.000E-11	8.406E-11	8.292E-11	3.35	5.09	-1.02	-1.93	-3.52	1.38
2	1.509E-09	1.352E-09	1.355E-09	1.384E-09	1.451E-09	1.410E-09	4.82	7.00	-4.15	-3.89	-1.84	2.89
3	7.111E-09	6.449E-09	6.466E-09	6.684E-09	6.976E-09	6.737E-09	4.43	5.55	-4.28	-4.02	-0.78	3.54
4	2.071E-08	1.872E-08	1.873E-08	1.948E-08	2.023E-08	1.957E-08	4.54	5.80	-4.35	-4.31	-0.49	3.35
5	4.577E-08	4.159E-08	4.148E-08	4.330E-08	4.471E-08	4.337E-08	4.36	5.53	-4.10	-4.35	-0.17	3.09
6	8.518E-08	7.816E-08	7.771E-08	8.132E-08	8.349E-08	8.117E-08	4.01	4.94	-3.71	-4.26	0.18	2.85
7	1.419E-07	1.311E-07	1.299E-07	1.362E-07	1.391E-07	1.357E-07	3.77	4.61	-3.36	-4.21	0.43	2.54
8	2.178E-07	2.026E-07	2.003E-07	2.103E-07	2.134E-07	2.089E-07	3.51	4.27	-3.00	-4.11	0.68	2.16
9	3.161E-07	2.947E-07	2.907E-07	3.056E-07	3.082E-07	3.031E-07	3.40	4.31	-2.75	-4.09	0.83	1.70
10	4.397E-07	4.092E-07	4.027E-07	4.238E-07	4.252E-07	4.201E-07	3.46	4.66	-2.59	-4.14	0.87	1.21
11	5.904E-07	5.478E-07	5.379E-07	5.665E-07	5.656E-07	5.616E-07	3.59	5.12	-2.47	-4.22	0.86	0.71
12	7.687E-07	7.116E-07	6.974E-07	7.349E-07	7.308E-07	7.287E-07	3.70	5.49	-2.34	-4.29	0.85	0.29
13	9.761E-07	9.018E-07	8.822E-07	9.299E-07	9.215E-07	9.223E-07	3.83	5.83	-2.22	-4.35	0.83	-0.09
14	1.211E-06	1.119E-06	1.093E-06	1.152E-06	1.138E-06	1.143E-06	3.87	5.99	-2.06	-4.36	0.83	-0.40
15	1.474E-06	1.364E-06	1.330E-06	1.402E-06	1.382E-06	1.390E-06	3.87	6.02	-1.89	-4.36	0.84	-0.60
20	3.259E-06	3.011E-06	2.910E-06	3.064E-06	3.001E-06	3.049E-06	4.26	6.89	-1.25	-4.57	0.50	-1.57
25	5.876E-06	5.345E-06	5.126E-06	5.382E-06	5.249E-06	5.396E-06	5.30	8.90	-0.95	-4.99	-0.25	-2.72
30	9.141E-06	8.294E-06	7.908E-06	8.262E-06	8.030E-06	8.327E-06	5.80	9.78	-0.40	-5.03	-0.78	-3.56
35	1.281E-05	1.176E-05	1.116E-05	1.159E-05	1.122E-05	1.171E-05	5.68	9.42	0.47	-4.69	-1.04	-4.16
40	1.683E-05	1.565E-05	1.478E-05	1.524E-05	1.468E-05	1.543E-05	5.64	9.05	1.38	-4.26	-1.28	-4.88

**Table 22. UGD. Isotopic Composition in Cell 1. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	9.935E-09	9.723E-09	1.006E-08	9.894E-09	1.020E-08	9.962E-09	1.80	-0.27	-2.40	0.96	-0.68	2.39
2	1.003E-08	9.774E-09	1.011E-08	9.956E-09	1.026E-08	1.003E-08	1.80	0.04	-2.51	0.85	-0.70	2.33
3	1.010E-08	9.798E-09	1.013E-08	9.984E-09	1.028E-08	1.006E-08	1.79	0.41	-2.60	0.73	-0.74	2.20
4	1.011E-08	9.800E-09	1.013E-08	9.992E-09	1.028E-08	1.006E-08	1.78	0.47	-2.61	0.69	-0.70	2.16
5	1.006E-08	9.785E-09	1.011E-08	9.981E-09	1.025E-08	1.004E-08	1.71	0.22	-2.52	0.74	-0.57	2.12
6	1.010E-08	9.755E-09	1.008E-08	9.955E-09	1.021E-08	1.002E-08	1.73	0.80	-2.64	0.59	-0.65	1.90
7	9.941E-09	9.717E-09	1.004E-08	9.920E-09	1.016E-08	9.955E-09	1.64	-0.14	-2.39	0.82	-0.35	2.06
8	9.979E-09	9.677E-09	9.997E-09	9.885E-09	1.011E-08	9.930E-09	1.63	0.50	-2.54	0.68	-0.45	1.82
9	9.990E-09	9.639E-09	9.962E-09	9.851E-09	1.006E-08	9.901E-09	1.66	0.90	-2.64	0.62	-0.50	1.61
10	9.888E-09	9.603E-09	9.931E-09	9.817E-09	1.001E-08	9.850E-09	1.57	0.39	-2.51	0.83	-0.33	1.62
11	9.892E-09	9.566E-09	9.901E-09	9.793E-09	9.967E-09	9.824E-09	1.60	0.69	-2.62	0.78	-0.31	1.46
12	9.806E-09	9.527E-09	9.869E-09	9.759E-09	9.924E-09	9.777E-09	1.57	0.30	-2.56	0.94	-0.18	1.50
13	9.753E-09	9.484E-09	9.834E-09	9.722E-09	9.878E-09	9.734E-09	1.57	0.19	-2.57	1.02	-0.12	1.48
14	9.667E-09	9.438E-09	9.796E-09	9.682E-09	9.829E-09	9.682E-09	1.59	-0.16	-2.52	1.17	-0.01	1.52
15	9.648E-09	9.389E-09	9.755E-09	9.638E-09	9.776E-09	9.641E-09	1.60	0.07	-2.62	1.18	-0.03	1.40
20	9.405E-09	9.112E-09	9.523E-09	9.419E-09	9.485E-09	9.389E-09	1.73	0.17	-2.95	1.43	0.32	1.02
25	9.142E-09	8.804E-09	9.258E-09	9.129E-09	9.147E-09	9.096E-09	1.88	0.51	-3.21	1.78	0.37	0.56
30	8.804E-09	8.487E-09	8.983E-09	8.823E-09	8.798E-09	8.779E-09	2.05	0.29	-3.32	2.32	0.50	0.22
35	8.334E-09	8.180E-09	8.713E-09	8.519E-09	8.455E-09	8.440E-09	2.37	-1.26	-3.08	3.23	0.94	0.18
40	8.079E-09	7.894E-09	8.460E-09	8.232E-09	8.134E-09	8.160E-09	2.55	-0.99	-3.26	3.68	0.88	-0.32

**Table 23. UGD. Isotopic Composition in Cell 1. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with equilibrium concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	7.014E-08	7.671E-08	7.343E-08	6.33	-4.47	4.47
1	7.145E-08	7.266E-08	7.205E-08	1.18	-0.84	0.84
2	7.393E-08	7.618E-08	7.505E-08	2.12	-1.50	1.50
3	7.624E-08	7.912E-08	7.768E-08	2.62	-1.85	1.85
4	7.828E-08	8.185E-08	8.007E-08	3.15	-2.23	2.23
5	8.009E-08	8.430E-08	8.219E-08	3.62	-2.56	2.56
6	8.167E-08	8.646E-08	8.407E-08	4.03	-2.85	2.85
7	8.307E-08	8.837E-08	8.572E-08	4.37	-3.09	3.09
8	8.431E-08	9.006E-08	8.718E-08	4.66	-3.30	3.30
9	8.542E-08	9.157E-08	8.850E-08	4.91	-3.48	3.48
10	8.643E-08	9.294E-08	8.968E-08	5.13	-3.63	3.63
11	8.734E-08	9.426E-08	9.080E-08	5.39	-3.81	3.81
12	8.816E-08	9.542E-08	9.179E-08	5.59	-3.95	3.95
13	8.888E-08	9.646E-08	9.267E-08	5.78	-4.09	4.09
14	8.951E-08	9.739E-08	9.345E-08	5.96	-4.22	4.22
15	9.005E-08	9.821E-08	9.413E-08	6.12	-4.33	4.33
20	9.166E-08	1.012E-07	9.645E-08	7.02	-4.97	4.97
25	9.186E-08	1.022E-07	9.703E-08	7.54	-5.33	5.33
30	9.111E-08	1.019E-07	9.652E-08	7.92	-5.60	5.60
35	8.980E-08	1.009E-07	9.533E-08	8.20	-5.80	5.80
40	8.822E-08	9.936E-08	9.379E-08	8.40	-5.94	5.94

**Table 24. UGD. Isotopic Composition in Cell 1. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	7.128E-08	6.751E-08	7.077E-08	6.985E-08	2.93	2.04	-3.36	1.31
2	7.635E-08	7.224E-08	7.546E-08	7.468E-08	2.90	2.23	-3.27	1.04
3	7.999E-08	7.530E-08	7.865E-08	7.798E-08	3.09	2.58	-3.43	0.86
4	8.148E-08	7.817E-08	8.167E-08	8.044E-08	2.45	1.29	-2.82	1.53
5	8.376E-08	8.075E-08	8.439E-08	8.297E-08	2.34	0.96	-2.67	1.71
6	8.509E-08	8.305E-08	8.682E-08	8.499E-08	2.22	0.12	-2.28	2.16
7	8.623E-08	8.509E-08	8.895E-08	8.676E-08	2.28	-0.61	-1.92	2.53
8	8.819E-08	8.695E-08	9.081E-08	8.865E-08	2.22	-0.52	-1.92	2.44
9	9.016E-08	8.866E-08	9.248E-08	9.043E-08	2.13	-0.30	-1.96	2.26
10	9.060E-08	9.027E-08	9.400E-08	9.162E-08	2.26	-1.12	-1.48	2.60
11	9.182E-08	9.175E-08	9.540E-08	9.299E-08	2.25	-1.26	-1.34	2.59
12	9.163E-08	9.311E-08	9.670E-08	9.381E-08	2.78	-2.33	-0.75	3.08
13	9.252E-08	9.434E-08	9.787E-08	9.491E-08	2.87	-2.52	-0.60	3.12
14	9.294E-08	9.546E-08	9.891E-08	9.577E-08	3.13	-2.96	-0.32	3.28
15	9.325E-08	9.648E-08	9.984E-08	9.652E-08	3.41	-3.39	-0.05	3.44
20	9.552E-08	1.002E-07	1.029E-07	9.955E-08	3.75	-4.05	0.69	3.36
25	9.485E-08	1.021E-07	1.038E-07	1.002E-07	4.74	-5.38	1.82	3.55
30	9.498E-08	1.026E-07	1.033E-07	1.003E-07	4.61	-5.31	2.33	2.98
35	9.025E-08	1.024E-07	1.019E-07	9.818E-08	7.00	-8.08	4.29	3.79
40	8.835E-08	1.017E-07	1.000E-07	9.668E-08	7.51	-8.61	5.18	3.44

**Table 25. UGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM**

	UGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM								
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> U	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm
MCU	-2.45	0.45	-0.06	1.08	0.05	1.31	9.05	-0.99	-7.51
TVS-M	0.11	-0.24	0.04	1.06	6.17	-5.29	1.38	-3.26	-7.65
WIMS8A	6.89	-2.69	-0.01	5.11	0.40	4.00	-4.26	3.68	6.45
HELIOS	-1.07	2.87	0.01	-3.30	-6.05	1.52	-1.28	0.88	4.02
MULTICELL	-3.47	-0.38	0.03	-3.95	-0.57	-1.54	-4.88	-0.32	4.69
R.M.S. %	4.08	1.99	0.04	3.70	4.33	3.55	5.64	2.55	6.97

**Table 26. UGD. Isotopic Composition in Cell 24. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	7.288E-04	7.288E-04	7.288E-04	7.288E-04	7.288E-04	7.288E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	7.195E-04	7.196E-04	7.192E-04	7.191E-04	7.195E-04	7.194E-04	0.03	0.02	0.02	-0.03	-0.04	0.02
2	7.093E-04	7.094E-04	7.086E-04	7.086E-04	7.094E-04	7.091E-04	0.06	0.03	0.05	-0.06	-0.07	0.05
3	6.979E-04	6.982E-04	6.970E-04	6.970E-04	6.983E-04	6.977E-04	0.10	0.04	0.08	-0.10	-0.10	0.09
4	6.854E-04	6.859E-04	6.842E-04	6.842E-04	6.860E-04	6.851E-04	0.13	0.04	0.11	-0.14	-0.13	0.13
5	6.717E-04	6.723E-04	6.702E-04	6.704E-04	6.727E-04	6.715E-04	0.17	0.04	0.13	-0.19	-0.16	0.19
6	6.568E-04	6.575E-04	6.550E-04	6.553E-04	6.582E-04	6.565E-04	0.21	0.03	0.14	-0.24	-0.19	0.25
7	6.405E-04	6.412E-04	6.385E-04	6.391E-04	6.425E-04	6.404E-04	0.25	0.02	0.13	-0.29	-0.20	0.33
8	6.232E-04	6.238E-04	6.211E-04	6.218E-04	6.258E-04	6.231E-04	0.29	0.01	0.10	-0.33	-0.21	0.43
9	6.050E-04	6.055E-04	6.031E-04	6.040E-04	6.082E-04	6.052E-04	0.32	-0.03	0.06	-0.33	-0.20	0.50
10	5.868E-04	5.870E-04	5.851E-04	5.859E-04	5.903E-04	5.870E-04	0.34	-0.04	-0.01	-0.33	-0.19	0.56
11	5.687E-04	5.686E-04	5.672E-04	5.681E-04	5.724E-04	5.690E-04	0.35	-0.05	-0.07	-0.31	-0.17	0.60
12	5.510E-04	5.506E-04	5.497E-04	5.505E-04	5.548E-04	5.513E-04	0.36	-0.07	-0.13	-0.29	-0.15	0.63
13	5.336E-04	5.330E-04	5.327E-04	5.334E-04	5.375E-04	5.340E-04	0.37	-0.08	-0.19	-0.25	-0.12	0.65
14	5.165E-04	5.158E-04	5.161E-04	5.167E-04	5.207E-04	5.172E-04	0.39	-0.12	-0.25	-0.21	-0.10	0.69
15	5.000E-04	4.991E-04	4.999E-04	5.003E-04	5.043E-04	5.007E-04	0.41	-0.14	-0.32	-0.17	-0.08	0.71
20	4.238E-04	4.219E-04	4.251E-04	4.248E-04	4.281E-04	4.247E-04	0.53	-0.21	-0.67	0.08	0.01	0.80
25	3.567E-04	3.541E-04	3.595E-04	3.583E-04	3.609E-04	3.579E-04	0.73	-0.32	-1.06	0.44	0.10	0.84
30	2.984E-04	2.949E-04	3.021E-04	3.000E-04	3.019E-04	2.995E-04	1.00	-0.34	-1.54	0.89	0.17	0.82
35	2.472E-04	2.434E-04	2.523E-04	2.492E-04	2.504E-04	2.485E-04	1.36	-0.52	-2.04	1.51	0.29	0.76
40	2.029E-04	1.992E-04	2.092E-04	2.054E-04	2.059E-04	2.045E-04	1.82	-0.79	-2.60	2.29	0.42	0.67

**Table 27. UGD. Isotopic Composition in Cell 24. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	2.256E-06	2.241E-06	2.268E-06	2.392E-06	2.222E-06	2.276E-06	2.95	-0.87	-1.52	-0.35	5.10	-2.36
2	4.633E-06	4.603E-06	4.672E-06	4.901E-06	4.563E-06	4.675E-06	2.84	-0.89	-1.53	-0.05	4.85	-2.39
3	7.157E-06	7.103E-06	7.213E-06	7.543E-06	7.037E-06	7.211E-06	2.73	-0.75	-1.49	0.03	4.61	-2.41
4	9.836E-06	9.747E-06	9.896E-06	1.032E-05	9.649E-06	9.890E-06	2.61	-0.54	-1.44	0.07	4.35	-2.43
5	1.265E-05	1.254E-05	1.273E-05	1.324E-05	1.240E-05	1.271E-05	2.50	-0.45	-1.33	0.12	4.12	-2.45
6	1.563E-05	1.550E-05	1.571E-05	1.629E-05	1.529E-05	1.568E-05	2.39	-0.32	-1.19	0.14	3.88	-2.51
7	1.876E-05	1.861E-05	1.882E-05	1.948E-05	1.833E-05	1.880E-05	2.26	-0.23	-1.00	0.12	3.61	-2.51
8	2.200E-05	2.187E-05	2.205E-05	2.278E-05	2.148E-05	2.204E-05	2.14	-0.14	-0.75	0.05	3.36	-2.52
9	2.534E-05	2.520E-05	2.531E-05	2.612E-05	2.472E-05	2.534E-05	1.99	-0.01	-0.53	-0.12	3.10	-2.44
10	2.866E-05	2.854E-05	2.855E-05	2.946E-05	2.797E-05	2.863E-05	1.86	0.08	-0.34	-0.30	2.88	-2.32
11	3.191E-05	3.181E-05	3.172E-05	3.274E-05	3.118E-05	3.187E-05	1.76	0.12	-0.19	-0.47	2.71	-2.17
12	3.507E-05	3.500E-05	3.481E-05	3.593E-05	3.432E-05	3.502E-05	1.67	0.14	-0.08	-0.63	2.58	-2.01
13	3.815E-05	3.809E-05	3.779E-05	3.903E-05	3.737E-05	3.808E-05	1.60	0.16	0.01	-0.77	2.48	-1.88
14	4.115E-05	4.108E-05	4.068E-05	4.203E-05	4.032E-05	4.105E-05	1.56	0.23	0.06	-0.90	2.39	-1.78
15	4.403E-05	4.397E-05	4.348E-05	4.495E-05	4.318E-05	4.392E-05	1.53	0.24	0.12	-1.01	2.33	-1.69
20	5.699E-05	5.701E-05	5.606E-05	5.815E-05	5.613E-05	5.687E-05	1.49	0.22	0.25	-1.43	2.25	-1.30
25	6.790E-05	6.791E-05	6.653E-05	6.926E-05	6.698E-05	6.772E-05	1.55	0.27	0.28	-1.75	2.28	-1.09
30	7.686E-05	7.686E-05	7.510E-05	7.846E-05	7.590E-05	7.664E-05	1.64	0.29	0.29	-2.00	2.39	-0.96
35	8.424E-05	8.402E-05	8.194E-05	8.591E-05	8.304E-05	8.383E-05	1.76	0.48	0.22	-2.25	2.49	-0.94
40	9.006E-05	8.954E-05	8.722E-05	9.176E-05	8.855E-05	8.943E-05	1.90	0.71	0.13	-2.47	2.61	-0.98



**Table 28. UGD. Isotopic Composition in Cell 24. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.927E-02	1.927E-02	1.927E-02	1.927E-02	1.927E-02	1.927E-02	0.00	0.00	0.00	0.00	0.00	0.00
1	1.926E-02	1.926E-02	1.926E-02	1.926E-02	1.926E-02	1.926E-02	0.01	0.00	-0.01	-0.01	0.00	0.01
2	1.924E-02	1.925E-02	1.924E-02	1.925E-02	1.924E-02	1.924E-02	0.01	0.00	0.01	0.00	0.01	-0.02
3	1.923E-02	1.923E-02	1.923E-02	1.923E-02	1.923E-02	1.923E-02	0.01	0.00	0.01	0.00	0.01	-0.01
4	1.922E-02	1.922E-02	1.922E-02	1.922E-02	1.922E-02	1.922E-02	0.00	0.00	0.00	-0.01	0.01	0.00
5	1.921E-02	1.921E-02	1.921E-02	1.921E-02	1.921E-02	1.921E-02	0.01	0.00	0.00	-0.01	0.00	0.01
6	1.919E-02	1.920E-02	1.919E-02	1.920E-02	1.920E-02	1.920E-02	0.02	-0.01	0.00	-0.02	0.00	0.02
7	1.918E-02	1.918E-02	1.918E-02	1.918E-02	1.918E-02	1.918E-02	0.01	0.00	0.01	-0.01	0.01	0.00
8	1.917E-02	1.917E-02	1.917E-02	1.917E-02	1.917E-02	1.917E-02	0.01	0.00	0.00	-0.02	0.01	0.01
9	1.916E-02	1.916E-02	1.915E-02	1.916E-02	1.916E-02	1.916E-02	0.02	0.00	0.00	-0.03	0.01	0.02
10	1.914E-02	1.914E-02	1.914E-02	1.914E-02	1.914E-02	1.914E-02	0.01	0.00	0.01	-0.02	0.02	0.00
11	1.913E-02	1.913E-02	1.912E-02	1.913E-02	1.913E-02	1.913E-02	0.02	-0.01	0.01	-0.03	0.01	0.01
12	1.911E-02	1.912E-02	1.911E-02	1.912E-02	1.911E-02	1.911E-02	0.02	0.01	0.01	-0.02	0.02	-0.01
13	1.910E-02	1.910E-02	1.909E-02	1.910E-02	1.910E-02	1.910E-02	0.02	-0.01	0.01	-0.03	0.02	0.00
14	1.908E-02	1.909E-02	1.908E-02	1.909E-02	1.909E-02	1.909E-02	0.02	-0.01	0.00	-0.03	0.02	0.02
15	1.907E-02	1.907E-02	1.906E-02	1.907E-02	1.907E-02	1.907E-02	0.02	-0.01	0.01	-0.03	0.02	0.00
20	1.899E-02	1.900E-02	1.899E-02	1.900E-02	1.900E-02	1.900E-02	0.03	-0.01	0.01	-0.04	0.03	0.02
25	1.892E-02	1.892E-02	1.891E-02	1.893E-02	1.892E-02	1.892E-02	0.03	-0.01	0.02	-0.05	0.04	0.00
30	1.884E-02	1.884E-02	1.883E-02	1.885E-02	1.884E-02	1.884E-02	0.04	-0.02	0.02	-0.06	0.05	0.01
35	1.875E-02	1.876E-02	1.874E-02	1.877E-02	1.876E-02	1.876E-02	0.05	-0.02	0.02	-0.07	0.05	0.02
40	1.866E-02	1.867E-02	1.865E-02	1.868E-02	1.867E-02	1.867E-02	0.05	-0.03	0.03	-0.07	0.07	0.01

**Table 29. UGD. Isotopic Composition in Cell 24. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	8.943E-06	8.677E-06	8.995E-06	8.595E-06	8.720E-06	8.786E-06	1.98	1.79	-1.25	2.38	-2.18	-0.75
2	1.860E-05	1.827E-05	1.897E-05	1.793E-05	1.840E-05	1.843E-05	2.11	0.89	-0.91	2.94	-2.74	-0.18
3	2.780E-05	2.734E-05	2.839E-05	2.674E-05	2.759E-05	2.757E-05	2.21	0.84	-0.85	2.98	-3.03	0.06
4	3.648E-05	3.585E-05	3.721E-05	3.498E-05	3.623E-05	3.615E-05	2.27	0.90	-0.84	2.93	-3.22	0.22
5	4.444E-05	4.376E-05	4.539E-05	4.264E-05	4.429E-05	4.410E-05	2.29	0.77	-0.79	2.91	-3.32	0.42
6	5.179E-05	5.104E-05	5.292E-05	4.969E-05	5.174E-05	5.143E-05	2.30	0.68	-0.76	2.88	-3.40	0.59
7	5.840E-05	5.770E-05	5.979E-05	5.613E-05	5.854E-05	5.811E-05	2.31	0.49	-0.71	2.89	-3.41	0.74
8	6.457E-05	6.376E-05	6.607E-05	6.200E-05	6.474E-05	6.423E-05	2.33	0.53	-0.73	2.87	-3.47	0.80
9	7.016E-05	6.928E-05	7.181E-05	6.736E-05	7.038E-05	6.980E-05	2.35	0.52	-0.75	2.89	-3.49	0.83
10	7.545E-05	7.433E-05	7.709E-05	7.228E-05	7.553E-05	7.493E-05	2.38	0.69	-0.81	2.87	-3.55	0.80
11	8.018E-05	7.897E-05	8.196E-05	7.681E-05	8.027E-05	7.964E-05	2.39	0.68	-0.84	2.91	-3.55	0.79
12	8.458E-05	8.326E-05	8.647E-05	8.100E-05	8.464E-05	8.399E-05	2.41	0.70	-0.87	2.96	-3.57	0.77
13	8.883E-05	8.724E-05	9.067E-05	8.487E-05	8.869E-05	8.806E-05	2.45	0.87	-0.93	2.96	-3.62	0.72
14	9.259E-05	9.092E-05	9.456E-05	8.847E-05	9.244E-05	9.180E-05	2.47	0.87	-0.95	3.02	-3.63	0.70
15	9.617E-05	9.433E-05	9.819E-05	9.180E-05	9.592E-05	9.528E-05	2.50	0.93	-1.00	3.05	-3.66	0.67
20	1.105E-04	1.079E-04	1.128E-04	1.052E-04	1.098E-04	1.092E-04	2.62	1.15	-1.23	3.25	-3.72	0.54
25	1.206E-04	1.170E-04	1.229E-04	1.143E-04	1.192E-04	1.188E-04	2.79	1.51	-1.49	3.47	-3.82	0.33
30	1.277E-04	1.232E-04	1.300E-04	1.204E-04	1.254E-04	1.253E-04	2.99	1.88	-1.72	3.72	-3.94	0.06
35	1.316E-04	1.271E-04	1.348E-04	1.244E-04	1.293E-04	1.294E-04	3.10	1.65	-1.79	4.14	-3.90	-0.11
40	1.334E-04	1.296E-04	1.381E-04	1.269E-04	1.316E-04	1.319E-04	3.18	1.11	-1.76	4.67	-3.78	-0.23

**Table 30. UGD. Isotopic Composition in Cell 24. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	9.724E-08	9.343E-08	1.003E-07	8.679E-08	8.114E-08	9.178E-08	8.50	5.95	1.79	9.29	-5.44	-11.60
2	4.146E-07	4.006E-07	4.311E-07	3.890E-07	3.670E-07	4.005E-07	6.11	3.53	0.04	7.66	-2.87	-8.36
3	9.453E-07	9.199E-07	9.847E-07	9.009E-07	8.573E-07	9.216E-07	5.18	2.57	-0.18	6.84	-2.25	-6.98
4	1.686E-06	1.643E-06	1.748E-06	1.610E-06	1.546E-06	1.647E-06	4.64	2.40	-0.21	6.15	-2.23	-6.12
5	2.608E-06	2.562E-06	2.708E-06	2.503E-06	2.425E-06	2.561E-06	4.17	1.84	0.04	5.72	-2.28	-5.31
6	3.714E-06	3.665E-06	3.847E-06	3.563E-06	3.484E-06	3.655E-06	3.83	1.61	0.29	5.27	-2.51	-4.67
7	4.973E-06	4.939E-06	5.145E-06	4.771E-06	4.710E-06	4.908E-06	3.52	1.33	0.64	4.83	-2.78	-4.03
8	6.371E-06	6.356E-06	6.567E-06	6.099E-06	6.080E-06	6.295E-06	3.26	1.21	0.98	4.33	-3.10	-3.41
9	7.824E-06	7.879E-06	8.076E-06	7.512E-06	7.558E-06	7.770E-06	3.02	0.69	1.41	3.94	-3.32	-2.73
10	9.408E-06	9.473E-06	9.639E-06	8.978E-06	9.112E-06	9.322E-06	2.91	0.92	1.62	3.41	-3.69	-2.25
11	1.099E-05	1.111E-05	1.123E-05	1.047E-05	1.071E-05	1.090E-05	2.84	0.85	1.86	3.02	-3.97	-1.76
12	1.260E-05	1.276E-05	1.284E-05	1.197E-05	1.233E-05	1.250E-05	2.82	0.82	2.07	2.69	-4.22	-1.36
13	1.422E-05	1.443E-05	1.444E-05	1.348E-05	1.397E-05	1.411E-05	2.84	0.78	2.26	2.39	-4.46	-0.97
14	1.579E-05	1.610E-05	1.605E-05	1.498E-05	1.560E-05	1.570E-05	2.88	0.56	2.50	2.21	-4.61	-0.66
15	1.747E-05	1.777E-05	1.765E-05	1.648E-05	1.724E-05	1.732E-05	2.96	0.84	2.59	1.91	-4.88	-0.47
20	2.556E-05	2.596E-05	2.552E-05	2.375E-05	2.530E-05	2.522E-05	3.39	1.36	2.95	1.18	-5.82	0.32
25	3.318E-05	3.383E-05	3.293E-05	3.059E-05	3.305E-05	3.272E-05	3.79	1.43	3.41	0.65	-6.51	1.02
30	4.005E-05	4.119E-05	3.976E-05	3.686E-05	4.030E-05	3.963E-05	4.13	1.05	3.93	0.33	-6.99	1.69
35	4.670E-05	4.792E-05	4.595E-05	4.251E-05	4.695E-05	4.601E-05	4.51	1.50	4.16	-0.11	-7.60	2.05
40	5.235E-05	5.395E-05	5.148E-05	4.751E-05	5.291E-05	5.164E-05	4.80	1.38	4.47	-0.32	-8.00	2.46

**Table 31. UGD. Isotopic Composition in Cell 24. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	4.377E-09	4.057E-09	4.743E-09	3.982E-09	3.525E-09	4.137E-09	11.01	5.81	-1.93	14.66	-3.74	-14.79
2	3.707E-08	3.504E-08	4.130E-08	3.678E-08	3.284E-08	3.660E-08	8.52	1.27	-4.28	12.82	0.47	-10.28
3	1.272E-07	1.194E-07	1.402E-07	1.276E-07	1.149E-07	1.258E-07	7.66	1.11	-5.16	11.38	1.36	-8.70
4	2.948E-07	2.782E-07	3.250E-07	2.994E-07	2.715E-07	2.938E-07	7.12	0.35	-5.31	10.64	1.90	-7.58
5	5.602E-07	5.265E-07	6.118E-07	5.681E-07	5.185E-07	5.570E-07	6.69	0.58	-5.48	9.84	1.98	-6.92
6	9.309E-07	8.729E-07	1.009E-06	9.424E-07	8.652E-07	9.241E-07	6.33	0.74	-5.54	9.20	1.98	-6.37
7	1.393E-06	1.320E-06	1.518E-06	1.424E-06	1.314E-06	1.394E-06	6.03	-0.04	-5.31	8.92	2.17	-5.74
8	1.968E-06	1.866E-06	2.136E-06	2.011E-06	1.864E-06	1.969E-06	5.76	-0.03	-5.26	8.50	2.13	-5.34
9	2.655E-06	2.504E-06	2.856E-06	2.696E-06	2.509E-06	2.644E-06	5.53	0.42	-5.29	8.02	1.96	-5.11
10	3.371E-06	3.228E-06	3.668E-06	3.470E-06	3.240E-06	3.395E-06	5.37	-0.72	-4.94	8.03	2.20	-4.57
11	4.193E-06	4.026E-06	4.562E-06	4.325E-06	4.048E-06	4.231E-06	5.22	-0.89	-4.83	7.82	2.22	-4.32
12	5.071E-06	4.890E-06	5.525E-06	5.248E-06	4.923E-06	5.132E-06	5.10	-1.18	-4.70	7.68	2.27	-4.06
13	6.026E-06	5.809E-06	6.548E-06	6.228E-06	5.854E-06	6.093E-06	4.98	-1.10	-4.67	7.47	2.21	-3.92
14	7.079E-06	6.771E-06	7.619E-06	7.254E-06	6.832E-06	7.111E-06	4.83	-0.45	-4.78	7.14	2.01	-3.92
15	8.057E-06	7.769E-06	8.727E-06	8.317E-06	7.846E-06	8.143E-06	4.78	-1.06	-4.60	7.17	2.13	-3.65
20	1.352E-05	1.308E-05	1.455E-05	1.394E-05	1.327E-05	1.367E-05	4.28	-1.10	-4.31	6.41	1.95	-2.95
25	1.907E-05	1.835E-05	2.037E-05	1.951E-05	1.867E-05	1.920E-05	4.12	-0.63	-4.42	6.14	1.65	-2.74
30	2.421E-05	2.320E-05	2.578E-05	2.463E-05	2.367E-05	2.430E-05	4.07	-0.36	-4.52	6.10	1.36	-2.58
35	2.838E-05	2.748E-05	3.057E-05	2.910E-05	2.810E-05	2.873E-05	4.12	-1.22	-4.34	6.42	1.31	-2.18
40	3.225E-05	3.114E-05	3.469E-05	3.289E-05	3.189E-05	3.257E-05	4.11	-0.99	-4.38	6.50	0.97	-2.09

**Table 32. UGD. Isotopic Composition in Cell 24. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.379E-11	1.249E-11	1.354E-11	1.100E-11	8.761E-12	1.191E-11	17.44	15.73	4.83	13.63	-7.72	-26.47
2	2.662E-10	2.431E-10	2.665E-10	2.331E-10	1.864E-10	2.390E-10	13.73	11.34	1.71	11.48	-2.51	-22.02
3	1.493E-09	1.376E-09	1.500E-09	1.345E-09	1.091E-09	1.361E-09	12.18	9.68	1.11	10.20	-1.16	-19.83
4	5.066E-09	4.679E-09	5.064E-09	4.599E-09	3.788E-09	4.639E-09	11.25	9.20	0.87	9.15	-0.87	-18.35
5	1.294E-08	1.203E-08	1.292E-08	1.182E-08	9.882E-09	1.192E-08	10.47	8.60	0.95	8.40	-0.86	-17.09
6	2.792E-08	2.590E-08	2.759E-08	2.535E-08	2.150E-08	2.565E-08	9.99	8.83	0.97	7.55	-1.17	-16.18
7	5.271E-08	4.925E-08	5.197E-08	4.794E-08	4.119E-08	4.861E-08	9.43	8.43	1.31	6.90	-1.38	-15.27
8	9.032E-08	8.519E-08	8.897E-08	8.241E-08	7.173E-08	8.373E-08	8.83	7.88	1.75	6.27	-1.58	-14.33
9	1.440E-07	1.365E-07	1.411E-07	1.312E-07	1.157E-07	1.337E-07	8.36	7.73	2.07	5.53	-1.86	-13.47
10	2.146E-07	2.052E-07	2.103E-07	1.963E-07	1.750E-07	2.003E-07	7.83	7.16	2.45	5.00	-2.00	-12.61
11	3.032E-07	2.927E-07	2.979E-07	2.788E-07	2.510E-07	2.847E-07	7.35	6.50	2.81	4.62	-2.08	-11.84
12	4.127E-07	4.003E-07	4.050E-07	3.800E-07	3.448E-07	3.886E-07	7.02	6.21	3.02	4.23	-2.20	-11.26
13	5.429E-07	5.290E-07	5.326E-07	5.008E-07	4.570E-07	5.125E-07	6.77	5.95	3.22	3.93	-2.27	-10.82
14	6.985E-07	6.797E-07	6.815E-07	6.420E-07	5.885E-07	6.580E-07	6.69	6.15	3.29	3.57	-2.44	-10.57
15	8.745E-07	8.533E-07	8.524E-07	8.040E-07	7.398E-07	8.248E-07	6.56	6.02	3.45	3.34	-2.52	-10.30
20	2.111E-06	2.079E-06	2.046E-06	1.938E-06	1.808E-06	1.997E-06	6.21	5.75	4.15	2.47	-2.93	-9.44
25	3.953E-06	3.904E-06	3.800E-06	3.606E-06	3.389E-06	3.730E-06	6.24	5.97	4.66	1.86	-3.34	-9.15
30	6.308E-06	6.283E-06	6.066E-06	5.753E-06	5.433E-06	5.969E-06	6.25	5.69	5.26	1.63	-3.61	-8.97
35	9.176E-06	9.141E-06	8.769E-06	8.303E-06	7.859E-06	8.650E-06	6.54	6.09	5.69	1.38	-4.01	-9.14
40	1.248E-05	1.239E-05	1.182E-05	1.117E-05	1.058E-05	1.169E-05	6.96	6.77	6.04	1.15	-4.48	-9.48

**Table 33. UGD. Isotopic Composition in Cell 24. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	9.434E-09	9.290E-09	9.630E-09	8.879E-09	9.562E-09	9.359E-09	3.18	0.80	-0.74	2.90	-5.13	2.17
2	9.536E-09	9.476E-09	9.808E-09	9.138E-09	9.827E-09	9.557E-09	2.95	-0.22	-0.85	2.63	-4.38	2.82
3	9.744E-09	9.575E-09	9.888E-09	9.309E-09	9.993E-09	9.702E-09	2.78	0.43	-1.30	1.92	-4.05	3.00
4	9.675E-09	9.585E-09	9.876E-09	9.402E-09	1.006E-08	9.720E-09	2.63	-0.46	-1.39	1.61	-3.27	3.50
5	9.673E-09	9.506E-09	9.779E-09	9.410E-09	1.003E-08	9.680E-09	2.51	-0.07	-1.79	1.03	-2.79	3.62
6	9.564E-09	9.356E-09	9.621E-09	9.344E-09	9.921E-09	9.561E-09	2.47	0.02	-2.14	0.63	-2.27	3.76
7	9.359E-09	9.194E-09	9.461E-09	9.248E-09	9.752E-09	9.403E-09	2.35	-0.47	-2.22	0.62	-1.64	3.72
8	9.322E-09	9.088E-09	9.354E-09	9.179E-09	9.599E-09	9.308E-09	2.10	0.15	-2.37	0.49	-1.39	3.12
9	9.244E-09	9.025E-09	9.294E-09	9.140E-09	9.503E-09	9.241E-09	1.94	0.03	-2.34	0.57	-1.09	2.83
10	9.235E-09	8.985E-09	9.259E-09	9.113E-09	9.446E-09	9.208E-09	1.87	0.30	-2.41	0.55	-1.03	2.59
11	9.252E-09	8.955E-09	9.235E-09	9.097E-09	9.411E-09	9.190E-09	1.88	0.68	-2.56	0.49	-1.01	2.41
12	9.222E-09	8.925E-09	9.213E-09	9.080E-09	9.384E-09	9.165E-09	1.88	0.63	-2.62	0.53	-0.93	2.39
13	9.194E-09	8.894E-09	9.192E-09	9.060E-09	9.358E-09	9.140E-09	1.90	0.60	-2.69	0.57	-0.87	2.39
14	9.106E-09	8.860E-09	9.168E-09	9.038E-09	9.331E-09	9.101E-09	1.90	0.06	-2.64	0.74	-0.69	2.53
15	9.166E-09	8.823E-09	9.150E-09	9.013E-09	9.301E-09	9.091E-09	1.99	0.83	-2.94	0.65	-0.85	2.32
20	8.974E-09	8.609E-09	8.983E-09	8.875E-09	9.121E-09	8.912E-09	2.14	0.70	-3.41	0.79	-0.42	2.34
25	8.682E-09	8.357E-09	8.786E-09	8.676E-09	8.890E-09	8.678E-09	2.30	0.05	-3.70	1.24	-0.03	2.44
30	8.419E-09	8.086E-09	8.571E-09	8.449E-09	8.631E-09	8.431E-09	2.51	-0.15	-4.09	1.66	0.22	2.37
35	8.144E-09	7.812E-09	8.350E-09	8.211E-09	8.361E-09	8.176E-09	2.73	-0.39	-4.44	2.13	0.43	2.27
40	7.908E-09	7.548E-09	8.132E-09	7.971E-09	8.091E-09	7.930E-09	2.92	-0.28	-4.82	2.55	0.52	2.03

**Table 34. UGD. Isotopic Composition in Cell 24. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with equilibrium concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>149</sup> Sm, atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	2.903E-07	2.121E-07	2.512E-07	22.00	15.56	-15.56
1	2.210E-07	2.016E-07	2.113E-07	6.50	4.60	-4.60
2	1.689E-07	1.910E-07	1.800E-07	8.66	-6.12	6.12
3	1.323E-07	1.708E-07	1.515E-07	17.98	-12.71	12.71
4	1.081E-07	1.452E-07	1.266E-07	20.72	-14.65	14.65
5	9.290E-08	1.196E-07	1.062E-07	17.75	-12.55	12.55
6	8.367E-08	9.955E-08	9.161E-08	12.26	-8.67	8.67
7	7.873E-08	8.807E-08	8.340E-08	7.91	-5.60	5.60
8	7.700E-08	8.366E-08	8.033E-08	5.86	-4.15	4.15
9	7.686E-08	8.282E-08	7.984E-08	5.28	-3.73	3.73
10	7.746E-08	8.337E-08	8.042E-08	5.20	-3.68	3.68
11	7.835E-08	8.462E-08	8.148E-08	5.44	-3.85	3.85
12	7.930E-08	8.583E-08	8.257E-08	5.59	-3.95	3.95
13	8.023E-08	8.708E-08	8.365E-08	5.79	-4.10	4.10
14	8.108E-08	8.827E-08	8.468E-08	6.01	-4.25	4.25
15	8.185E-08	8.938E-08	8.562E-08	6.22	-4.40	4.40
20	8.454E-08	9.376E-08	8.915E-08	7.31	-5.17	5.17
25	8.567E-08	9.604E-08	9.086E-08	8.07	-5.70	5.70
30	8.568E-08	9.687E-08	9.127E-08	8.67	-6.13	6.13
35	8.493E-08	9.671E-08	9.082E-08	9.17	-6.48	6.48
40	8.375E-08	9.590E-08	8.982E-08	9.56	-6.76	6.76

**Table 35. UGD. Isotopic Composition in Cell 24. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	6.599E-08	6.673E-08	6.687E-08	6.653E-08	0.71	-0.81	0.30	0.51
2	1.090E-07	1.094E-07	1.113E-07	1.099E-07	1.13	-0.83	-0.46	1.29
3	1.235E-07	1.231E-07	1.286E-07	1.251E-07	2.46	-1.23	-1.60	2.83
4	1.191E-07	1.178E-07	1.274E-07	1.214E-07	4.30	-1.91	-3.01	4.92
5	1.075E-07	1.037E-07	1.158E-07	1.090E-07	5.68	-1.39	-4.85	6.24
6	9.357E-08	9.003E-08	1.013E-07	9.497E-08	6.07	-1.47	-5.20	6.67
7	8.364E-08	8.202E-08	9.016E-08	8.527E-08	5.05	-1.92	-3.81	5.73
8	8.128E-08	7.943E-08	8.470E-08	8.180E-08	3.27	-0.64	-2.90	3.54
9	8.052E-08	7.945E-08	8.336E-08	8.111E-08	2.49	-0.73	-2.04	2.77
10	8.180E-08	8.049E-08	8.380E-08	8.203E-08	2.03	-0.28	-1.88	2.16
11	8.306E-08	8.192E-08	8.498E-08	8.332E-08	1.86	-0.31	-1.68	1.99
12	8.409E-08	8.343E-08	8.643E-08	8.465E-08	1.86	-0.66	-1.44	2.10
13	8.422E-08	8.489E-08	8.790E-08	8.567E-08	2.29	-1.69	-0.91	2.60
14	8.468E-08	8.628E-08	8.930E-08	8.675E-08	2.71	-2.39	-0.55	2.94
15	8.675E-08	8.756E-08	9.061E-08	8.831E-08	2.30	-1.76	-0.85	2.61
20	8.921E-08	9.259E-08	9.559E-08	9.246E-08	3.45	-3.52	0.14	3.38
25	8.954E-08	9.558E-08	9.831E-08	9.447E-08	4.75	-5.23	1.17	4.06
30	8.892E-08	9.712E-08	9.934E-08	9.512E-08	5.77	-6.52	2.09	4.43
35	8.682E-08	9.765E-08	9.918E-08	9.455E-08	7.13	-8.18	3.28	4.90
40	8.569E-08	9.752E-08	9.823E-08	9.381E-08	7.51	-8.66	3.95	4.71



**Table 36. UGD. Isotopic Composition in Cell 24. <sup>155</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>155</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.854E-04	1.854E-04	1.854E-04	1.854E-04	1.854E-04	1.854E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	1.649E-04	1.658E-04	1.647E-04	1.648E-04	1.657E-04	1.652E-04	0.32	-0.16	0.38	-0.28	-0.25	0.31
2	1.400E-04	1.417E-04	1.396E-04	1.402E-04	1.421E-04	1.407E-04	0.79	-0.49	0.69	-0.80	-0.39	0.99
3	1.130E-04	1.152E-04	1.125E-04	1.137E-04	1.164E-04	1.142E-04	1.41	-1.01	0.91	-1.44	-0.42	1.96
4	8.599E-05	8.869E-05	8.563E-05	8.737E-05	9.081E-05	8.770E-05	2.42	-1.95	1.13	-2.35	-0.37	3.55
5	6.112E-05	6.364E-05	6.044E-05	6.269E-05	6.669E-05	6.292E-05	3.90	-2.85	1.14	-3.93	-0.36	6.00
6	3.931E-05	4.124E-05	3.830E-05	4.086E-05	4.510E-05	4.096E-05	6.34	-4.04	0.69	-6.49	-0.26	10.10
7	2.148E-05	2.288E-05	2.081E-05	2.317E-05	2.699E-05	2.306E-05	10.41	-6.89	-0.82	-9.78	0.46	17.02
8	9.760E-06	1.043E-05	9.477E-06	1.108E-05	1.364E-05	1.088E-05	15.31	-10.26	-4.14	-12.86	1.85	25.42
9	3.717E-06	4.019E-06	3.755E-06	4.571E-06	5.838E-06	4.380E-06	20.18	-15.15	-8.24	-14.27	4.37	33.29
10	1.351E-06	1.439E-06	1.412E-06	1.755E-06	2.248E-06	1.641E-06	22.78	-17.67	-12.32	-13.95	6.95	36.99
11	5.335E-07	5.573E-07	5.767E-07	7.058E-07	8.698E-07	6.486E-07	21.66	-17.74	-14.08	-11.09	8.81	34.10
12	2.682E-07	2.794E-07	2.988E-07	3.424E-07	3.941E-07	3.166E-07	16.35	-15.28	-11.75	-5.62	8.16	24.50
13	1.899E-07	1.942E-07	2.087E-07	2.208E-07	2.376E-07	2.102E-07	9.32	-9.69	-7.63	-0.74	5.03	13.02
14	1.647E-07	1.679E-07	1.794E-07	1.804E-07	1.868E-07	1.759E-07	5.25	-6.34	-4.50	2.03	2.59	6.23
15	1.563E-07	1.593E-07	1.695E-07	1.667E-07	1.700E-07	1.644E-07	3.78	-4.92	-3.06	3.15	1.39	3.43
20	1.492E-07	1.498E-07	1.599E-07	1.550E-07	1.566E-07	1.541E-07	2.97	-3.20	-2.79	3.79	0.56	1.63
25	1.403E-07	1.427E-07	1.536E-07	1.486E-07	1.496E-07	1.469E-07	3.65	-4.50	-2.90	4.50	1.10	1.81
30	1.332E-07	1.353E-07	1.468E-07	1.418E-07	1.422E-07	1.399E-07	3.98	-4.79	-3.26	4.98	1.41	1.67
35	1.244E-07	1.279E-07	1.400E-07	1.350E-07	1.347E-07	1.324E-07	4.70	-6.06	-3.40	5.75	1.97	1.75
40	1.181E-07	1.206E-07	1.332E-07	1.282E-07	1.273E-07	1.255E-07	4.86	-5.88	-3.90	6.16	2.18	1.44

**Table 37. UGD. Isotopic Composition in Cell 24. <sup>157</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	UGD. Isotopic Composition in Cell 24. <sup>157</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.948E-04	1.948E-04	1.948E-04	1.948E-04	1.948E-04	1.948E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	1.352E-04	1.374E-04	1.360E-04	1.367E-04	1.383E-04	1.367E-04	0.90	-1.14	0.53	-0.55	0.01	1.16
2	8.960E-05	9.226E-05	8.988E-05	9.164E-05	9.449E-05	9.157E-05	2.17	-2.16	0.75	-1.85	0.07	3.19
3	5.518E-05	5.778E-05	5.490E-05	5.717E-05	6.079E-05	5.716E-05	4.15	-3.47	1.07	-3.96	0.01	6.34
4	2.992E-05	3.224E-05	2.953E-05	3.186E-05	3.550E-05	3.181E-05	7.47	-5.93	1.34	-7.18	0.16	11.61
5	1.342E-05	1.472E-05	1.279E-05	1.471E-05	1.769E-05	1.467E-05	12.86	-8.52	0.38	-12.78	0.32	20.61
6	4.192E-06	4.635E-06	3.812E-06	4.898E-06	6.688E-06	4.845E-06	22.93	-13.48	-4.33	-21.32	1.09	38.03
7	7.523E-07	8.430E-07	7.374E-07	1.022E-06	1.603E-06	9.915E-07	36.32	-24.13	-14.98	-25.62	3.06	61.67
8	2.276E-07	2.295E-07	2.543E-07	2.680E-07	3.617E-07	2.682E-07	20.49	-15.16	-14.43	-5.18	-0.07	34.85
9	1.821E-07	1.778E-07	2.091E-07	1.956E-07	2.265E-07	1.982E-07	10.09	-8.14	-10.28	5.51	-1.35	14.26
10	1.797E-07	1.670E-07	1.990E-07	1.832E-07	2.067E-07	1.871E-07	8.45	-3.94	-10.76	6.36	-2.12	10.47
11	1.733E-07	1.635E-07	1.958E-07	1.799E-07	1.997E-07	1.824E-07	8.35	-5.00	-10.40	7.34	-1.41	9.47
12	1.605E-07	1.626E-07	1.953E-07	1.782E-07	1.975E-07	1.788E-07	9.76	-10.24	-9.06	9.23	-0.37	10.45
13	1.690E-07	1.626E-07	1.957E-07	1.779E-07	1.971E-07	1.805E-07	8.61	-6.34	-9.90	8.44	-1.41	9.21
14	1.684E-07	1.628E-07	1.963E-07	1.782E-07	1.971E-07	1.806E-07	8.71	-6.73	-9.85	8.71	-1.30	9.16
15	1.708E-07	1.630E-07	1.969E-07	1.786E-07	1.973E-07	1.813E-07	8.51	-5.80	-10.13	8.59	-1.48	8.82
20	1.597E-07	1.627E-07	1.985E-07	1.794E-07	1.970E-07	1.795E-07	10.21	-11.02	-9.33	10.61	-0.04	9.78
25	1.681E-07	1.614E-07	1.985E-07	1.791E-07	1.952E-07	1.804E-07	9.03	-6.86	-10.56	9.98	-0.74	8.18
30	1.684E-07	1.592E-07	1.973E-07	1.777E-07	1.923E-07	1.790E-07	8.91	-5.91	-11.06	10.22	-0.70	7.45
35	1.618E-07	1.565E-07	1.954E-07	1.757E-07	1.888E-07	1.756E-07	9.53	-7.87	-10.90	11.24	0.03	7.50
40	1.598E-07	1.536E-07	1.932E-07	1.734E-07	1.851E-07	1.730E-07	9.60	-7.64	-11.21	11.65	0.21	6.98

**Table 38. UGD. Isotopic Composition in Cell 24 Deviation from Average Value, %.  
Burnup=40 MWd/kgHM**

	UGD. Isotopic Composition in Cell 24 Deviation from Average Value, %. Burnup=40 MWd/kgHM										
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> Pu	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm	<sup>155</sup> Gd	<sup>157</sup> Gd
MCU	-0.79	0.71	-0.03	1.11	1.38	-0.99	6.77	-0.28	-7.08	-5.88	-7.64
TVS-M	-2.60	0.13	0.03	-1.76	4.47	-4.38	6.04	-4.82	-9.18	-3.90	-11.21
WIMS8A	2.29	-2.47	-0.07	4.67	-0.32	6.50	1.15	2.55	5.75	6.16	11.65
HELIOS	0.42	2.61	0.07	-3.78	-8.00	0.97	-4.48	0.52	3.99	2.18	0.21
MULTICELL	0.67	-0.98	0.01	-0.23	2.46	-2.09	-9.48	2.03	6.52	1.44	6.98
R.M.S. %	1.82	1.90	0.05	3.18	4.80	4.11	6.96	2.92	7.52	4.86	9.60

**Table 39. UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>235</sup>U, atoms/barn\*cm**

UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>235</sup> U, atoms/barn*cm						
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	2.170E-04	2.103E-04	2.035E-04	1.967E-04	1.870E-04	2.029E-04
TVS-M	2.142E-04	2.077E-04	2.000E-04	1.918E-04	1.823E-04	1.992E-04
WIMS8A	2.243E-04	2.173E-04	2.100E-04	2.020E-04	1.925E-04	2.092E-04
HELIOS	2.185E-04	2.128E-04	2.062E-04	1.991E-04	1.903E-04	2.054E-04
MULTICELL	2.226E-04	2.149E-04	2.067E-04	1.978E-04	1.874E-04	2.059E-04
Mean	2.193E-04	2.126E-04	2.053E-04	1.975E-04	1.879E-04	2.045E-04
R.M.S. %	1.87	1.77	1.83	1.89	2.05	1.82

**Table 40. UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>239</sup>Pu, atoms/barn\*cm**

UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>239</sup> Pu, atoms/barn*cm						
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.084E-04	1.101E-04	1.171E-04	1.282E-04	2.030E-04	1.334E-04
TVS-M	1.079E-04	1.104E-04	1.146E-04	1.250E-04	1.900E-04	1.296E-04
WIMS8A	1.148E-04	1.174E-04	1.218E-04	1.334E-04	2.030E-04	1.381E-04
HELIOS	1.021E-04	1.049E-04	1.100E-04	1.225E-04	1.951E-04	1.269E-04
Mean	1.083E-04	1.107E-04	1.159E-04	1.273E-04	1.978E-04	1.320E-04
R.M.S. %	4.79	4.63	4.23	3.70	3.22	3.67

**Table 41. UGD. Isotopic Composition in Cell 24 vs Radius, Rurnup=2 MWd/kgHM. <sup>155</sup>Gd, atoms/barn\*cm**

	UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>155</sup> Gd, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.678E-04	1.637E-04	1.546E-04	1.313E-04	8.272E-05	1.400E-04
TVS-M	1.685E-04	1.645E-04	1.558E-04	1.338E-04	8.580E-05	1.417E-04
WIMS8A	1.667E-04	1.626E-04	1.543E-04	1.328E-04	8.157E-05	1.396E-04
HELIOS	1.671E-04	1.631E-04	1.545E-04	1.327E-04	8.345E-05	1.402E-04
MULTICELL	1.677E-04	1.640E-04	1.563E-04	1.359E-04	8.683E-05	1.421E-04
Mean	1.676E-04	1.636E-04	1.551E-04	1.333E-04	8.407E-05	1.407E-04
R.M.S. %	0.43	0.45	0.57	1.28	2.60	0.79

**Table 42. UGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>157</sup>Gd, atoms/barn\*cm**

	UGD. Isotopic Composition in Cell 24 vs radius, burnup=2 MWd/kgHM. <sup>157</sup> Gd, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.501E-04	1.344E-04	1.047E-04	5.151E-05	7.269E-06	8.960E-05
TVS-M	1.521E-04	1.369E-04	1.080E-04	5.583E-05	8.407E-06	9.226E-05
WIMS8A	1.467E-04	1.320E-04	1.054E-04	5.635E-05	9.026E-06	8.988E-05
HELIOS	1.497E-04	1.349E-04	1.068E-04	5.678E-05	9.966E-06	9.164E-05
MULTICELL	1.523E-04	1.384E-04	1.121E-04	6.070E-05	8.943E-06	9.449E-05
Mean	1.502E-04	1.353E-04	1.074E-04	5.624E-05	8.722E-06	9.157E-05
R.M.S. %	1.51	1.82	2.73	5.81	11.32	2.17

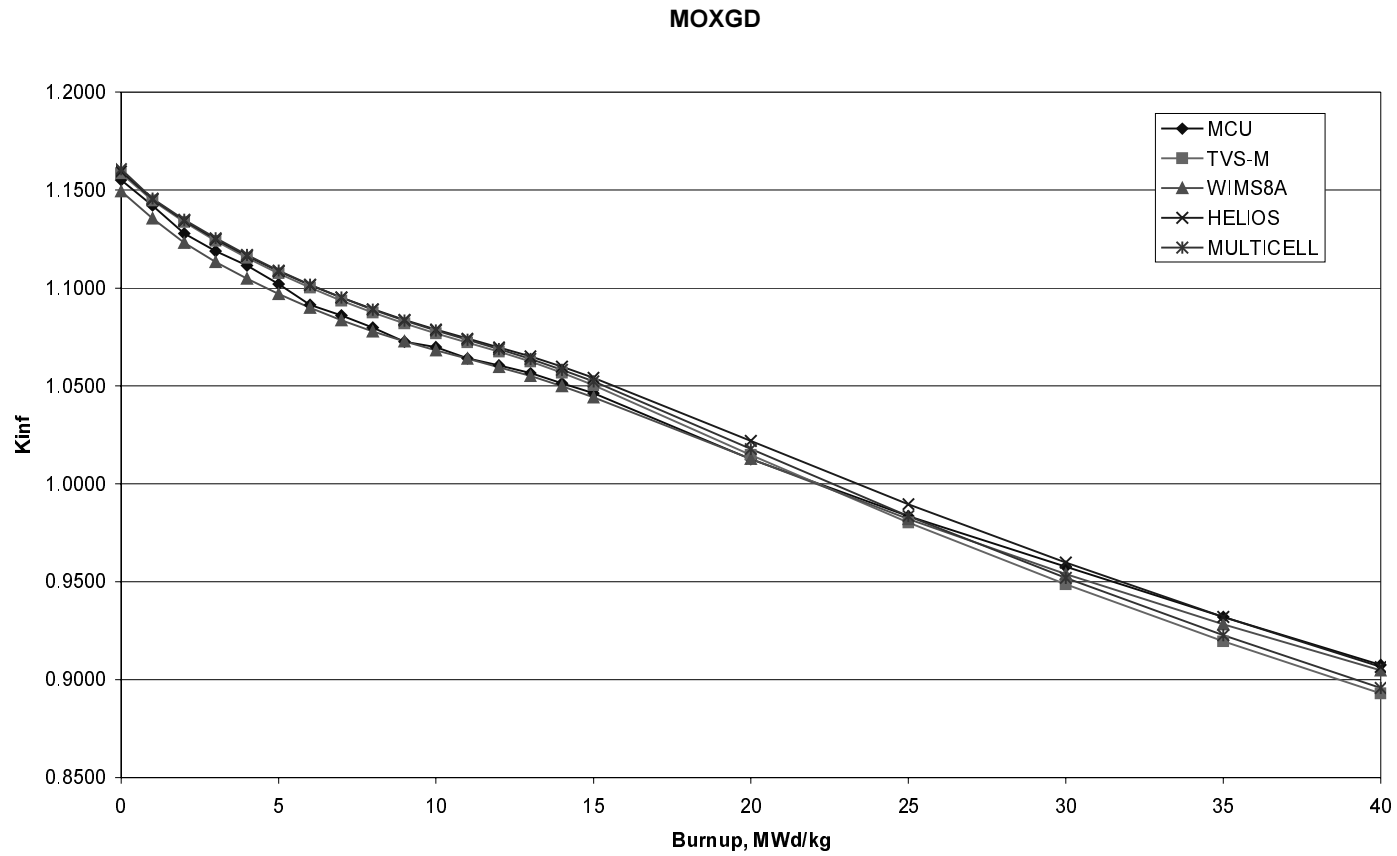
**Table 43. UGD. Reactivity Effects,  $100*(K_{init}-K_{fin})$**

Initial State	Final State	Comment	Burnup	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL	MCNP4B	Mean	R.M.S. %
S1	S2	Xe+Sm Cb>0	0	-4.26	-4.15	-3.67	-3.95	-4.13		-4.03	-5.69
			20	-4.06	-3.76	-3.98	-3.92	-4.08		-3.96	-3.23
			40	-3.41	-3.00	-3.33	-3.30	-3.39		-3.29	-5.02
S3	S4	Boron 0.6 g/kg	0	-6.00	-6.04	-5.88	-5.96	-5.99	-6.06	-5.99	-1.10
			20	-5.46	-5.56	-5.36	-5.48	-5.54		-5.48	-1.39
			40	-5.01	-4.94	-4.75	-4.91	-4.96		-4.91	-2.04
S3	S2	T fuel Cb>0	0	1.20	1.32	1.50	1.44	1.43	1.25	1.36	8.74
			20	1.41	1.47	1.60	1.60	1.54		1.52	5.55
			40	1.30	1.35	1.44	1.50	1.41		1.40	5.57
S4	S5	T all Cb=0	0	-6.98	-7.09	-6.89	-6.91	-6.46	-7.04	-6.90	-3.27
			20	-6.96	-6.54	-6.95	-6.63	-6.49		-6.72	-3.36
			40	-5.69	-5.16	-5.63	-5.15	-5.00		-5.33	-5.87

**Table 44. MOXGD Variant.  $K_{inf}$ . Abs. deviation from Mean Value**

Burnup MWd/kgHM	$K_{inf}$					Mean	$\Delta$	Abs.Deviation from Mean (K-Mean)				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.1551	1.1585	1.1494	1.1595	1.1606	1.1566	0.004	-0.002	0.002	-0.007	0.003	0.004
1	1.1421	1.1448	1.1355	1.1454	1.1457	1.1427	0.004	-0.001	0.002	-0.007	0.003	0.003
2	1.1278	1.1337	1.1232	1.1344	1.1349	1.1308	0.005	-0.003	0.003	-0.008	0.004	0.004
3	1.1188	1.1241	1.1133	1.1249	1.1255	1.1213	0.005	-0.003	0.003	-0.008	0.004	0.004
4	1.1114	1.1154	1.1047	1.1164	1.1169	1.1130	0.005	-0.002	0.002	-0.008	0.003	0.004
5	1.1020	1.1074	1.0970	1.1086	1.1090	1.1048	0.005	-0.003	0.003	-0.008	0.004	0.004
6	1.0914	1.1002	1.0899	1.1016	1.1017	1.0970	0.005	-0.006	0.003	-0.007	0.005	0.005
7	1.0860	1.0936	1.0836	1.0951	1.0951	1.0907	0.005	-0.005	0.003	-0.007	0.004	0.004
8	1.0798	1.0875	1.0779	1.0892	1.0890	1.0847	0.005	-0.005	0.003	-0.007	0.005	0.004
9	1.0725	1.0820	1.0728	1.0838	1.0834	1.0789	0.005	-0.006	0.003	-0.006	0.005	0.005
10	1.0698	1.0769	1.0682	1.0788	1.0783	1.0744	0.005	-0.005	0.003	-0.006	0.004	0.004
11	1.0640	1.0722	1.0639	1.0742	1.0735	1.0696	0.005	-0.006	0.003	-0.006	0.005	0.004
12	1.0606	1.0675	1.0596	1.0697	1.0688	1.0653	0.004	-0.005	0.002	-0.006	0.004	0.004
13	1.0565	1.0624	1.0550	1.0650	1.0638	1.0605	0.004	-0.004	0.002	-0.006	0.004	0.003
14	1.0514	1.0567	1.0498	1.0599	1.0583	1.0552	0.004	-0.004	0.001	-0.005	0.005	0.003
15	1.0463	1.0504	1.0442	1.0542	1.0523	1.0495	0.004	-0.003	0.001	-0.005	0.005	0.003
20	1.0126	1.0148	1.0127	1.0220	1.0178	1.0160	0.004	-0.003	-0.001	-0.003	0.006	0.002
25	0.9837	0.9803	0.9820	0.9897	0.9836	0.9839	0.004	0.000	-0.004	-0.002	0.006	0.000
30	0.9577	0.9487	0.9540	0.9598	0.9520	0.9544	0.005	0.003	-0.006	0.000	0.005	-0.002
35	0.9320	0.9196	0.9283	0.9321	0.9228	0.9270	0.006	0.005	-0.007	0.001	0.005	-0.004
40	0.9075	0.8931	0.9048	0.9065	0.8958	0.9015	0.007	0.006	-0.008	0.003	0.005	-0.006

Figure 2. MOXGD Variant.  $K_{inf}$  vs Burnup





**Table 45. MOXGD. Assembly Average Isotopic Composition. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.072E-05	2.073E-05	2.073E-05	2.073E-05	2.073E-05	2.073E-05	0.02	-0.04	0.01	0.01	0.01	0.01
1	2.039E-05	2.040E-05	2.041E-05	2.041E-05	2.041E-05	2.040E-05	0.03	-0.05	-0.01	0.01	0.01	0.03
2	2.007E-05	2.007E-05	2.008E-05	2.008E-05	2.008E-05	2.008E-05	0.03	-0.05	-0.02	0.02	0.03	0.02
3	1.974E-05	1.974E-05	1.975E-05	1.976E-05	1.975E-05	1.975E-05	0.04	-0.05	-0.03	0.03	0.04	0.01
4	1.940E-05	1.941E-05	1.942E-05	1.943E-05	1.942E-05	1.942E-05	0.05	-0.06	-0.05	0.04	0.05	0.02
5	1.907E-05	1.907E-05	1.909E-05	1.909E-05	1.908E-05	1.908E-05	0.06	-0.06	-0.06	0.06	0.07	-0.01
6	1.873E-05	1.873E-05	1.876E-05	1.876E-05	1.875E-05	1.875E-05	0.08	-0.07	-0.09	0.06	0.08	0.02
7	1.839E-05	1.838E-05	1.842E-05	1.842E-05	1.841E-05	1.841E-05	0.09	-0.08	-0.12	0.08	0.09	0.02
8	1.805E-05	1.804E-05	1.808E-05	1.808E-05	1.806E-05	1.806E-05	0.11	-0.08	-0.14	0.10	0.12	-0.01
9	1.770E-05	1.769E-05	1.774E-05	1.774E-05	1.772E-05	1.772E-05	0.14	-0.09	-0.18	0.11	0.14	0.01
10	1.735E-05	1.733E-05	1.739E-05	1.740E-05	1.737E-05	1.737E-05	0.16	-0.10	-0.22	0.14	0.17	0.01
11	1.700E-05	1.697E-05	1.704E-05	1.705E-05	1.701E-05	1.701E-05	0.19	-0.10	-0.26	0.17	0.21	-0.02
12	1.664E-05	1.661E-05	1.669E-05	1.670E-05	1.666E-05	1.666E-05	0.23	-0.11	-0.32	0.19	0.23	0.00
13	1.628E-05	1.624E-05	1.634E-05	1.635E-05	1.630E-05	1.630E-05	0.27	-0.12	-0.38	0.23	0.27	0.00
14	1.592E-05	1.587E-05	1.598E-05	1.599E-05	1.594E-05	1.594E-05	0.31	-0.14	-0.45	0.26	0.31	0.00
15	1.556E-05	1.550E-05	1.563E-05	1.563E-05	1.558E-05	1.558E-05	0.36	-0.15	-0.52	0.31	0.35	0.01
20	1.378E-05	1.369E-05	1.389E-05	1.389E-05	1.380E-05	1.381E-05	0.61	-0.21	-0.88	0.61	0.55	-0.07
25	1.210E-05	1.198E-05	1.226E-05	1.223E-05	1.212E-05	1.214E-05	0.91	-0.30	-1.28	0.99	0.74	-0.14
30	1.053E-05	1.039E-05	1.073E-05	1.068E-05	1.054E-05	1.058E-05	1.26	-0.40	-1.72	1.49	0.97	-0.34
35	9.088E-06	8.933E-06	9.329E-06	9.245E-06	9.091E-06	9.137E-06	1.68	-0.54	-2.23	2.10	1.18	-0.51
40	7.780E-06	7.606E-06	8.046E-06	7.934E-06	7.765E-06	7.826E-06	2.16	-0.59	-2.81	2.81	1.37	-0.78

**Table 46. MOXGD. Assembly Average Isotopic Composition. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	7.415E-08	7.427E-08	7.368E-08	7.673E-08	7.414E-08	7.459E-08	1.63	-0.59	-0.43	-1.23	2.86	-0.61
2	1.484E-07	1.483E-07	1.473E-07	1.532E-07	1.481E-07	1.490E-07	1.57	-0.43	-0.50	-1.19	2.76	-0.63
3	2.222E-07	2.221E-07	2.206E-07	2.292E-07	2.219E-07	2.232E-07	1.54	-0.44	-0.51	-1.17	2.70	-0.58
4	2.960E-07	2.956E-07	2.935E-07	3.050E-07	2.955E-07	2.971E-07	1.51	-0.38	-0.52	-1.20	2.64	-0.54
5	3.692E-07	3.688E-07	3.662E-07	3.803E-07	3.687E-07	3.706E-07	1.49	-0.38	-0.51	-1.20	2.61	-0.52
6	4.423E-07	4.417E-07	4.384E-07	4.552E-07	4.417E-07	4.439E-07	1.47	-0.36	-0.49	-1.22	2.56	-0.49
7	5.150E-07	5.143E-07	5.103E-07	5.298E-07	5.144E-07	5.168E-07	1.45	-0.35	-0.47	-1.24	2.52	-0.46
8	5.871E-07	5.867E-07	5.819E-07	6.039E-07	5.868E-07	5.893E-07	1.43	-0.37	-0.44	-1.26	2.48	-0.42
9	6.590E-07	6.588E-07	6.530E-07	6.776E-07	6.589E-07	6.615E-07	1.42	-0.38	-0.40	-1.27	2.44	-0.39
10	7.307E-07	7.306E-07	7.238E-07	7.509E-07	7.306E-07	7.333E-07	1.40	-0.36	-0.37	-1.30	2.39	-0.37
11	8.022E-07	8.022E-07	7.942E-07	8.238E-07	8.021E-07	8.049E-07	1.38	-0.33	-0.33	-1.33	2.34	-0.35
12	8.734E-07	8.736E-07	8.642E-07	8.962E-07	8.732E-07	8.761E-07	1.36	-0.31	-0.29	-1.36	2.29	-0.33
13	9.440E-07	9.445E-07	9.337E-07	9.681E-07	9.440E-07	9.468E-07	1.34	-0.31	-0.24	-1.39	2.24	-0.30
14	1.014E-06	1.015E-06	1.002E-06	1.039E-06	1.014E-06	1.017E-06	1.33	-0.28	-0.20	-1.43	2.20	-0.29
15	1.083E-06	1.085E-06	1.070E-06	1.110E-06	1.084E-06	1.086E-06	1.32	-0.30	-0.16	-1.48	2.16	-0.22
20	1.411E-06	1.413E-06	1.391E-06	1.445E-06	1.414E-06	1.415E-06	1.36	-0.26	-0.11	-1.68	2.11	-0.07
25	1.705E-06	1.706E-06	1.678E-06	1.746E-06	1.710E-06	1.709E-06	1.41	-0.21	-0.18	-1.81	2.15	0.06
30	1.962E-06	1.961E-06	1.929E-06	2.010E-06	1.970E-06	1.966E-06	1.48	-0.22	-0.30	-1.89	2.23	0.18
35	2.183E-06	2.177E-06	2.145E-06	2.238E-06	2.193E-06	2.187E-06	1.54	-0.18	-0.45	-1.94	2.32	0.26
40	2.368E-06	2.357E-06	2.326E-06	2.430E-06	2.379E-06	2.372E-06	1.60	-0.17	-0.64	-1.93	2.44	0.30

**Table 47. MOXGD. Assembly Average Isotopic Composition. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	6.254E-03	6.257E-03	6.257E-03	6.257E-03	6.257E-03	6.256E-03	0.02	-0.03	0.01	0.01	0.01	0.01
1	6.250E-03	6.253E-03	6.253E-03	6.253E-03	6.253E-03	6.252E-03	0.02	-0.04	0.01	0.01	0.01	0.01
2	6.245E-03	6.248E-03	6.248E-03	6.249E-03	6.248E-03	6.248E-03	0.02	-0.04	0.01	0.01	0.01	0.01
3	6.241E-03	6.244E-03	6.244E-03	6.244E-03	6.244E-03	6.243E-03	0.02	-0.04	0.01	0.00	0.01	0.01
4	6.237E-03	6.240E-03	6.239E-03	6.240E-03	6.240E-03	6.239E-03	0.02	-0.04	0.01	0.00	0.01	0.01
5	6.232E-03	6.235E-03	6.235E-03	6.236E-03	6.236E-03	6.235E-03	0.02	-0.04	0.01	0.00	0.01	0.02
6	6.228E-03	6.231E-03	6.230E-03	6.232E-03	6.231E-03	6.230E-03	0.02	-0.04	0.01	0.00	0.02	0.01
7	6.223E-03	6.227E-03	6.226E-03	6.227E-03	6.227E-03	6.226E-03	0.02	-0.04	0.01	0.00	0.02	0.02
8	6.219E-03	6.222E-03	6.221E-03	6.223E-03	6.222E-03	6.221E-03	0.02	-0.04	0.02	0.00	0.02	0.01
9	6.214E-03	6.218E-03	6.217E-03	6.218E-03	6.218E-03	6.217E-03	0.03	-0.04	0.01	-0.01	0.02	0.02
10	6.210E-03	6.213E-03	6.212E-03	6.214E-03	6.214E-03	6.213E-03	0.03	-0.05	0.01	-0.01	0.02	0.02
11	6.205E-03	6.209E-03	6.207E-03	6.209E-03	6.209E-03	6.208E-03	0.03	-0.05	0.01	-0.01	0.02	0.02
12	6.201E-03	6.204E-03	6.203E-03	6.205E-03	6.205E-03	6.203E-03	0.03	-0.05	0.01	-0.01	0.02	0.02
13	6.196E-03	6.200E-03	6.198E-03	6.201E-03	6.200E-03	6.199E-03	0.03	-0.05	0.01	-0.02	0.03	0.02
14	6.191E-03	6.195E-03	6.193E-03	6.196E-03	6.196E-03	6.194E-03	0.03	-0.05	0.01	-0.02	0.03	0.03
15	6.187E-03	6.191E-03	6.188E-03	6.191E-03	6.191E-03	6.190E-03	0.03	-0.05	0.02	-0.02	0.03	0.02
20	6.163E-03	6.167E-03	6.164E-03	6.168E-03	6.168E-03	6.166E-03	0.04	-0.05	0.02	-0.03	0.03	0.03
25	6.138E-03	6.142E-03	6.139E-03	6.144E-03	6.143E-03	6.141E-03	0.04	-0.06	0.02	-0.03	0.04	0.03
30	6.112E-03	6.117E-03	6.113E-03	6.119E-03	6.118E-03	6.116E-03	0.05	-0.06	0.02	-0.04	0.05	0.03
35	6.086E-03	6.091E-03	6.087E-03	6.093E-03	6.093E-03	6.090E-03	0.06	-0.07	0.02	-0.05	0.05	0.05
40	6.058E-03	6.064E-03	6.060E-03	6.067E-03	6.066E-03	6.063E-03	0.06	-0.07	0.01	-0.05	0.06	0.05

**Table 48. MOXGD. Assembly Average Isotopic Composition. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.056E-04	2.057E-04	2.057E-04	2.057E-04	2.057E-04	2.057E-04	0.02	-0.04	0.01	0.01	0.01	0.00
1	1.998E-04	1.999E-04	2.000E-04	2.000E-04	1.999E-04	1.999E-04	0.04	-0.06	0.01	0.04	0.02	-0.01
2	1.946E-04	1.948E-04	1.949E-04	1.948E-04	1.948E-04	1.948E-04	0.06	-0.07	0.00	0.08	-0.01	0.01
3	1.896E-04	1.897E-04	1.900E-04	1.896E-04	1.897E-04	1.897E-04	0.08	-0.08	-0.01	0.14	-0.04	-0.01
4	1.846E-04	1.847E-04	1.851E-04	1.846E-04	1.847E-04	1.848E-04	0.11	-0.08	-0.02	0.20	-0.07	-0.03
5	1.797E-04	1.798E-04	1.804E-04	1.797E-04	1.799E-04	1.799E-04	0.15	-0.10	-0.04	0.25	-0.10	-0.01
6	1.750E-04	1.751E-04	1.757E-04	1.749E-04	1.751E-04	1.752E-04	0.19	-0.10	-0.05	0.32	-0.13	-0.03
7	1.703E-04	1.704E-04	1.712E-04	1.702E-04	1.704E-04	1.705E-04	0.23	-0.10	-0.07	0.40	-0.16	-0.06
8	1.658E-04	1.658E-04	1.667E-04	1.656E-04	1.658E-04	1.659E-04	0.27	-0.11	-0.09	0.48	-0.20	-0.08
9	1.613E-04	1.613E-04	1.624E-04	1.611E-04	1.613E-04	1.615E-04	0.32	-0.11	-0.11	0.56	-0.23	-0.11
10	1.570E-04	1.569E-04	1.581E-04	1.567E-04	1.570E-04	1.571E-04	0.36	-0.12	-0.15	0.63	-0.28	-0.09
11	1.527E-04	1.526E-04	1.540E-04	1.524E-04	1.527E-04	1.529E-04	0.41	-0.11	-0.18	0.73	-0.31	-0.12
12	1.486E-04	1.484E-04	1.500E-04	1.482E-04	1.485E-04	1.487E-04	0.47	-0.11	-0.21	0.82	-0.35	-0.15
13	1.445E-04	1.443E-04	1.460E-04	1.441E-04	1.444E-04	1.447E-04	0.53	-0.11	-0.24	0.92	-0.38	-0.19
14	1.406E-04	1.403E-04	1.422E-04	1.401E-04	1.404E-04	1.407E-04	0.59	-0.11	-0.27	1.03	-0.42	-0.22
15	1.367E-04	1.364E-04	1.384E-04	1.362E-04	1.365E-04	1.369E-04	0.65	-0.11	-0.31	1.14	-0.46	-0.26
20	1.191E-04	1.187E-04	1.214E-04	1.184E-04	1.186E-04	1.192E-04	1.03	-0.09	-0.44	1.80	-0.74	-0.53
25	1.042E-04	1.036E-04	1.068E-04	1.031E-04	1.033E-04	1.042E-04	1.48	-0.03	-0.60	2.55	-1.06	-0.85
30	9.152E-05	9.088E-05	9.465E-05	9.026E-05	9.039E-05	9.154E-05	1.98	-0.02	-0.73	3.40	-1.40	-1.26
35	8.108E-05	8.046E-05	8.460E-05	7.971E-05	7.977E-05	8.112E-05	2.49	-0.06	-0.82	4.29	-1.74	-1.67
40	7.303E-05	7.207E-05	7.645E-05	7.119E-05	7.118E-05	7.278E-05	3.00	0.34	-0.99	5.04	-2.19	-2.20

**Table 49. MOXGD. Assembly Average Isotopic Composition. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.321E-05	1.322E-05	1.322E-05	1.322E-05	1.322E-05	1.322E-05	0.03	-0.05	0.01	0.01	0.01	0.03
1	1.545E-05	1.551E-05	1.543E-05	1.539E-05	1.545E-05	1.545E-05	0.27	0.05	0.39	-0.09	-0.38	0.03
2	1.758E-05	1.769E-05	1.753E-05	1.745E-05	1.757E-05	1.757E-05	0.51	0.10	0.73	-0.18	-0.67	0.02
3	1.961E-05	1.979E-05	1.953E-05	1.941E-05	1.959E-05	1.959E-05	0.70	0.14	1.02	-0.27	-0.91	0.02
4	2.154E-05	2.179E-05	2.143E-05	2.127E-05	2.153E-05	2.151E-05	0.87	0.13	1.28	-0.37	-1.12	0.08
5	2.338E-05	2.370E-05	2.324E-05	2.304E-05	2.337E-05	2.335E-05	1.03	0.15	1.51	-0.46	-1.30	0.09
6	2.514E-05	2.553E-05	2.496E-05	2.473E-05	2.513E-05	2.510E-05	1.17	0.16	1.72	-0.55	-1.47	0.13
7	2.680E-05	2.728E-05	2.660E-05	2.633E-05	2.681E-05	2.676E-05	1.30	0.13	1.93	-0.63	-1.61	0.18
8	2.839E-05	2.895E-05	2.815E-05	2.786E-05	2.841E-05	2.835E-05	1.42	0.13	2.11	-0.71	-1.74	0.21
9	2.990E-05	3.054E-05	2.962E-05	2.930E-05	2.993E-05	2.986E-05	1.53	0.14	2.28	-0.79	-1.87	0.24
10	3.133E-05	3.206E-05	3.102E-05	3.067E-05	3.138E-05	3.129E-05	1.64	0.12	2.45	-0.86	-1.99	0.29
11	3.268E-05	3.350E-05	3.234E-05	3.196E-05	3.276E-05	3.265E-05	1.74	0.09	2.60	-0.93	-2.09	0.34
12	3.396E-05	3.487E-05	3.360E-05	3.319E-05	3.406E-05	3.393E-05	1.84	0.07	2.75	-1.00	-2.20	0.37
13	3.517E-05	3.617E-05	3.478E-05	3.435E-05	3.530E-05	3.515E-05	1.93	0.06	2.89	-1.07	-2.30	0.42
14	3.632E-05	3.740E-05	3.589E-05	3.543E-05	3.647E-05	3.630E-05	2.02	0.04	3.02	-1.13	-2.39	0.46
15	3.739E-05	3.856E-05	3.694E-05	3.645E-05	3.757E-05	3.738E-05	2.11	0.03	3.15	-1.19	-2.48	0.50
20	4.169E-05	4.330E-05	4.117E-05	4.058E-05	4.204E-05	4.176E-05	2.46	-0.16	3.71	-1.41	-2.82	0.68
25	4.449E-05	4.654E-05	4.398E-05	4.325E-05	4.504E-05	4.466E-05	2.78	-0.38	4.21	-1.52	-3.16	0.85
30	4.602E-05	4.846E-05	4.557E-05	4.467E-05	4.675E-05	4.629E-05	3.08	-0.59	4.68	-1.56	-3.51	0.98
35	4.651E-05	4.927E-05	4.616E-05	4.504E-05	4.737E-05	4.687E-05	3.37	-0.76	5.11	-1.51	-3.90	1.07
40	4.600E-05	4.916E-05	4.595E-05	4.458E-05	4.711E-05	4.656E-05	3.67	-1.21	5.59	-1.31	-4.26	1.18

**Table 50. MOXGD. Assembly Average Isotopic Composition. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean					
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL	
0	2.193E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	0.02	-0.04	0.01	0.01	0.01	0.01	0.02
1	3.016E-06	2.938E-06	3.042E-06	3.048E-06	2.983E-06	3.005E-06	1.52	0.34	-2.24	1.23	1.43	1.43	-0.74
2	3.885E-06	3.723E-06	3.940E-06	3.945E-06	3.817E-06	3.862E-06	2.42	0.61	-3.61	2.02	2.15	2.15	-1.16
3	4.784E-06	4.537E-06	4.869E-06	4.871E-06	4.680E-06	4.748E-06	2.98	0.75	-4.45	2.54	2.59	2.59	-1.43
4	5.711E-06	5.371E-06	5.818E-06	5.816E-06	5.562E-06	5.656E-06	3.37	0.97	-5.03	2.88	2.84	2.84	-1.65
5	6.643E-06	6.219E-06	6.781E-06	6.772E-06	6.455E-06	6.574E-06	3.62	1.05	-5.40	3.14	3.02	3.02	-1.81
6	7.579E-06	7.074E-06	7.748E-06	7.733E-06	7.354E-06	7.497E-06	3.80	1.08	-5.65	3.34	3.14	3.14	-1.91
7	8.520E-06	7.930E-06	8.715E-06	8.691E-06	8.253E-06	8.422E-06	3.93	1.17	-5.84	3.48	3.20	3.20	-2.01
8	9.450E-06	8.785E-06	9.677E-06	9.643E-06	9.147E-06	9.340E-06	4.02	1.18	-5.95	3.60	3.24	3.24	-2.07
9	1.036E-05	9.632E-06	1.063E-05	1.058E-05	1.003E-05	1.025E-05	4.08	1.14	-6.01	3.71	3.28	3.28	-2.12
10	1.127E-05	1.047E-05	1.156E-05	1.151E-05	1.091E-05	1.115E-05	4.11	1.15	-6.07	3.76	3.27	3.27	-2.11
11	1.217E-05	1.129E-05	1.248E-05	1.242E-05	1.176E-05	1.202E-05	4.14	1.20	-6.09	3.82	3.27	3.27	-2.20
12	1.304E-05	1.210E-05	1.338E-05	1.330E-05	1.260E-05	1.289E-05	4.15	1.20	-6.10	3.86	3.25	3.25	-2.21
13	1.389E-05	1.289E-05	1.426E-05	1.417E-05	1.342E-05	1.372E-05	4.16	1.18	-6.09	3.90	3.23	3.23	-2.22
14	1.471E-05	1.366E-05	1.511E-05	1.501E-05	1.422E-05	1.454E-05	4.15	1.14	-6.07	3.93	3.20	3.20	-2.20
15	1.550E-05	1.441E-05	1.594E-05	1.582E-05	1.499E-05	1.533E-05	4.14	1.11	-6.03	3.97	3.18	3.18	-2.22
20	1.916E-05	1.783E-05	1.968E-05	1.949E-05	1.854E-05	1.894E-05	4.00	1.14	-5.87	3.92	2.92	2.92	-2.11
25	2.205E-05	2.058E-05	2.267E-05	2.239E-05	2.135E-05	2.181E-05	3.88	1.09	-5.63	3.97	2.67	2.67	-2.10
30	2.413E-05	2.261E-05	2.488E-05	2.448E-05	2.340E-05	2.390E-05	3.78	0.96	-5.39	4.12	2.41	2.41	-2.09
35	2.541E-05	2.394E-05	2.634E-05	2.578E-05	2.469E-05	2.523E-05	3.72	0.71	-5.12	4.40	2.17	2.17	-2.15
40	2.613E-05	2.463E-05	2.712E-05	2.638E-05	2.531E-05	2.592E-05	3.73	0.84	-4.96	4.66	1.80	1.80	-2.34

**Table 51. MOXGD. Assembly Average Isotopic Composition. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	3.256E-08	3.215E-08	2.920E-08	2.870E-08	2.904E-08	3.033E-08	6.15	7.35	6.01	-3.71	-5.39	-4.25
2	7.609E-08	7.435E-08	6.852E-08	6.737E-08	6.749E-08	7.076E-08	5.85	7.53	5.06	-3.17	-4.80	-4.63
3	1.312E-07	1.272E-07	1.186E-07	1.166E-07	1.159E-07	1.219E-07	5.65	7.62	4.37	-2.72	-4.36	-4.91
4	1.984E-07	1.913E-07	1.798E-07	1.768E-07	1.747E-07	1.842E-07	5.55	7.74	3.84	-2.37	-4.04	-5.16
5	2.783E-07	2.669E-07	2.526E-07	2.482E-07	2.442E-07	2.580E-07	5.51	7.87	3.43	-2.11	-3.82	-5.37
6	3.709E-07	3.544E-07	3.372E-07	3.311E-07	3.245E-07	3.436E-07	5.50	7.95	3.15	-1.88	-3.64	-5.57
7	4.765E-07	4.541E-07	4.336E-07	4.257E-07	4.159E-07	4.412E-07	5.50	8.02	2.93	-1.71	-3.51	-5.72
8	5.953E-07	5.660E-07	5.421E-07	5.319E-07	5.184E-07	5.507E-07	5.52	8.08	2.78	-1.56	-3.42	-5.87
9	7.270E-07	6.904E-07	6.627E-07	6.498E-07	6.320E-07	6.724E-07	5.53	8.12	2.68	-1.44	-3.36	-6.00
10	8.715E-07	8.272E-07	7.952E-07	7.794E-07	7.566E-07	8.060E-07	5.55	8.13	2.63	-1.33	-3.30	-6.13
11	1.029E-06	9.765E-07	9.398E-07	9.206E-07	8.923E-07	9.516E-07	5.57	8.14	2.61	-1.25	-3.27	-6.24
12	1.200E-06	1.138E-06	1.096E-06	1.073E-06	1.039E-06	1.109E-06	5.60	8.17	2.61	-1.19	-3.25	-6.34
13	1.383E-06	1.312E-06	1.264E-06	1.237E-06	1.196E-06	1.279E-06	5.65	8.20	2.63	-1.13	-3.24	-6.46
14	1.579E-06	1.498E-06	1.444E-06	1.412E-06	1.364E-06	1.460E-06	5.68	8.21	2.67	-1.08	-3.24	-6.55
15	1.788E-06	1.697E-06	1.635E-06	1.598E-06	1.542E-06	1.652E-06	5.72	8.22	2.72	-1.04	-3.25	-6.65
20	3.006E-06	2.859E-06	2.747E-06	2.684E-06	2.580E-06	2.775E-06	5.90	8.31	3.01	-1.00	-3.29	-7.03
25	4.496E-06	4.290E-06	4.103E-06	4.005E-06	3.834E-06	4.146E-06	6.17	8.45	3.48	-1.02	-3.39	-7.52
30	6.208E-06	5.950E-06	5.659E-06	5.518E-06	5.251E-06	5.717E-06	6.52	8.58	4.07	-1.01	-3.49	-8.16
35	8.082E-06	7.786E-06	7.364E-06	7.170E-06	6.769E-06	7.434E-06	6.93	8.71	4.73	-0.94	-3.55	-8.95
40	1.000E-05	9.739E-06	9.165E-06	8.907E-06	8.324E-06	9.227E-06	7.24	8.40	5.54	-0.68	-3.47	-9.79

**Table 52. MOXGD. Assembly Average Isotopic Composition. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	5.250E-09	5.032E-09	5.032E-09	5.122E-09	5.267E-09	5.141E-09	2.21	2.12	-2.10	-2.11	-0.37	2.46
2	5.199E-09	4.972E-09	4.985E-09	5.068E-09	5.215E-09	5.088E-09	2.26	2.18	-2.28	-2.02	-0.39	2.50
3	5.133E-09	4.910E-09	4.933E-09	5.013E-09	5.157E-09	5.029E-09	2.24	2.06	-2.37	-1.91	-0.32	2.54
4	5.072E-09	4.848E-09	4.879E-09	4.957E-09	5.096E-09	4.970E-09	2.24	2.04	-2.46	-1.84	-0.26	2.53
5	5.004E-09	4.785E-09	4.825E-09	4.901E-09	5.034E-09	4.910E-09	2.21	1.92	-2.54	-1.74	-0.18	2.53
6	4.952E-09	4.722E-09	4.784E-09	4.844E-09	4.971E-09	4.855E-09	2.20	2.00	-2.72	-1.46	-0.21	2.40
7	4.879E-09	4.659E-09	4.728E-09	4.787E-09	4.908E-09	4.792E-09	2.16	1.81	-2.78	-1.34	-0.10	2.42
8	4.819E-09	4.595E-09	4.671E-09	4.729E-09	4.844E-09	4.732E-09	2.18	1.84	-2.89	-1.28	-0.05	2.38
9	4.760E-09	4.530E-09	4.614E-09	4.671E-09	4.780E-09	4.671E-09	2.22	1.91	-3.02	-1.22	0.00	2.34
10	4.686E-09	4.464E-09	4.556E-09	4.611E-09	4.714E-09	4.606E-09	2.19	1.73	-3.08	-1.10	0.11	2.34
11	4.626E-09	4.398E-09	4.497E-09	4.551E-09	4.648E-09	4.544E-09	2.23	1.80	-3.21	-1.03	0.16	2.29
12	4.566E-09	4.333E-09	4.439E-09	4.491E-09	4.581E-09	4.482E-09	2.26	1.88	-3.33	-0.96	0.20	2.21
13	4.495E-09	4.270E-09	4.383E-09	4.432E-09	4.516E-09	4.419E-09	2.23	1.72	-3.38	-0.82	0.29	2.19
14	4.421E-09	4.209E-09	4.329E-09	4.375E-09	4.453E-09	4.357E-09	2.19	1.46	-3.41	-0.65	0.40	2.19
15	4.367E-09	4.150E-09	4.277E-09	4.320E-09	4.392E-09	4.301E-09	2.21	1.53	-3.51	-0.56	0.43	2.11
20	4.084E-09	3.887E-09	4.021E-09	4.110E-09	4.121E-09	4.045E-09	2.38	0.97	-3.90	-0.58	1.62	1.89
25	3.845E-09	3.646E-09	3.812E-09	3.874E-09	3.869E-09	3.809E-09	2.47	0.93	-4.28	0.08	1.70	1.57
30	3.609E-09	3.425E-09	3.619E-09	3.653E-09	3.635E-09	3.588E-09	2.58	0.58	-4.54	0.86	1.80	1.31
35	3.400E-09	3.224E-09	3.440E-09	3.447E-09	3.419E-09	3.386E-09	2.73	0.41	-4.79	1.60	1.80	0.98
40	3.252E-09	3.043E-09	3.277E-09	3.259E-09	3.223E-09	3.211E-09	2.99	1.28	-5.23	2.06	1.50	0.39



**Table 53. MOXGD. Assembly Average Isotopic Composition. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with equilibrium concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>149</sup> Sm, atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	5.307E-08	5.737E-08	5.522E-08	5.51	-3.90	3.90
1	5.156E-08	5.400E-08	5.278E-08	3.27	-2.31	2.31
2	5.053E-08	5.540E-08	5.296E-08	6.50	-4.60	4.60
3	4.973E-08	5.551E-08	5.262E-08	7.77	-5.49	5.49
4	4.907E-08	5.538E-08	5.222E-08	8.54	-6.04	6.04
5	4.847E-08	5.514E-08	5.181E-08	9.11	-6.44	6.44
6	4.792E-08	5.482E-08	5.137E-08	9.51	-6.72	6.72
7	4.740E-08	5.443E-08	5.091E-08	9.76	-6.90	6.90
8	4.690E-08	5.396E-08	5.043E-08	9.90	-7.00	7.00
9	4.642E-08	5.346E-08	4.994E-08	9.97	-7.05	7.05
10	4.593E-08	5.293E-08	4.943E-08	10.01	-7.08	7.08
11	4.546E-08	5.241E-08	4.893E-08	10.04	-7.10	7.10
12	4.500E-08	5.191E-08	4.845E-08	10.08	-7.13	7.13
13	4.457E-08	5.144E-08	4.800E-08	10.12	-7.16	7.16
14	4.416E-08	5.100E-08	4.758E-08	10.17	-7.19	7.19
15	4.377E-08	5.060E-08	4.718E-08	10.23	-7.23	7.23
20	4.205E-08	4.939E-08	4.572E-08	11.35	-8.02	8.02
25	4.029E-08	4.750E-08	4.389E-08	11.61	-8.21	8.21
30	3.850E-08	4.550E-08	4.200E-08	11.79	-8.34	8.34
35	3.675E-08	4.349E-08	4.012E-08	11.87	-8.39	8.39
40	3.510E-08	4.153E-08	3.832E-08	11.87	-8.39	8.39

**Table 54. MOXGD. Assembly Average Isotopic Composition. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	3.826E-08	3.837E-08	3.726E-08	3.796E-08	1.61	0.79	1.06	-1.85
2	4.950E-08	4.920E-08	4.776E-08	4.882E-08	1.90	1.39	0.78	-2.17
3	5.214E-08	5.181E-08	5.035E-08	5.143E-08	1.85	1.37	0.74	-2.11
4	5.277E-08	5.260E-08	5.120E-08	5.219E-08	1.65	1.11	0.79	-1.90
5	5.287E-08	5.287E-08	5.155E-08	5.243E-08	1.46	0.84	0.84	-1.68
6	5.286E-08	5.290E-08	5.168E-08	5.248E-08	1.32	0.72	0.80	-1.53
7	5.374E-08	5.277E-08	5.166E-08	5.272E-08	1.98	1.93	0.08	-2.02
8	5.329E-08	5.251E-08	5.150E-08	5.243E-08	1.71	1.63	0.15	-1.78
9	5.267E-08	5.216E-08	5.125E-08	5.203E-08	1.38	1.23	0.26	-1.49
10	5.191E-08	5.177E-08	5.093E-08	5.154E-08	1.03	0.73	0.45	-1.18
11	5.130E-08	5.135E-08	5.058E-08	5.108E-08	0.84	0.43	0.54	-0.97
12	5.065E-08	5.094E-08	5.021E-08	5.060E-08	0.73	0.10	0.67	-0.77
13	5.004E-08	5.056E-08	4.986E-08	5.015E-08	0.72	-0.23	0.81	-0.58
14	4.930E-08	5.020E-08	4.953E-08	4.968E-08	0.95	-0.76	1.06	-0.30
15	4.889E-08	4.988E-08	4.922E-08	4.933E-08	1.02	-0.89	1.11	-0.22
20	4.681E-08	4.846E-08	4.786E-08	4.771E-08	1.75	-1.89	1.57	0.32
25	4.449E-08	4.689E-08	4.625E-08	4.588E-08	2.71	-3.03	2.22	0.81
30	4.196E-08	4.521E-08	4.445E-08	4.387E-08	3.88	-4.37	3.05	1.31
35	3.958E-08	4.350E-08	4.255E-08	4.188E-08	4.88	-5.48	3.88	1.60
40	3.818E-08	4.183E-08	4.067E-08	4.023E-08	4.64	-5.09	3.99	1.10

**Table 55. MOXGD. Assembly Average Isotopic Composition. <sup>155</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>155</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.158E-06	2.159E-06	2.159E-06	2.159E-06	2.159E-06	2.159E-06	0.02	-0.04	0.01	0.01	0.01	0.00
1	2.023E-06	2.024E-06	2.021E-06	2.022E-06	2.020E-06	2.022E-06	0.08	0.03	0.10	-0.05	0.01	-0.09
2	1.873E-06	1.873E-06	1.867E-06	1.872E-06	1.870E-06	1.871E-06	0.13	0.09	0.13	-0.19	0.03	-0.06
3	1.709E-06	1.707E-06	1.701E-06	1.709E-06	1.706E-06	1.707E-06	0.20	0.15	0.05	-0.32	0.16	-0.04
4	1.533E-06	1.530E-06	1.526E-06	1.539E-06	1.531E-06	1.532E-06	0.31	0.07	-0.12	-0.37	0.46	-0.04
5	1.352E-06	1.347E-06	1.346E-06	1.364E-06	1.353E-06	1.352E-06	0.53	-0.02	-0.43	-0.45	0.85	0.04
6	1.170E-06	1.162E-06	1.166E-06	1.188E-06	1.174E-06	1.172E-06	0.85	-0.16	-0.84	-0.53	1.38	0.15
7	9.914E-07	9.813E-07	9.885E-07	1.015E-06	9.978E-07	9.949E-07	1.29	-0.34	-1.37	-0.64	2.05	0.30
8	8.179E-07	8.063E-07	8.169E-07	8.477E-07	8.283E-07	8.234E-07	1.90	-0.67	-2.08	-0.80	2.95	0.59
9	6.547E-07	6.405E-07	6.541E-07	6.883E-07	6.681E-07	6.611E-07	2.73	-0.98	-3.11	-1.06	4.10	1.05
10	5.015E-07	4.870E-07	5.034E-07	5.396E-07	5.195E-07	5.102E-07	3.93	-1.70	-4.54	-1.34	5.76	1.82
11	3.642E-07	3.492E-07	3.685E-07	4.048E-07	3.854E-07	3.744E-07	5.70	-2.72	-6.74	-1.59	8.12	2.93
12	2.490E-07	2.321E-07	2.542E-07	2.876E-07	2.691E-07	2.584E-07	8.13	-3.62	-10.19	-1.62	11.30	4.14
13	1.582E-07	1.417E-07	1.647E-07	1.921E-07	1.752E-07	1.664E-07	11.31	-4.91	-14.82	-1.02	15.45	5.31
14	9.387E-08	8.011E-08	1.007E-07	1.207E-07	1.065E-07	1.004E-07	14.98	-6.48	-20.19	0.31	20.26	6.10
15	5.258E-08	4.272E-08	5.890E-08	7.208E-08	6.131E-08	5.752E-08	18.88	-8.59	-25.72	2.39	25.32	6.59
20	4.122E-09	3.280E-09	5.791E-09	5.991E-09	4.965E-09	4.830E-09	23.59	-14.65	-32.08	19.91	24.03	2.80
25	2.352E-09	2.256E-09	3.676E-09	3.164E-09	2.990E-09	2.888E-09	20.44	-18.54	-21.86	27.30	9.55	3.55
30	2.136E-09	2.083E-09	3.584E-09	3.080E-09	2.869E-09	2.750E-09	23.28	-22.32	-24.27	30.31	11.97	4.31
35	1.970E-09	1.929E-09	3.558E-09	3.086E-09	2.792E-09	2.667E-09	26.61	-26.13	-27.66	33.39	15.71	4.68
40	1.876E-09	1.785E-09	3.536E-09	3.103E-09	2.714E-09	2.603E-09	29.32	-27.93	-31.40	35.84	19.23	4.27

**Table 56. MOXGD. Assembly Average Isotopic Composition. <sup>157</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Assembly Average Isotopic Composition. <sup>155</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.267E-06	2.269E-06	2.269E-06	2.269E-06	2.269E-06	2.268E-06	0.03	-0.04	0.01	0.01	0.00	0.03
1	1.896E-06	1.892E-06	1.898E-06	1.910E-06	1.901E-06	1.899E-06	0.34	-0.16	-0.37	-0.09	0.53	0.08
2	1.558E-06	1.551E-06	1.561E-06	1.583E-06	1.569E-06	1.564E-06	0.78	-0.41	-0.85	-0.23	1.19	0.30
3	1.257E-06	1.248E-06	1.260E-06	1.290E-06	1.273E-06	1.266E-06	1.28	-0.67	-1.37	-0.45	1.93	0.57
4	9.920E-07	9.838E-07	9.953E-07	1.031E-06	1.014E-06	1.003E-06	1.90	-1.12	-1.94	-0.79	2.78	1.07
5	7.631E-07	7.538E-07	7.644E-07	8.036E-07	7.868E-07	7.743E-07	2.63	-1.45	-2.66	-1.29	3.78	1.61
6	5.672E-07	5.562E-07	5.661E-07	6.066E-07	5.910E-07	5.774E-07	3.59	-1.77	-3.68	-1.97	5.06	2.35
7	4.030E-07	3.899E-07	3.995E-07	4.392E-07	4.251E-07	4.113E-07	4.91	-2.03	-5.21	-2.88	6.77	3.34
8	2.667E-07	2.545E-07	2.643E-07	3.008E-07	2.884E-07	2.749E-07	6.92	-2.99	-7.44	-3.87	9.41	4.89
9	1.616E-07	1.498E-07	1.603E-07	1.912E-07	1.806E-07	1.687E-07	9.94	-4.21	-11.21	-4.97	13.32	7.06
10	8.578E-08	7.574E-08	8.690E-08	1.099E-07	1.012E-07	9.190E-08	14.73	-6.65	-17.59	-5.44	19.56	10.12
11	3.946E-08	3.123E-08	4.176E-08	5.579E-08	4.929E-08	4.350E-08	21.64	-9.29	-28.22	-4.02	28.24	13.30
12	1.688E-08	1.125E-08	1.913E-08	2.553E-08	2.158E-08	1.887E-08	28.25	-10.54	-40.39	1.37	35.24	14.33
13	8.566E-09	5.248E-09	1.034E-08	1.220E-08	1.060E-08	9.391E-09	28.22	-8.78	-44.12	10.09	29.93	12.88
14	5.943E-09	3.888E-09	7.657E-09	7.707E-09	7.387E-09	6.516E-09	25.11	-8.80	-40.33	17.51	18.27	13.36
15	5.407E-09	3.498E-09	6.898E-09	6.442E-09	6.526E-09	5.754E-09	23.94	-6.03	-39.21	19.88	11.95	13.42
20	4.872E-09	3.052E-09	6.312E-09	5.710E-09	5.809E-09	5.151E-09	24.89	-5.42	-40.74	22.55	10.85	12.77
25	4.397E-09	2.880E-09	6.195E-09	5.511E-09	5.629E-09	4.922E-09	26.71	-10.66	-41.49	25.86	11.95	14.36
30	4.100E-09	2.722E-09	6.139E-09	5.422E-09	5.524E-09	4.781E-09	28.65	-14.26	-43.06	28.38	13.40	15.53
35	3.809E-09	2.571E-09	6.114E-09	5.381E-09	5.471E-09	4.669E-09	31.00	-18.43	-44.93	30.94	15.24	17.17
40	3.708E-09	2.429E-09	6.123E-09	5.383E-09	5.464E-09	4.622E-09	32.78	-19.76	-47.43	32.48	16.48	18.23

**Table 57. MOXGD. Assembly Average Isotopic Composition Deviation from Average Value, %.  
Burnup=40 MWd/kgHM**

	MOXGD. Assembly Average Isotopic Composition Deviation from Average Value, %. Burnup=40 MWd/kgHM								
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> Pu	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm
MCU	-0.59	-0.17	-0.07	0.34	-1.21	0.84	8.40	1.28	-3.25
TVS-M	-2.81	-0.64	0.01	-0.99	5.59	-4.96	5.54	-5.23	-11.05
WIMS8A	2.81	-1.93	-0.05	5.04	-1.31	4.66	-0.68	2.06	6.01
HELIOS	1.37	2.44	0.06	-2.19	-4.26	1.80	-3.47	1.50	5.24
MULTICELL	-0.78	0.30	0.05	-2.20	1.18	-2.34	-9.79	0.39	3.06
R.M.S. %	2.16	1.60	0.06	3.00	3.67	3.73	7.24	2.99	7.17

**Table 58. MOXGD. Isotopic Composition in Cell 1. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	4.267E-05	4.267E-05	4.267E-05	4.267E-05	4.267E-05	4.267E-05	0.00	0.00	0.00	0.00	0.00	0.00
1	4.153E-05	4.154E-05	4.159E-05	4.155E-05	4.153E-05	4.155E-05	0.06	-0.04	-0.02	0.10	0.00	-0.04
2	4.040E-05	4.041E-05	4.052E-05	4.043E-05	4.040E-05	4.043E-05	0.12	-0.08	-0.05	0.20	0.00	-0.08
3	3.929E-05	3.930E-05	3.946E-05	3.934E-05	3.928E-05	3.933E-05	0.18	-0.11	-0.08	0.31	0.01	-0.13
4	3.818E-05	3.820E-05	3.841E-05	3.825E-05	3.818E-05	3.824E-05	0.25	-0.17	-0.11	0.43	0.01	-0.17
5	3.708E-05	3.712E-05	3.738E-05	3.718E-05	3.710E-05	3.717E-05	0.33	-0.25	-0.13	0.55	0.02	-0.19
6	3.601E-05	3.606E-05	3.636E-05	3.613E-05	3.604E-05	3.612E-05	0.39	-0.30	-0.18	0.67	0.02	-0.22
7	3.496E-05	3.501E-05	3.536E-05	3.509E-05	3.499E-05	3.508E-05	0.47	-0.34	-0.22	0.80	0.02	-0.26
8	3.390E-05	3.397E-05	3.438E-05	3.407E-05	3.396E-05	3.406E-05	0.56	-0.46	-0.25	0.95	0.04	-0.28
9	3.287E-05	3.296E-05	3.341E-05	3.306E-05	3.294E-05	3.305E-05	0.65	-0.54	-0.28	1.10	0.05	-0.33
10	3.187E-05	3.196E-05	3.246E-05	3.208E-05	3.195E-05	3.206E-05	0.73	-0.61	-0.33	1.24	0.05	-0.36
11	3.089E-05	3.098E-05	3.153E-05	3.111E-05	3.098E-05	3.110E-05	0.82	-0.67	-0.38	1.39	0.04	-0.38
12	2.994E-05	3.002E-05	3.062E-05	3.016E-05	3.002E-05	3.015E-05	0.90	-0.71	-0.43	1.54	0.04	-0.44
13	2.901E-05	2.908E-05	2.972E-05	2.924E-05	2.909E-05	2.923E-05	0.99	-0.74	-0.50	1.69	0.03	-0.47
14	2.808E-05	2.816E-05	2.884E-05	2.833E-05	2.818E-05	2.832E-05	1.08	-0.84	-0.56	1.86	0.03	-0.49
15	2.718E-05	2.726E-05	2.798E-05	2.743E-05	2.728E-05	2.743E-05	1.18	-0.90	-0.62	2.03	0.02	-0.53
20	2.296E-05	2.303E-05	2.393E-05	2.324E-05	2.306E-05	2.324E-05	1.72	-1.22	-0.93	2.97	-0.03	-0.79
25	1.917E-05	1.924E-05	2.029E-05	1.948E-05	1.929E-05	1.950E-05	2.36	-1.67	-1.29	4.09	-0.08	-1.05
30	1.587E-05	1.591E-05	1.706E-05	1.616E-05	1.595E-05	1.619E-05	3.08	-1.98	-1.72	5.36	-0.17	-1.49
35	1.300E-05	1.302E-05	1.422E-05	1.328E-05	1.305E-05	1.331E-05	3.90	-2.36	-2.19	6.81	-0.28	-1.98
40	1.053E-05	1.055E-05	1.176E-05	1.080E-05	1.057E-05	1.084E-05	4.85	-2.89	-2.69	8.48	-0.38	-2.52

**Table 59. MOXGD. Isotopic Composition in Cell 1. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	2.256E-07	2.230E-07	2.155E-07	2.289E-07	2.262E-07	2.238E-07	2.28	0.79	-0.38	-3.72	2.25	1.05
2	4.468E-07	4.419E-07	4.273E-07	4.534E-07	4.482E-07	4.435E-07	2.25	0.74	-0.36	-3.66	2.22	1.06
3	6.628E-07	6.564E-07	6.348E-07	6.732E-07	6.656E-07	6.586E-07	2.21	0.64	-0.33	-3.60	2.22	1.07
4	8.759E-07	8.662E-07	8.380E-07	8.883E-07	8.782E-07	8.693E-07	2.21	0.76	-0.36	-3.60	2.18	1.02
5	1.085E-06	1.071E-06	1.037E-06	1.098E-06	1.086E-06	1.075E-06	2.21	0.89	-0.39	-3.61	2.13	0.98
6	1.290E-06	1.272E-06	1.231E-06	1.304E-06	1.288E-06	1.277E-06	2.21	1.04	-0.40	-3.62	2.10	0.88
7	1.486E-06	1.467E-06	1.420E-06	1.504E-06	1.486E-06	1.472E-06	2.18	0.92	-0.38	-3.58	2.11	0.92
8	1.683E-06	1.657E-06	1.604E-06	1.698E-06	1.678E-06	1.664E-06	2.20	1.14	-0.42	-3.60	2.05	0.84
9	1.871E-06	1.842E-06	1.784E-06	1.888E-06	1.865E-06	1.850E-06	2.19	1.14	-0.42	-3.58	2.04	0.82
10	2.052E-06	2.022E-06	1.958E-06	2.072E-06	2.046E-06	2.030E-06	2.16	1.08	-0.39	-3.54	2.06	0.79
11	2.228E-06	2.197E-06	2.128E-06	2.251E-06	2.223E-06	2.205E-06	2.15	1.03	-0.39	-3.51	2.06	0.81
12	2.398E-06	2.366E-06	2.292E-06	2.424E-06	2.394E-06	2.375E-06	2.13	0.97	-0.38	-3.47	2.07	0.80
13	2.563E-06	2.530E-06	2.452E-06	2.592E-06	2.559E-06	2.539E-06	2.10	0.93	-0.36	-3.43	2.09	0.77
14	2.726E-06	2.689E-06	2.607E-06	2.755E-06	2.720E-06	2.700E-06	2.10	0.98	-0.39	-3.42	2.07	0.76
15	2.879E-06	2.843E-06	2.758E-06	2.913E-06	2.875E-06	2.854E-06	2.07	0.89	-0.36	-3.37	2.09	0.75
20	3.579E-06	3.539E-06	3.441E-06	3.629E-06	3.583E-06	3.554E-06	1.99	0.70	-0.43	-3.18	2.10	0.81
25	4.163E-06	4.117E-06	4.017E-06	4.226E-06	4.177E-06	4.140E-06	1.91	0.56	-0.55	-2.97	2.07	0.90
30	4.626E-06	4.582E-06	4.489E-06	4.708E-06	4.660E-06	4.613E-06	1.80	0.28	-0.67	-2.68	2.06	1.01
35	4.990E-06	4.941E-06	4.864E-06	5.083E-06	5.037E-06	4.983E-06	1.70	0.14	-0.85	-2.38	2.01	1.08
40	5.267E-06	5.201E-06	5.150E-06	5.359E-06	5.318E-06	5.259E-06	1.61	0.15	-1.10	-2.08	1.90	1.12

**Table 60. MOXGD. Isotopic Composition in Cell 1. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.103E-02	2.103E-02	2.103E-02	2.103E-02	2.103E-02	2.103E-02	0.01	0.01	-0.01	-0.01	-0.01	0.01
1	2.101E-02	2.101E-02	2.101E-02	2.101E-02	2.101E-02	2.101E-02	0.00	0.00	0.00	0.00	0.00	0.00
2	2.099E-02	2.100E-02	2.099E-02	2.100E-02	2.100E-02	2.099E-02	0.02	-0.02	0.00	0.00	0.00	0.02
3	2.098E-02	2.098E-02	2.098E-02	2.098E-02	2.098E-02	2.098E-02	0.00	0.00	0.00	-0.01	0.00	0.00
4	2.096E-02	2.097E-02	2.096E-02	2.096E-02	2.097E-02	2.096E-02	0.02	-0.02	0.00	-0.01	0.00	0.03
5	2.095E-02	2.095E-02	2.095E-02	2.095E-02	2.095E-02	2.095E-02	0.01	0.01	0.00	-0.01	0.00	0.01
6	2.093E-02	2.093E-02	2.093E-02	2.093E-02	2.093E-02	2.093E-02	0.01	-0.01	0.01	-0.01	0.01	-0.01
7	2.091E-02	2.092E-02	2.091E-02	2.092E-02	2.092E-02	2.092E-02	0.02	-0.03	0.01	-0.01	0.01	0.02
8	2.090E-02	2.090E-02	2.090E-02	2.090E-02	2.090E-02	2.090E-02	0.01	0.00	0.01	-0.01	0.01	0.00
9	2.088E-02	2.089E-02	2.088E-02	2.089E-02	2.089E-02	2.088E-02	0.02	-0.02	0.01	-0.02	0.01	0.03
10	2.087E-02	2.087E-02	2.087E-02	2.087E-02	2.087E-02	2.087E-02	0.01	0.00	0.00	-0.02	0.00	0.00
11	2.085E-02	2.085E-02	2.085E-02	2.085E-02	2.086E-02	2.085E-02	0.02	-0.02	0.00	-0.02	0.00	0.03
12	2.083E-02	2.084E-02	2.083E-02	2.084E-02	2.084E-02	2.084E-02	0.02	-0.03	0.01	-0.02	0.01	0.02
13	2.081E-02	2.082E-02	2.082E-02	2.082E-02	2.083E-02	2.082E-02	0.04	-0.05	0.01	-0.02	0.01	0.05
14	2.080E-02	2.081E-02	2.080E-02	2.081E-02	2.081E-02	2.080E-02	0.02	-0.02	0.01	-0.03	0.01	0.03
15	2.078E-02	2.079E-02	2.078E-02	2.079E-02	2.079E-02	2.079E-02	0.02	-0.03	0.02	-0.02	0.01	0.02
20	2.069E-02	2.071E-02	2.070E-02	2.071E-02	2.071E-02	2.070E-02	0.04	-0.06	0.02	-0.02	0.02	0.04
25	2.061E-02	2.062E-02	2.061E-02	2.062E-02	2.063E-02	2.062E-02	0.04	-0.04	0.01	-0.04	0.01	0.06
30	2.051E-02	2.053E-02	2.052E-02	2.053E-02	2.054E-02	2.053E-02	0.06	-0.07	0.02	-0.04	0.02	0.07
35	2.042E-02	2.044E-02	2.042E-02	2.044E-02	2.046E-02	2.044E-02	0.08	-0.08	0.01	-0.06	0.01	0.12
40	2.032E-02	2.034E-02	2.033E-02	2.034E-02	2.036E-02	2.034E-02	0.08	-0.09	0.02	-0.05	0.02	0.11



**Table 61. MOXGD. Isotopic Composition in Cell 1. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	4.241E-04	4.241E-04	4.241E-04	4.241E-04	4.241E-04	4.241E-04	0.01	-0.01	0.00	0.00	0.00	-0.01
1	4.063E-04	4.069E-04	4.077E-04	4.064E-04	4.059E-04	4.066E-04	0.17	-0.08	0.06	0.26	-0.06	-0.18
2	3.913E-04	3.921E-04	3.938E-04	3.910E-04	3.903E-04	3.917E-04	0.34	-0.10	0.10	0.54	-0.18	-0.36
3	3.768E-04	3.779E-04	3.806E-04	3.763E-04	3.754E-04	3.774E-04	0.53	-0.16	0.14	0.84	-0.30	-0.53
4	3.628E-04	3.644E-04	3.679E-04	3.622E-04	3.611E-04	3.637E-04	0.73	-0.24	0.19	1.16	-0.41	-0.71
5	3.496E-04	3.514E-04	3.558E-04	3.487E-04	3.475E-04	3.506E-04	0.92	-0.29	0.23	1.48	-0.53	-0.89
6	3.374E-04	3.390E-04	3.442E-04	3.359E-04	3.345E-04	3.382E-04	1.11	-0.24	0.24	1.78	-0.68	-1.10
7	3.255E-04	3.272E-04	3.332E-04	3.237E-04	3.222E-04	3.264E-04	1.31	-0.27	0.26	2.10	-0.81	-1.28
8	3.142E-04	3.160E-04	3.228E-04	3.122E-04	3.104E-04	3.151E-04	1.52	-0.29	0.28	2.44	-0.94	-1.49
9	3.035E-04	3.053E-04	3.128E-04	3.012E-04	2.993E-04	3.044E-04	1.72	-0.30	0.30	2.76	-1.07	-1.68
10	2.935E-04	2.952E-04	3.034E-04	2.907E-04	2.888E-04	2.943E-04	1.91	-0.28	0.30	3.08	-1.22	-1.88
11	2.840E-04	2.856E-04	2.944E-04	2.809E-04	2.788E-04	2.847E-04	2.12	-0.26	0.30	3.40	-1.36	-2.08
12	2.755E-04	2.765E-04	2.859E-04	2.715E-04	2.693E-04	2.758E-04	2.32	-0.09	0.27	3.69	-1.53	-2.34
13	2.674E-04	2.679E-04	2.779E-04	2.627E-04	2.604E-04	2.673E-04	2.52	0.05	0.23	3.98	-1.69	-2.57
14	2.592E-04	2.597E-04	2.703E-04	2.544E-04	2.520E-04	2.591E-04	2.71	0.03	0.24	4.30	-1.82	-2.75
15	2.521E-04	2.520E-04	2.631E-04	2.466E-04	2.440E-04	2.516E-04	2.92	0.21	0.19	4.58	-1.98	-3.01
20	2.201E-04	2.199E-04	2.327E-04	2.138E-04	2.108E-04	2.195E-04	3.83	0.29	0.19	6.03	-2.56	-3.94
25	1.956E-04	1.962E-04	2.100E-04	1.900E-04	1.865E-04	1.957E-04	4.58	-0.03	0.28	7.33	-2.90	-4.68
30	1.793E-04	1.791E-04	1.933E-04	1.730E-04	1.690E-04	1.787E-04	5.16	0.32	0.22	8.14	-3.23	-5.45
35	1.680E-04	1.670E-04	1.811E-04	1.610E-04	1.567E-04	1.668E-04	5.55	0.74	0.14	8.62	-3.47	-6.03
40	1.596E-04	1.585E-04	1.723E-04	1.526E-04	1.481E-04	1.582E-04	5.78	0.89	0.16	8.91	-3.57	-6.38

**Table 62. MOXGD. Isotopic Composition in Cell 1. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	2.725E-05	2.725E-05	2.725E-05	2.725E-05	2.725E-05	2.725E-05	0.00	0.00	0.00	0.00	0.00	0.00
1	3.482E-05	3.480E-05	3.443E-05	3.468E-05	3.486E-05	3.472E-05	0.51	0.30	0.23	-0.84	-0.10	0.41
2	4.174E-05	4.180E-05	4.103E-05	4.150E-05	4.184E-05	4.158E-05	0.81	0.38	0.52	-1.33	-0.19	0.62
3	4.822E-05	4.830E-05	4.711E-05	4.778E-05	4.830E-05	4.794E-05	1.07	0.58	0.75	-1.74	-0.34	0.75
4	5.410E-05	5.435E-05	5.272E-05	5.355E-05	5.426E-05	5.380E-05	1.25	0.56	1.02	-1.99	-0.45	0.86
5	5.977E-05	5.996E-05	5.791E-05	5.887E-05	5.975E-05	5.925E-05	1.45	0.87	1.20	-2.27	-0.64	0.84
6	6.471E-05	6.518E-05	6.269E-05	6.376E-05	6.482E-05	6.423E-05	1.57	0.74	1.47	-2.40	-0.74	0.92
7	6.931E-05	7.001E-05	6.710E-05	6.824E-05	6.948E-05	6.883E-05	1.69	0.70	1.72	-2.51	-0.86	0.95
8	7.345E-05	7.449E-05	7.117E-05	7.234E-05	7.376E-05	7.304E-05	1.78	0.56	1.98	-2.57	-0.96	0.98
9	7.744E-05	7.862E-05	7.490E-05	7.608E-05	7.768E-05	7.694E-05	1.90	0.64	2.18	-2.66	-1.12	0.96
10	8.098E-05	8.243E-05	7.832E-05	7.949E-05	8.125E-05	8.049E-05	1.99	0.60	2.41	-2.70	-1.25	0.94
11	8.421E-05	8.594E-05	8.146E-05	8.257E-05	8.451E-05	8.374E-05	2.09	0.56	2.63	-2.72	-1.39	0.92
12	8.699E-05	8.915E-05	8.432E-05	8.536E-05	8.745E-05	8.665E-05	2.17	0.39	2.88	-2.70	-1.49	0.92
13	8.946E-05	9.210E-05	8.693E-05	8.786E-05	9.012E-05	8.929E-05	2.25	0.19	3.14	-2.65	-1.60	0.93
14	9.184E-05	9.478E-05	8.929E-05	9.010E-05	9.251E-05	9.171E-05	2.35	0.15	3.35	-2.63	-1.75	0.88
15	9.392E-05	9.723E-05	9.144E-05	9.210E-05	9.466E-05	9.387E-05	2.44	0.06	3.58	-2.59	-1.89	0.84
20	1.008E-04	1.062E-04	9.924E-05	9.879E-05	1.020E-04	1.014E-04	2.91	-0.59	4.69	-2.13	-2.57	0.60
25	1.040E-04	1.109E-04	1.033E-04	1.014E-04	1.051E-04	1.049E-04	3.44	-0.90	5.70	-1.54	-3.41	0.15
30	1.032E-04	1.128E-04	1.048E-04	1.012E-04	1.054E-04	1.055E-04	4.18	-2.17	6.94	-0.62	-4.08	-0.08
35	1.012E-04	1.127E-04	1.046E-04	9.931E-05	1.038E-04	1.043E-04	4.94	-3.01	8.05	0.30	-4.82	-0.52
40	9.897E-05	1.115E-04	1.034E-04	9.653E-05	1.011E-04	1.023E-04	5.61	-3.26	8.98	1.12	-5.65	-1.18

**Table 63. MOXGD. Isotopic Composition in Cell 1. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	4.523E-06	4.523E-06	4.523E-06	4.523E-06	4.523E-06	4.523E-06	0.00	0.00	0.00	0.00	0.00	0.00
1	6.982E-06	6.665E-06	6.959E-06	7.034E-06	6.932E-06	6.914E-06	2.09	0.98	-3.60	0.64	1.73	0.26
2	9.665E-06	9.012E-06	9.636E-06	9.765E-06	9.561E-06	9.528E-06	3.12	1.44	-5.42	1.14	2.49	0.35
3	1.237E-05	1.149E-05	1.245E-05	1.263E-05	1.231E-05	1.225E-05	3.61	0.97	-6.22	1.66	3.10	0.48
4	1.529E-05	1.404E-05	1.535E-05	1.557E-05	1.512E-05	1.508E-05	3.97	1.42	-6.85	1.84	3.28	0.30
5	1.810E-05	1.663E-05	1.829E-05	1.853E-05	1.796E-05	1.790E-05	4.14	1.10	-7.09	2.15	3.53	0.32
6	2.103E-05	1.923E-05	2.122E-05	2.149E-05	2.077E-05	2.075E-05	4.29	1.37	-7.33	2.28	3.57	0.11
7	2.391E-05	2.180E-05	2.412E-05	2.440E-05	2.354E-05	2.355E-05	4.38	1.52	-7.46	2.41	3.59	-0.05
8	2.683E-05	2.432E-05	2.697E-05	2.725E-05	2.625E-05	2.632E-05	4.47	1.93	-7.61	2.45	3.51	-0.28
9	2.949E-05	2.678E-05	2.974E-05	3.001E-05	2.888E-05	2.898E-05	4.48	1.76	-7.59	2.62	3.56	-0.35
10	3.208E-05	2.917E-05	3.243E-05	3.268E-05	3.141E-05	3.155E-05	4.49	1.67	-7.55	2.77	3.57	-0.45
11	3.467E-05	3.147E-05	3.501E-05	3.524E-05	3.384E-05	3.405E-05	4.51	1.83	-7.57	2.84	3.50	-0.61
12	3.712E-05	3.367E-05	3.749E-05	3.768E-05	3.615E-05	3.642E-05	4.52	1.91	-7.55	2.94	3.45	-0.75
13	3.949E-05	3.578E-05	3.986E-05	4.000E-05	3.835E-05	3.870E-05	4.54	2.05	-7.54	3.01	3.37	-0.89
14	4.167E-05	3.778E-05	4.211E-05	4.220E-05	4.043E-05	4.084E-05	4.53	2.04	-7.49	3.12	3.33	-1.00
15	4.368E-05	3.968E-05	4.425E-05	4.426E-05	4.239E-05	4.285E-05	4.51	1.94	-7.41	3.25	3.30	-1.08
20	5.242E-05	4.764E-05	5.319E-05	5.279E-05	5.051E-05	5.131E-05	4.47	2.16	-7.16	3.66	2.89	-1.56
25	5.794E-05	5.302E-05	5.933E-05	5.830E-05	5.577E-05	5.687E-05	4.42	1.88	-6.77	4.31	2.51	-1.94
30	6.183E-05	5.619E-05	6.305E-05	6.126E-05	5.860E-05	6.019E-05	4.59	2.73	-6.63	4.77	1.77	-2.64
35	6.291E-05	5.765E-05	6.489E-05	6.226E-05	5.958E-05	6.146E-05	4.64	2.36	-6.19	5.58	1.30	-3.06
40	6.197E-05	5.790E-05	6.536E-05	6.191E-05	5.927E-05	6.128E-05	4.68	1.12	-5.51	6.65	1.03	-3.28

**Table 64. MOXGD. Isotopic Composition in Cell 1. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.103E-07	1.054E-07	9.415E-08	9.807E-08	9.938E-08	1.015E-07	6.29	8.72	3.88	-7.20	-3.34	-2.05
2	2.711E-07	2.540E-07	2.309E-07	2.414E-07	2.430E-07	2.481E-07	6.15	9.28	2.39	-6.93	-2.69	-2.05
3	4.836E-07	4.497E-07	4.140E-07	4.336E-07	4.344E-07	4.431E-07	5.86	9.15	1.50	-6.55	-2.14	-1.95
4	7.532E-07	6.950E-07	6.457E-07	6.769E-07	6.753E-07	6.892E-07	5.79	9.28	0.84	-6.31	-1.79	-2.02
5	1.084E-06	9.917E-07	9.273E-07	9.727E-07	9.670E-07	9.885E-07	5.90	9.66	0.32	-6.20	-1.60	-2.18
6	1.468E-06	1.341E-06	1.259E-06	1.321E-06	1.310E-06	1.340E-06	5.80	9.56	0.05	-6.01	-1.38	-2.23
7	1.914E-06	1.742E-06	1.642E-06	1.723E-06	1.703E-06	1.745E-06	5.84	9.70	-0.16	-5.90	-1.26	-2.39
8	2.422E-06	2.196E-06	2.074E-06	2.176E-06	2.145E-06	2.203E-06	5.95	9.96	-0.32	-5.83	-1.20	-2.61
9	2.988E-06	2.700E-06	2.555E-06	2.680E-06	2.636E-06	2.712E-06	6.05	10.18	-0.42	-5.79	-1.17	-2.80
10	3.603E-06	3.255E-06	3.083E-06	3.233E-06	3.174E-06	3.270E-06	6.05	10.19	-0.44	-5.70	-1.12	-2.93
11	4.281E-06	3.859E-06	3.657E-06	3.833E-06	3.756E-06	3.877E-06	6.16	10.41	-0.48	-5.68	-1.13	-3.13
12	4.990E-06	4.509E-06	4.274E-06	4.478E-06	4.380E-06	4.526E-06	6.08	10.24	-0.39	-5.57	-1.06	-3.23
13	5.755E-06	5.204E-06	4.933E-06	5.166E-06	5.043E-06	5.220E-06	6.08	10.24	-0.32	-5.49	-1.04	-3.40
14	6.579E-06	5.942E-06	5.632E-06	5.895E-06	5.744E-06	5.958E-06	6.18	10.42	-0.28	-5.47	-1.07	-3.60
15	7.414E-06	6.721E-06	6.369E-06	6.662E-06	6.481E-06	6.729E-06	6.06	10.17	-0.12	-5.35	-1.01	-3.69
20	1.219E-05	1.116E-05	1.055E-05	1.100E-05	1.063E-05	1.111E-05	5.91	9.76	0.46	-4.99	-0.95	-4.28
25	1.778E-05	1.632E-05	1.539E-05	1.597E-05	1.532E-05	1.616E-05	6.18	10.06	1.02	-4.76	-1.15	-5.17
30	2.383E-05	2.193E-05	2.061E-05	2.127E-05	2.024E-05	2.158E-05	6.56	10.44	1.64	-4.47	-1.42	-6.19
35	3.020E-05	2.773E-05	2.599E-05	2.664E-05	2.511E-05	2.713E-05	7.23	11.30	2.18	-4.20	-1.83	-7.45
40	3.636E-05	3.350E-05	3.134E-05	3.186E-05	2.969E-05	3.255E-05	7.76	11.71	2.91	-3.71	-2.13	-8.78

**Table 65. MOXGD. Isotopic Composition in Cell 1. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	1.213E-08	1.155E-08	1.165E-08	1.210E-08	1.226E-08	1.194E-08	2.65	1.61	-3.27	-2.38	1.34	2.70
2	1.189E-08	1.129E-08	1.146E-08	1.183E-08	1.199E-08	1.169E-08	2.58	1.69	-3.44	-1.99	1.19	2.55
3	1.153E-08	1.104E-08	1.123E-08	1.158E-08	1.171E-08	1.142E-08	2.40	0.98	-3.28	-1.65	1.39	2.56
4	1.137E-08	1.081E-08	1.103E-08	1.133E-08	1.144E-08	1.120E-08	2.39	1.55	-3.47	-1.49	1.23	2.18
5	1.111E-08	1.058E-08	1.084E-08	1.110E-08	1.119E-08	1.097E-08	2.29	1.32	-3.48	-1.14	1.25	2.05
6	1.095E-08	1.037E-08	1.070E-08	1.088E-08	1.095E-08	1.077E-08	2.29	1.67	-3.72	-0.67	1.04	1.67
7	1.064E-08	1.016E-08	1.052E-08	1.067E-08	1.072E-08	1.054E-08	2.13	0.91	-3.60	-0.18	1.20	1.67
8	1.036E-08	9.968E-09	1.036E-08	1.047E-08	1.050E-08	1.033E-08	2.06	0.28	-3.52	0.27	1.34	1.63
9	1.022E-08	9.781E-09	1.020E-08	1.028E-08	1.028E-08	1.015E-08	2.07	0.67	-3.65	0.49	1.23	1.26
10	1.013E-08	9.602E-09	1.005E-08	1.009E-08	1.008E-08	9.991E-09	2.20	1.39	-3.89	0.60	1.02	0.89
11	9.936E-09	9.431E-09	9.907E-09	9.917E-09	9.890E-09	9.816E-09	2.20	1.22	-3.92	0.93	1.02	0.75
12	9.781E-09	9.270E-09	9.771E-09	9.750E-09	9.707E-09	9.656E-09	2.26	1.30	-4.00	1.20	0.97	0.53
13	9.526E-09	9.117E-09	9.644E-09	9.591E-09	9.533E-09	9.482E-09	2.21	0.46	-3.85	1.70	1.15	0.54
14	9.501E-09	8.974E-09	9.524E-09	9.443E-09	9.370E-09	9.362E-09	2.41	1.48	-4.15	1.73	0.86	0.08
15	9.369E-09	8.839E-09	9.413E-09	9.303E-09	9.218E-09	9.228E-09	2.49	1.52	-4.22	2.00	0.81	-0.11
20	8.785E-09	8.282E-09	8.906E-09	8.810E-09	8.596E-09	8.676E-09	2.85	1.26	-4.54	2.66	1.54	-0.92
25	8.393E-09	7.849E-09	8.544E-09	8.336E-09	8.107E-09	8.246E-09	3.30	1.79	-4.82	3.62	1.09	-1.68
30	8.020E-09	7.508E-09	8.248E-09	7.961E-09	7.721E-09	7.892E-09	3.61	1.63	-4.87	4.52	0.88	-2.16
35	7.632E-09	7.238E-09	8.003E-09	7.662E-09	7.414E-09	7.590E-09	3.80	0.56	-4.64	5.44	0.95	-2.31
40	7.416E-09	7.022E-09	7.798E-09	7.420E-09	7.168E-09	7.365E-09	4.01	0.70	-4.65	5.88	0.75	-2.67

**Table 66. MOXGD. Isotopic Composition in Cell 1. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with equilibrium concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value, 100%* (X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	9.426E-08	1.069E-07	1.006E-07	8.87	-6.27	6.27
1	9.200E-08	9.744E-08	9.472E-08	4.06	-2.87	2.87
2	9.125E-08	9.912E-08	9.518E-08	5.85	-4.13	4.13
3	9.085E-08	9.904E-08	9.494E-08	6.09	-4.31	4.31
4	9.053E-08	9.907E-08	9.480E-08	6.37	-4.51	4.51
5	9.021E-08	9.914E-08	9.467E-08	6.67	-4.72	4.72
6	8.987E-08	9.917E-08	9.452E-08	6.95	-4.92	4.92
7	8.952E-08	9.915E-08	9.433E-08	7.22	-5.10	5.10
8	8.914E-08	9.907E-08	9.411E-08	7.46	-5.27	5.27
9	8.875E-08	9.895E-08	9.385E-08	7.68	-5.43	5.43
10	8.835E-08	9.877E-08	9.356E-08	7.88	-5.57	5.57
11	8.793E-08	9.856E-08	9.325E-08	8.06	-5.70	5.70
12	8.751E-08	9.831E-08	9.291E-08	8.22	-5.82	5.82
13	8.708E-08	9.804E-08	9.256E-08	8.37	-5.92	5.92
14	8.666E-08	9.775E-08	9.220E-08	8.51	-6.01	6.01
15	8.624E-08	9.744E-08	9.184E-08	8.63	-6.10	6.10
20	8.435E-08	9.689E-08	9.062E-08	9.78	-6.92	6.92
25	8.253E-08	9.506E-08	8.879E-08	9.98	-7.05	7.05
30	8.085E-08	9.324E-08	8.704E-08	10.07	-7.12	7.12
35	7.933E-08	9.150E-08	8.541E-08	10.07	-7.12	7.12
40	7.799E-08	8.988E-08	8.393E-08	10.02	-7.08	7.08

**Table 67. MOXGD. Isotopic Composition in Cell 1. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 1. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	8.997E-08	8.869E-08	8.665E-08	8.844E-08	1.89	1.73	0.29	-2.02
2	9.867E-08	9.808E-08	9.458E-08	9.711E-08	2.28	1.61	1.00	-2.60
3	9.892E-08	9.860E-08	9.504E-08	9.752E-08	2.21	1.44	1.11	-2.54
4	9.751E-08	9.892E-08	9.532E-08	9.725E-08	1.86	0.27	1.71	-1.98
5	9.805E-08	9.926E-08	9.561E-08	9.764E-08	1.90	0.42	1.66	-2.08
6	9.662E-08	9.957E-08	9.584E-08	9.734E-08	2.02	-0.74	2.29	-1.55
7	9.655E-08	9.982E-08	9.599E-08	9.745E-08	2.12	-0.93	2.43	-1.50
8	9.457E-08	1.000E-07	9.607E-08	9.688E-08	2.90	-2.39	3.22	-0.84
9	9.519E-08	1.001E-07	9.607E-08	9.713E-08	2.71	-1.99	3.08	-1.09
10	9.495E-08	1.002E-07	9.600E-08	9.705E-08	2.85	-2.16	3.24	-1.08
11	9.605E-08	1.002E-07	9.587E-08	9.737E-08	2.51	-1.36	2.90	-1.54
12	9.453E-08	1.002E-07	9.568E-08	9.679E-08	3.08	-2.34	3.49	-1.15
13	9.313E-08	1.001E-07	9.545E-08	9.623E-08	3.70	-3.22	4.04	-0.81
14	9.236E-08	1.000E-07	9.519E-08	9.586E-08	4.05	-3.65	4.36	-0.70
15	9.349E-08	9.995E-08	9.490E-08	9.611E-08	3.53	-2.73	3.99	-1.26
20	9.264E-08	9.923E-08	9.344E-08	9.510E-08	3.78	-2.59	4.34	-1.75
25	9.105E-08	9.827E-08	9.174E-08	9.369E-08	4.25	-2.81	4.89	-2.08
30	8.728E-08	9.712E-08	8.996E-08	9.145E-08	5.56	-4.56	6.19	-1.63
35	8.336E-08	9.591E-08	8.822E-08	8.916E-08	7.10	-6.51	7.57	-1.06
40	8.181E-08	9.475E-08	8.659E-08	8.772E-08	7.46	-6.73	8.02	-1.28

**Table 68. MOXGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM**

	MOXGD. Isotopic Composition in Cell 1 Deviation from Average Value, %. Burnup=40 MWd/kgHM								
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> U	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm
MCU	-2.89	0.15	-0.09	0.89	-3.26	1.12	11.71	0.70	-5.10
TVS-M	-2.69	-1.10	0.02	0.16	8.98	-5.51	2.91	-4.65	-9.53
WIMS8A	8.48	-2.08	-0.05	8.91	1.12	6.65	-3.71	5.88	9.91
HELIOS	-0.38	1.90	0.02	-3.57	-5.65	1.03	-2.13	0.75	4.26
MULTICELL	-2.52	1.12	0.11	-6.38	-1.18	-3.28	-8.78	-2.67	0.45
R.M.S. %	4.85	1.61	0.08	5.78	5.61	4.68	7.76	4.01	7.64



**Table 69 MOXGD. Isotopic Composition in Cell 24. <sup>235</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>235</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	7.288E-04	7.288E-04	7.288E-04	7.288E-04	7.288E-04	7.288E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	7.211E-04	7.211E-04	7.210E-04	7.210E-04	7.212E-04	7.211E-04	0.01	0.00	0.01	-0.01	-0.01	0.02
2	7.130E-04	7.132E-04	7.129E-04	7.129E-04	7.134E-04	7.131E-04	0.03	-0.01	0.02	-0.03	-0.02	0.04
3	7.047E-04	7.050E-04	7.044E-04	7.046E-04	7.053E-04	7.048E-04	0.05	-0.02	0.03	-0.05	-0.03	0.07
4	6.959E-04	6.964E-04	6.956E-04	6.959E-04	6.968E-04	6.961E-04	0.07	-0.03	0.04	-0.07	-0.04	0.10
5	6.868E-04	6.874E-04	6.865E-04	6.868E-04	6.879E-04	6.871E-04	0.08	-0.04	0.04	-0.09	-0.04	0.12
6	6.773E-04	6.779E-04	6.769E-04	6.773E-04	6.786E-04	6.776E-04	0.10	-0.05	0.05	-0.11	-0.04	0.15
7	6.674E-04	6.680E-04	6.669E-04	6.675E-04	6.689E-04	6.678E-04	0.11	-0.05	0.04	-0.13	-0.04	0.17
8	6.571E-04	6.577E-04	6.565E-04	6.572E-04	6.587E-04	6.574E-04	0.13	-0.05	0.04	-0.15	-0.03	0.19
9	6.462E-04	6.468E-04	6.456E-04	6.465E-04	6.481E-04	6.466E-04	0.15	-0.07	0.02	-0.17	-0.02	0.23
10	6.347E-04	6.354E-04	6.342E-04	6.353E-04	6.370E-04	6.353E-04	0.17	-0.09	0.01	-0.18	0.00	0.26
11	6.228E-04	6.234E-04	6.223E-04	6.237E-04	6.254E-04	6.235E-04	0.19	-0.11	-0.02	-0.20	0.03	0.30
12	6.104E-04	6.109E-04	6.099E-04	6.116E-04	6.133E-04	6.112E-04	0.21	-0.13	-0.06	-0.21	0.05	0.34
13	5.976E-04	5.979E-04	5.972E-04	5.990E-04	6.008E-04	5.985E-04	0.24	-0.15	-0.10	-0.22	0.09	0.39
14	5.844E-04	5.845E-04	5.842E-04	5.862E-04	5.879E-04	5.854E-04	0.27	-0.18	-0.17	-0.21	0.13	0.42
15	5.712E-04	5.708E-04	5.711E-04	5.732E-04	5.748E-04	5.722E-04	0.30	-0.18	-0.24	-0.19	0.17	0.45
20	5.054E-04	5.033E-04	5.067E-04	5.085E-04	5.099E-04	5.068E-04	0.51	-0.28	-0.69	0.00	0.35	0.62
25	4.428E-04	4.397E-04	4.462E-04	4.473E-04	4.483E-04	4.449E-04	0.80	-0.47	-1.16	0.30	0.55	0.77
30	3.853E-04	3.810E-04	3.902E-04	3.905E-04	3.909E-04	3.876E-04	1.12	-0.59	-1.70	0.68	0.75	0.86
35	3.323E-04	3.271E-04	3.388E-04	3.381E-04	3.379E-04	3.348E-04	1.50	-0.76	-2.30	1.18	0.96	0.92
40	2.844E-04	2.784E-04	2.920E-04	2.902E-04	2.894E-04	2.869E-04	1.93	-0.87	-2.97	1.79	1.16	0.88

**Table 70. MOXGD. Isotopic Composition in Cell 24. <sup>236</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>236</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	2.048E-06	2.032E-06	2.041E-06	2.136E-06	1.984E-06	2.048E-06	2.69	-0.02	-0.79	-0.34	4.28	-3.13
2	4.144E-06	4.095E-06	4.125E-06	4.303E-06	4.004E-06	4.134E-06	2.63	0.24	-0.94	-0.22	4.09	-3.16
3	6.275E-06	6.196E-06	6.245E-06	6.506E-06	6.064E-06	6.257E-06	2.57	0.29	-0.97	-0.19	3.97	-3.09
4	8.457E-06	8.338E-06	8.402E-06	8.744E-06	8.165E-06	8.421E-06	2.51	0.43	-0.99	-0.23	3.83	-3.04
5	1.067E-05	1.052E-05	1.060E-05	1.102E-05	1.031E-05	1.062E-05	2.43	0.46	-0.96	-0.26	3.71	-2.95
6	1.291E-05	1.275E-05	1.283E-05	1.333E-05	1.250E-05	1.286E-05	2.35	0.36	-0.89	-0.26	3.63	-2.83
7	1.518E-05	1.502E-05	1.511E-05	1.568E-05	1.473E-05	1.514E-05	2.29	0.23	-0.80	-0.26	3.56	-2.74
8	1.750E-05	1.734E-05	1.742E-05	1.808E-05	1.700E-05	1.747E-05	2.23	0.20	-0.72	-0.26	3.48	-2.69
9	1.989E-05	1.972E-05	1.979E-05	2.051E-05	1.933E-05	1.985E-05	2.16	0.22	-0.66	-0.31	3.35	-2.61
10	2.233E-05	2.214E-05	2.220E-05	2.299E-05	2.170E-05	2.227E-05	2.09	0.26	-0.59	-0.34	3.23	-2.57
11	2.482E-05	2.462E-05	2.465E-05	2.551E-05	2.412E-05	2.474E-05	2.03	0.29	-0.50	-0.38	3.11	-2.52
12	2.735E-05	2.715E-05	2.714E-05	2.808E-05	2.659E-05	2.726E-05	1.97	0.33	-0.41	-0.45	2.99	-2.46
13	2.991E-05	2.972E-05	2.965E-05	3.067E-05	2.909E-05	2.981E-05	1.91	0.34	-0.29	-0.52	2.88	-2.41
14	3.250E-05	3.232E-05	3.218E-05	3.328E-05	3.162E-05	3.238E-05	1.85	0.39	-0.18	-0.63	2.77	-2.34
15	3.505E-05	3.492E-05	3.469E-05	3.588E-05	3.414E-05	3.494E-05	1.81	0.34	-0.04	-0.72	2.70	-2.28
20	4.739E-05	4.734E-05	4.660E-05	4.839E-05	4.626E-05	4.720E-05	1.74	0.41	0.30	-1.26	2.53	-1.98
25	5.846E-05	5.841E-05	5.723E-05	5.968E-05	5.719E-05	5.819E-05	1.77	0.45	0.37	-1.65	2.55	-1.73
30	6.806E-05	6.807E-05	6.652E-05	6.964E-05	6.680E-05	6.782E-05	1.83	0.35	0.37	-1.92	2.69	-1.50
35	7.642E-05	7.631E-05	7.448E-05	7.829E-05	7.511E-05	7.612E-05	1.92	0.39	0.25	-2.16	2.85	-1.33
40	8.344E-05	8.317E-05	8.116E-05	8.565E-05	8.211E-05	8.311E-05	2.03	0.40	0.08	-2.34	3.06	-1.20

**Table 71. MOXGD. Isotopic Composition in Cell 24. <sup>238</sup>U, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>238</sup> U, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.927E-02	1.927E-02	1.927E-02	1.927E-02	1.927E-02	1.927E-02	0.01	0.01	0.00	0.00	0.00	0.01
1	1.926E-02	1.926E-02	1.926E-02	1.926E-02	1.926E-02	1.926E-02	0.01	0.00	-0.01	-0.01	-0.01	0.01
2	1.924E-02	1.924E-02	1.924E-02	1.924E-02	1.924E-02	1.924E-02	0.01	0.00	0.00	0.00	0.00	-0.02
3	1.923E-02	1.923E-02	1.923E-02	1.923E-02	1.923E-02	1.923E-02	0.01	0.00	0.00	0.00	0.00	-0.01
4	1.922E-02	1.922E-02	1.922E-02	1.922E-02	1.922E-02	1.922E-02	0.01	0.00	0.00	-0.01	0.00	0.00
5	1.921E-02	1.921E-02	1.920E-02	1.921E-02	1.921E-02	1.921E-02	0.01	-0.01	0.00	-0.01	0.00	0.02
6	1.919E-02	1.920E-02	1.919E-02	1.920E-02	1.919E-02	1.919E-02	0.01	0.00	0.01	-0.01	0.01	-0.02
7	1.918E-02	1.918E-02	1.918E-02	1.918E-02	1.918E-02	1.918E-02	0.01	0.00	0.01	-0.01	0.01	0.00
8	1.917E-02	1.917E-02	1.916E-02	1.917E-02	1.917E-02	1.917E-02	0.01	0.00	0.00	-0.02	0.01	0.01
9	1.916E-02	1.916E-02	1.915E-02	1.916E-02	1.916E-02	1.916E-02	0.02	0.00	0.00	-0.03	0.01	0.02
10	1.914E-02	1.914E-02	1.914E-02	1.914E-02	1.914E-02	1.914E-02	0.02	-0.01	0.01	-0.02	0.02	0.00
11	1.913E-02	1.913E-02	1.912E-02	1.913E-02	1.913E-02	1.913E-02	0.02	-0.01	0.01	-0.03	0.02	0.01
12	1.911E-02	1.912E-02	1.911E-02	1.912E-02	1.912E-02	1.911E-02	0.02	-0.01	0.01	-0.03	0.01	0.03
13	1.910E-02	1.910E-02	1.909E-02	1.910E-02	1.910E-02	1.910E-02	0.02	-0.01	0.01	-0.03	0.02	0.00
14	1.908E-02	1.909E-02	1.908E-02	1.909E-02	1.909E-02	1.909E-02	0.02	-0.01	0.01	-0.03	0.02	0.02
15	1.907E-02	1.907E-02	1.907E-02	1.908E-02	1.907E-02	1.907E-02	0.02	-0.01	0.02	-0.03	0.03	-0.01
20	1.899E-02	1.900E-02	1.899E-02	1.901E-02	1.900E-02	1.900E-02	0.03	-0.03	0.02	-0.04	0.04	0.01
25	1.892E-02	1.893E-02	1.891E-02	1.893E-02	1.893E-02	1.892E-02	0.04	-0.03	0.02	-0.05	0.04	0.03
30	1.884E-02	1.885E-02	1.884E-02	1.886E-02	1.885E-02	1.885E-02	0.04	-0.03	0.02	-0.06	0.05	0.02
35	1.876E-02	1.877E-02	1.875E-02	1.878E-02	1.877E-02	1.877E-02	0.05	-0.04	0.02	-0.06	0.06	0.02
40	1.867E-02	1.869E-02	1.867E-02	1.870E-02	1.869E-02	1.868E-02	0.06	-0.06	0.02	-0.07	0.07	0.03

**Table 72. MOXGD. Isotopic Composition in Cell 24. <sup>239</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>239</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean					
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL	
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	8.820E-06	8.767E-06	9.148E-06	8.704E-06	8.811E-06	8.850E-06	1.96	-0.34	-0.94	3.37	-1.65	-0.44	
2	1.916E-05	1.878E-05	1.965E-05	1.849E-05	1.891E-05	1.900E-05	2.31	0.84	-1.15	3.45	-2.69	-0.46	
3	2.918E-05	2.852E-05	2.987E-05	2.800E-05	2.875E-05	2.886E-05	2.45	1.09	-1.19	3.49	-3.00	-0.40	
4	3.885E-05	3.795E-05	3.976E-05	3.721E-05	3.829E-05	3.841E-05	2.50	1.15	-1.21	3.51	-3.14	-0.32	
5	4.814E-05	4.703E-05	4.928E-05	4.608E-05	4.750E-05	4.761E-05	2.52	1.13	-1.21	3.52	-3.21	-0.22	
6	5.699E-05	5.573E-05	5.841E-05	5.459E-05	5.634E-05	5.641E-05	2.52	1.03	-1.20	3.54	-3.24	-0.13	
7	6.556E-05	6.403E-05	6.711E-05	6.271E-05	6.479E-05	6.484E-05	2.54	1.12	-1.25	3.50	-3.29	-0.08	
8	7.355E-05	7.190E-05	7.536E-05	7.042E-05	7.283E-05	7.281E-05	2.53	1.02	-1.25	3.50	-3.29	0.02	
9	8.117E-05	7.932E-05	8.315E-05	7.770E-05	8.042E-05	8.035E-05	2.54	1.02	-1.29	3.48	-3.30	0.08	
10	8.819E-05	8.627E-05	9.046E-05	8.455E-05	8.755E-05	8.740E-05	2.52	0.90	-1.30	3.50	-3.26	0.17	
11	9.490E-05	9.274E-05	9.728E-05	9.094E-05	9.421E-05	9.401E-05	2.53	0.95	-1.36	3.47	-3.27	0.21	
12	1.011E-04	9.873E-05	1.036E-04	9.688E-05	1.004E-04	1.001E-04	2.53	0.95	-1.42	3.46	-3.26	0.25	
13	1.068E-04	1.043E-04	1.095E-04	1.024E-04	1.061E-04	1.058E-04	2.53	0.93	-1.46	3.48	-3.23	0.28	
14	1.121E-04	1.094E-04	1.149E-04	1.075E-04	1.114E-04	1.111E-04	2.55	0.95	-1.53	3.49	-3.22	0.30	
15	1.174E-04	1.141E-04	1.200E-04	1.122E-04	1.163E-04	1.160E-04	2.59	1.22	-1.67	3.45	-3.26	0.26	
20	1.366E-04	1.329E-04	1.404E-04	1.313E-04	1.359E-04	1.354E-04	2.62	0.86	-1.88	3.71	-3.06	0.37	
25	1.497E-04	1.455E-04	1.544E-04	1.441E-04	1.492E-04	1.486E-04	2.72	0.73	-2.08	3.93	-3.00	0.42	
30	1.586E-04	1.534E-04	1.635E-04	1.522E-04	1.575E-04	1.570E-04	2.86	1.01	-2.33	4.10	-3.07	0.29	
35	1.641E-04	1.576E-04	1.687E-04	1.566E-04	1.620E-04	1.618E-04	3.05	1.40	-2.58	4.27	-3.21	0.12	
40	1.670E-04	1.592E-04	1.711E-04	1.582E-04	1.635E-04	1.638E-04	3.29	1.98	-2.83	4.43	-3.40	-0.18	

**Table 73. MOXGD. Isotopic Composition in Cell 24. <sup>240</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>240</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean					
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL	
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	6.229E-08	6.211E-08	6.541E-08	5.149E-08	5.024E-08	5.831E-08	11.89	6.83	6.51	12.18	-11.68	-13.84	
2	2.614E-07	2.583E-07	2.731E-07	2.329E-07	2.287E-07	2.509E-07	7.66	4.20	2.95	8.87	-7.18	-8.84	
3	6.048E-07	5.894E-07	6.209E-07	5.438E-07	5.367E-07	5.791E-07	6.44	4.44	1.78	7.22	-6.11	-7.32	
4	1.076E-06	1.055E-06	1.105E-06	9.809E-07	9.728E-07	1.038E-06	5.63	3.64	1.64	6.46	-5.48	-6.26	
5	1.679E-06	1.653E-06	1.721E-06	1.541E-06	1.535E-06	1.625E-06	5.15	3.27	1.66	5.86	-5.22	-5.57	
6	2.403E-06	2.380E-06	2.465E-06	2.219E-06	2.221E-06	2.338E-06	4.78	2.81	1.82	5.43	-5.08	-4.99	
7	3.235E-06	3.235E-06	3.332E-06	3.012E-06	3.028E-06	3.169E-06	4.46	2.10	2.11	5.17	-4.94	-4.44	
8	4.205E-06	4.215E-06	4.320E-06	3.916E-06	3.955E-06	4.122E-06	4.29	2.01	2.26	4.79	-5.01	-4.06	
9	5.291E-06	5.317E-06	5.423E-06	4.927E-06	4.999E-06	5.191E-06	4.16	1.92	2.42	4.46	-5.10	-3.70	
10	6.492E-06	6.537E-06	6.636E-06	6.039E-06	6.156E-06	6.372E-06	4.07	1.88	2.59	4.14	-5.22	-3.39	
11	7.787E-06	7.871E-06	7.953E-06	7.248E-06	7.421E-06	7.656E-06	3.99	1.72	2.80	3.88	-5.33	-3.07	
12	9.165E-06	9.308E-06	9.360E-06	8.544E-06	8.786E-06	9.033E-06	3.92	1.47	3.05	3.62	-5.41	-2.73	
13	1.060E-05	1.084E-05	1.084E-05	9.914E-06	1.024E-05	1.049E-05	3.85	1.09	3.33	3.40	-5.46	-2.35	
14	1.212E-05	1.244E-05	1.238E-05	1.134E-05	1.176E-05	1.201E-05	3.83	0.91	3.58	3.13	-5.55	-2.07	
15	1.370E-05	1.410E-05	1.397E-05	1.281E-05	1.334E-05	1.358E-05	3.82	0.88	3.76	2.84	-5.67	-1.80	
20	2.217E-05	2.270E-05	2.220E-05	2.042E-05	2.153E-05	2.180E-05	4.03	1.68	4.11	1.81	-6.35	-1.25	
25	3.062E-05	3.145E-05	3.048E-05	2.808E-05	2.992E-05	3.011E-05	4.18	1.70	4.44	1.23	-6.75	-0.63	
30	3.836E-05	4.006E-05	3.855E-05	3.553E-05	3.823E-05	3.814E-05	4.29	0.57	5.01	1.06	-6.87	0.22	
35	4.580E-05	4.830E-05	4.622E-05	4.258E-05	4.622E-05	4.582E-05	4.49	-0.04	5.40	0.86	-7.08	0.87	
40	5.219E-05	5.597E-05	5.331E-05	4.907E-05	5.372E-05	5.285E-05	4.77	-1.25	5.89	0.86	-7.15	1.64	

**Table 74. MOXGD. Isotopic Composition in Cell 24. <sup>241</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>241</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	2.352E-09	2.011E-09	2.405E-09	1.757E-09	1.590E-09	2.023E-09	17.69	16.26	-0.58	18.88	-13.16	-21.40
2	1.960E-08	1.673E-08	2.018E-08	1.643E-08	1.495E-08	1.758E-08	12.66	11.53	-4.85	14.80	-6.54	-14.95
3	6.485E-08	5.688E-08	6.848E-08	5.794E-08	5.305E-08	6.024E-08	10.42	7.66	-5.58	13.68	-3.82	-11.93
4	1.560E-07	1.344E-07	1.610E-07	1.390E-07	1.280E-07	1.437E-07	9.87	8.57	-6.48	12.05	-3.24	-10.90
5	3.049E-07	2.598E-07	3.095E-07	2.709E-07	2.506E-07	2.791E-07	9.55	9.21	-6.92	10.89	-2.96	-10.22
6	5.132E-07	4.425E-07	5.242E-07	4.632E-07	4.304E-07	4.747E-07	8.85	8.12	-6.79	10.43	-2.43	-9.33
7	8.002E-07	6.899E-07	8.128E-07	7.237E-07	6.753E-07	7.404E-07	8.51	8.08	-6.82	9.79	-2.25	-8.79
8	1.159E-06	1.008E-06	1.181E-06	1.058E-06	9.913E-07	1.080E-06	8.03	7.36	-6.65	9.43	-1.97	-8.17
9	1.599E-06	1.400E-06	1.633E-06	1.471E-06	1.383E-06	1.497E-06	7.62	6.81	-6.50	9.08	-1.75	-7.63
10	2.135E-06	1.868E-06	2.170E-06	1.964E-06	1.852E-06	1.998E-06	7.41	6.86	-6.48	8.62	-1.70	-7.30
11	2.747E-06	2.413E-06	2.791E-06	2.537E-06	2.399E-06	2.578E-06	7.12	6.58	-6.37	8.29	-1.57	-6.93
12	3.427E-06	3.033E-06	3.494E-06	3.189E-06	3.023E-06	3.233E-06	6.78	6.00	-6.19	8.07	-1.38	-6.51
13	4.234E-06	3.725E-06	4.276E-06	3.916E-06	3.720E-06	3.974E-06	6.76	6.54	-6.27	7.59	-1.46	-6.40
14	5.072E-06	4.485E-06	5.130E-06	4.715E-06	4.487E-06	4.778E-06	6.49	6.16	-6.13	7.38	-1.32	-6.09
15	5.912E-06	5.307E-06	6.052E-06	5.580E-06	5.319E-06	5.634E-06	6.02	4.93	-5.80	7.42	-0.96	-5.59
20	1.098E-05	1.020E-05	1.143E-05	1.073E-05	1.027E-05	1.072E-05	4.77	2.46	-4.89	6.59	0.05	-4.20
25	1.699E-05	1.576E-05	1.756E-05	1.661E-05	1.594E-05	1.657E-05	4.48	2.51	-4.90	5.95	0.25	-3.81
30	2.326E-05	2.139E-05	2.380E-05	2.261E-05	2.172E-05	2.256E-05	4.49	3.14	-5.16	5.50	0.24	-3.71
35	2.894E-05	2.670E-05	2.972E-05	2.828E-05	2.720E-05	2.817E-05	4.39	2.73	-5.21	5.51	0.40	-3.44
40	3.437E-05	3.145E-05	3.507E-05	3.336E-05	3.213E-05	3.328E-05	4.52	3.29	-5.48	5.39	0.25	-3.44

**Table 75. MOXGD. Isotopic Composition in Cell 24. <sup>242</sup>Pu, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>242</sup> Pu, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1	5.107E-12	4.128E-12	4.426E-12	2.923E-12	2.582E-12	3.833E-12	27.53	33.24	7.69	15.46	-23.75	-32.64
2	8.616E-11	7.323E-11	7.961E-11	6.143E-11	5.283E-11	7.065E-11	19.12	21.95	3.64	12.69	-13.06	-25.22
3	4.661E-10	3.975E-10	4.312E-10	3.493E-10	3.014E-10	3.891E-10	16.78	19.78	2.16	10.83	-10.23	-22.54
4	1.535E-09	1.329E-09	1.432E-09	1.189E-09	1.032E-09	1.303E-09	15.24	17.81	1.97	9.84	-8.81	-20.82
5	3.974E-09	3.400E-09	3.633E-09	3.062E-09	2.681E-09	3.350E-09	14.94	18.63	1.49	8.45	-8.59	-19.97
6	8.551E-09	7.336E-09	7.779E-09	6.623E-09	5.845E-09	7.227E-09	14.42	18.32	1.52	7.64	-8.36	-19.12
7	1.618E-08	1.407E-08	1.481E-08	1.270E-08	1.130E-08	1.381E-08	13.65	17.16	1.86	7.21	-8.05	-18.18
8	2.844E-08	2.473E-08	2.585E-08	2.230E-08	2.000E-08	2.426E-08	13.38	17.22	1.91	6.52	-8.08	-17.57
9	4.638E-08	4.066E-08	4.222E-08	3.662E-08	3.308E-08	3.979E-08	12.89	16.56	2.18	6.09	-7.96	-16.87
10	7.232E-08	6.340E-08	6.542E-08	5.699E-08	5.185E-08	6.200E-08	12.71	16.65	2.27	5.51	-8.07	-16.37
11	1.077E-07	9.467E-08	9.706E-08	8.489E-08	7.777E-08	9.242E-08	12.48	16.54	2.43	5.02	-8.15	-15.85
12	1.536E-07	1.363E-07	1.388E-07	1.218E-07	1.124E-07	1.326E-07	12.02	15.84	2.78	4.69	-8.09	-15.21
13	2.131E-07	1.899E-07	1.921E-07	1.693E-07	1.572E-07	1.843E-07	11.76	15.60	3.02	4.23	-8.13	-14.72
14	2.868E-07	2.571E-07	2.584E-07	2.287E-07	2.136E-07	2.489E-07	11.44	15.21	3.29	3.81	-8.12	-14.19
15	3.737E-07	3.393E-07	3.387E-07	3.010E-07	2.826E-07	3.271E-07	10.94	14.27	3.73	3.56	-7.97	-13.59
20	1.074E-06	1.002E-06	9.754E-07	8.827E-07	8.415E-07	9.551E-07	9.77	12.41	4.95	2.12	-7.59	-11.89
25	2.265E-06	2.149E-06	2.059E-06	1.886E-06	1.808E-06	2.034E-06	9.22	11.40	5.70	1.27	-7.28	-11.09
30	3.999E-06	3.826E-06	3.629E-06	3.345E-06	3.212E-06	3.602E-06	9.07	11.03	6.21	0.75	-7.15	-10.83
35	6.251E-06	6.034E-06	5.683E-06	5.256E-06	5.048E-06	5.654E-06	8.96	10.55	6.71	0.50	-7.04	-10.72
40	8.909E-06	8.742E-06	8.189E-06	7.587E-06	7.276E-06	8.140E-06	8.71	9.44	7.39	0.59	-6.80	-10.62

**Table 76. MOXGD. Isotopic Composition in Cell 24. <sup>135</sup>Xe, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>135</sup> Xe, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
1	9.606E-09	9.393E-09	9.589E-09	8.723E-09	9.432E-09	9.349E-09	3.87	2.76	0.47	2.57	-6.69	0.89
2	9.963E-09	9.681E-09	9.891E-09	9.030E-09	9.777E-09	9.668E-09	3.86	3.05	0.13	2.30	-6.60	1.12
3	1.024E-08	9.933E-09	1.015E-08	9.312E-09	1.008E-08	9.943E-09	3.72	3.01	-0.10	2.05	-6.35	1.38
4	1.044E-08	1.015E-08	1.037E-08	9.567E-09	1.034E-08	1.017E-08	3.49	2.63	-0.22	1.91	-5.95	1.64
5	1.058E-08	1.033E-08	1.055E-08	9.794E-09	1.057E-08	1.036E-08	3.24	2.10	-0.33	1.77	-5.51	1.98
6	1.072E-08	1.047E-08	1.069E-08	9.987E-09	1.075E-08	1.052E-08	3.04	1.87	-0.52	1.59	-5.10	2.15
7	1.086E-08	1.057E-08	1.079E-08	1.015E-08	1.089E-08	1.065E-08	2.91	2.01	-0.80	1.29	-4.74	2.25
8	1.088E-08	1.061E-08	1.084E-08	1.026E-08	1.098E-08	1.072E-08	2.67	1.55	-0.95	1.14	-4.22	2.47
9	1.107E-08	1.062E-08	1.084E-08	1.034E-08	1.103E-08	1.078E-08	2.83	2.70	-1.52	0.60	-4.10	2.31
10	1.094E-08	1.058E-08	1.081E-08	1.038E-08	1.102E-08	1.074E-08	2.47	1.80	-1.57	0.63	-3.43	2.56
11	1.091E-08	1.050E-08	1.076E-08	1.038E-08	1.098E-08	1.071E-08	2.41	1.87	-1.89	0.49	-3.04	2.57
12	1.087E-08	1.043E-08	1.071E-08	1.037E-08	1.091E-08	1.066E-08	2.32	1.97	-2.13	0.47	-2.69	2.38
13	1.081E-08	1.038E-08	1.067E-08	1.036E-08	1.086E-08	1.062E-08	2.22	1.81	-2.26	0.55	-2.39	2.30
14	1.076E-08	1.034E-08	1.066E-08	1.037E-08	1.083E-08	1.059E-08	2.13	1.61	-2.37	0.63	-2.12	2.25
15	1.076E-08	1.032E-08	1.066E-08	1.038E-08	1.081E-08	1.059E-08	2.12	1.66	-2.52	0.74	-1.99	2.11
20	1.087E-08	1.028E-08	1.070E-08	1.039E-08	1.082E-08	1.061E-08	2.48	2.43	-3.12	0.83	-2.09	1.96
25	1.079E-08	1.018E-08	1.067E-08	1.041E-08	1.077E-08	1.056E-08	2.50	2.14	-3.66	1.00	-1.47	1.98
30	1.054E-08	9.982E-09	1.055E-08	1.032E-08	1.063E-08	1.040E-08	2.52	1.29	-4.06	1.39	-0.79	2.17
35	1.024E-08	9.720E-09	1.036E-08	1.015E-08	1.040E-08	1.017E-08	2.67	0.64	-4.47	1.81	-0.20	2.22
40	1.007E-08	9.411E-09	1.011E-08	9.918E-09	1.011E-08	9.924E-09	3.00	1.44	-5.17	1.92	-0.06	1.87



**Table 77. MOXGD. Isotopic Composition in Cell 24. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with equilibrium concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>149</sup> Sm, atoms/barn*cm		Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean	
	TVS-M	HELIOS			TVS-M	HELIOS
0	4.183E-07	3.341E-07	3.762E-07	15.82	11.18	-11.18
1	3.658E-07	3.236E-07	3.447E-07	8.65	6.12	-6.12
2	3.172E-07	3.183E-07	3.177E-07	0.25	-0.18	0.18
3	2.734E-07	3.079E-07	2.906E-07	8.39	-5.94	5.94
4	2.356E-07	2.925E-07	2.640E-07	15.24	-10.77	10.77
5	2.038E-07	2.726E-07	2.382E-07	20.42	-14.44	14.44
6	1.777E-07	2.490E-07	2.133E-07	23.65	-16.72	16.72
7	1.567E-07	2.232E-07	1.900E-07	24.74	-17.49	17.49
8	1.404E-07	1.969E-07	1.686E-07	23.72	-16.77	16.77
9	1.277E-07	1.722E-07	1.500E-07	20.97	-14.83	14.83
10	1.181E-07	1.511E-07	1.346E-07	17.34	-12.26	12.26
11	1.111E-07	1.352E-07	1.231E-07	13.83	-9.78	9.78
12	1.066E-07	1.248E-07	1.157E-07	11.15	-7.88	7.88
13	1.041E-07	1.191E-07	1.116E-07	9.52	-6.73	6.73
14	1.029E-07	1.165E-07	1.097E-07	8.74	-6.18	6.18
15	1.025E-07	1.155E-07	1.090E-07	8.39	-5.94	5.94
20	1.049E-07	1.190E-07	1.119E-07	8.91	-6.30	6.30
25	1.067E-07	1.220E-07	1.144E-07	9.46	-6.69	6.69
30	1.070E-07	1.233E-07	1.151E-07	10.00	-7.07	7.07
35	1.060E-07	1.230E-07	1.145E-07	10.47	-7.40	7.40
40	1.042E-07	1.215E-07	1.129E-07	10.84	-7.67	7.67

**Table 78. MOXGD. Isotopic Composition in Cell 24. <sup>149</sup>Sm, atoms/barn\*cm  
(codes with zero concentration of <sup>149</sup>Sm at 0MWd/kgHM)**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>149</sup> Sm, atoms/barn*cm			Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean		
	MCU	WIMS8A	MULTICELL			MCU	WIMS8A	MULTICELL
1	6.379E-08	6.308E-08	6.226E-08	6.305E-08	1.22	1.19	0.06	-1.25
2	1.212E-07	1.196E-07	1.178E-07	1.195E-07	1.41	1.37	0.07	-1.44
3	1.610E-07	1.586E-07	1.565E-07	1.587E-07	1.41	1.45	-0.07	-1.38
4	1.844E-07	1.816E-07	1.802E-07	1.821E-07	1.19	1.29	-0.26	-1.04
5	1.949E-07	1.910E-07	1.914E-07	1.924E-07	1.11	1.28	-0.74	-0.53
6	1.936E-07	1.893E-07	1.923E-07	1.917E-07	1.14	0.97	-1.25	0.29
7	1.843E-07	1.796E-07	1.854E-07	1.831E-07	1.69	0.66	-1.92	1.25
8	1.691E-07	1.650E-07	1.731E-07	1.690E-07	2.40	0.01	-2.41	2.40
9	1.524E-07	1.488E-07	1.583E-07	1.532E-07	3.12	-0.51	-2.83	3.34
10	1.382E-07	1.342E-07	1.435E-07	1.386E-07	3.36	-0.33	-3.18	3.51
11	1.268E-07	1.232E-07	1.310E-07	1.270E-07	3.08	-0.13	-3.01	3.14
12	1.183E-07	1.164E-07	1.221E-07	1.189E-07	2.45	-0.54	-2.13	2.67
13	1.131E-07	1.130E-07	1.171E-07	1.144E-07	2.05	-1.15	-1.21	2.36
14	1.121E-07	1.117E-07	1.149E-07	1.129E-07	1.53	-0.73	-1.03	1.76
15	1.111E-07	1.116E-07	1.142E-07	1.123E-07	1.48	-1.09	-0.60	1.69
20	1.131E-07	1.164E-07	1.184E-07	1.160E-07	2.29	-2.44	0.35	2.09
25	1.175E-07	1.203E-07	1.223E-07	1.200E-07	2.00	-2.10	0.21	1.88
30	1.144E-07	1.223E-07	1.240E-07	1.202E-07	4.24	-4.82	1.69	3.13
35	1.120E-07	1.227E-07	1.239E-07	1.195E-07	5.47	-6.29	2.62	3.67
40	1.120E-07	1.219E-07	1.225E-07	1.188E-07	4.94	-5.70	2.59	3.11

**Table 79. MOXGD. Isotopic Composition in Cell 24. <sup>155</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>155</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative Deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.854E-04	1.854E-04	1.854E-04	1.854E-04	1.854E-04	1.854E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	1.734E-04	1.735E-04	1.731E-04	1.733E-04	1.732E-04	1.733E-04	0.10	0.06	0.13	-0.12	-0.02	-0.05
2	1.601E-04	1.602E-04	1.593E-04	1.598E-04	1.599E-04	1.599E-04	0.22	0.15	0.23	-0.35	-0.05	0.02
3	1.454E-04	1.456E-04	1.443E-04	1.452E-04	1.453E-04	1.452E-04	0.34	0.18	0.28	-0.59	0.04	0.09
4	1.296E-04	1.299E-04	1.285E-04	1.299E-04	1.298E-04	1.295E-04	0.46	0.05	0.28	-0.81	0.28	0.20
5	1.134E-04	1.138E-04	1.123E-04	1.142E-04	1.140E-04	1.135E-04	0.67	-0.12	0.24	-1.10	0.58	0.40
6	9.711E-05	9.772E-05	9.611E-05	9.849E-05	9.814E-05	9.751E-05	0.97	-0.42	0.22	-1.44	1.00	0.64
7	8.134E-05	8.196E-05	8.024E-05	8.306E-05	8.264E-05	8.185E-05	1.36	-0.62	0.14	-1.97	1.48	0.97
8	6.590E-05	6.684E-05	6.499E-05	6.820E-05	6.777E-05	6.674E-05	1.98	-1.26	0.15	-2.62	2.19	1.54
9	5.143E-05	5.261E-05	5.066E-05	5.416E-05	5.379E-05	5.253E-05	2.85	-2.09	0.14	-3.55	3.10	2.40
10	3.817E-05	3.953E-05	3.759E-05	4.122E-05	4.093E-05	3.949E-05	4.09	-3.35	0.12	-4.81	4.38	3.66
11	2.652E-05	2.792E-05	2.616E-05	2.968E-05	2.946E-05	2.795E-05	5.80	-5.11	-0.11	-6.38	6.19	5.41
12	1.708E-05	1.819E-05	1.690E-05	1.995E-05	1.973E-05	1.837E-05	7.80	-7.01	-0.99	-8.01	8.59	7.42
13	1.007E-05	1.084E-05	1.012E-05	1.244E-05	1.221E-05	1.114E-05	10.13	-9.55	-2.68	-9.09	11.68	9.64
14	5.608E-06	5.960E-06	5.700E-06	7.250E-06	7.026E-06	6.309E-06	12.24	-11.10	-5.53	-9.65	14.92	11.37
15	2.940E-06	3.092E-06	3.081E-06	4.019E-06	3.832E-06	3.393E-06	14.57	-13.35	-8.87	-9.19	18.45	12.95
20	2.690E-07	2.522E-07	2.938E-07	3.221E-07	3.062E-07	2.887E-07	9.75	-6.82	-12.62	1.77	11.60	6.07
25	1.919E-07	1.875E-07	2.083E-07	2.024E-07	2.019E-07	1.984E-07	4.27	-3.27	-5.49	4.98	2.02	1.77
30	1.787E-07	1.738E-07	1.932E-07	1.868E-07	1.861E-07	1.837E-07	4.12	-2.73	-5.41	5.17	1.69	1.28
35	1.638E-07	1.614E-07	1.803E-07	1.741E-07	1.727E-07	1.705E-07	4.56	-3.92	-5.31	5.80	2.12	1.31
40	1.554E-07	1.499E-07	1.684E-07	1.622E-07	1.602E-07	1.592E-07	4.40	-2.40	-5.88	5.75	1.90	0.62

**Table 80. MOXGD. Isotopic Composition in Cell 24. <sup>157</sup>Gd, atoms/barn\*cm**

Burnup MWd/kgHM	MOXGD. Isotopic Composition in Cell 24. <sup>157</sup> Gd, atoms/barn*cm					Mean	R.M.S. %	Relative deviation from Mean Value 100%*(X-Mean)/Mean				
	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL			MCU	TVS-M	WIMS8A	HELIOS	MULTICELL
0	1.948E-04	1.948E-04	1.948E-04	1.948E-04	1.948E-04	1.948E-04	0.00	0.00	0.00	0.00	0.00	0.00
1	1.616E-04	1.615E-04	1.613E-04	1.625E-04	1.620E-04	1.618E-04	0.28	-0.12	-0.16	-0.29	0.42	0.14
2	1.317E-04	1.316E-04	1.312E-04	1.333E-04	1.327E-04	1.321E-04	0.68	-0.32	-0.39	-0.69	0.94	0.46
3	1.051E-04	1.053E-04	1.045E-04	1.074E-04	1.067E-04	1.058E-04	1.15	-0.67	-0.51	-1.21	1.54	0.86
4	8.185E-05	8.240E-05	8.119E-05	8.461E-05	8.405E-05	8.282E-05	1.76	-1.17	-0.51	-1.97	2.16	1.49
5	6.194E-05	6.265E-05	6.103E-05	6.475E-05	6.437E-05	6.295E-05	2.52	-1.61	-0.47	-3.05	2.87	2.26
6	4.483E-05	4.580E-05	4.391E-05	4.771E-05	4.749E-05	4.595E-05	3.60	-2.43	-0.32	-4.44	3.84	3.35
7	3.096E-05	3.174E-05	2.976E-05	3.342E-05	3.334E-05	3.184E-05	4.93	-2.79	-0.34	-6.53	4.96	4.70
8	1.949E-05	2.040E-05	1.856E-05	2.184E-05	2.185E-05	2.043E-05	7.08	-4.57	-0.15	-9.13	6.90	6.96
9	1.089E-05	1.175E-05	1.028E-05	1.293E-05	1.297E-05	1.176E-05	10.21	-7.45	-0.12	-12.57	9.89	10.26
10	5.079E-06	5.760E-06	4.842E-06	6.649E-06	6.683E-06	5.802E-06	14.77	-12.47	-0.74	-16.55	14.58	15.18
11	1.927E-06	2.282E-06	1.915E-06	2.851E-06	2.852E-06	2.365E-06	19.76	-18.52	-3.51	-19.05	20.51	20.57
12	7.296E-07	8.097E-07	7.656E-07	1.079E-06	1.079E-06	8.925E-07	19.32	-18.25	-9.27	-14.22	20.84	20.90
13	4.059E-07	4.012E-07	4.514E-07	5.038E-07	5.225E-07	4.570E-07	12.10	-11.17	-12.20	-1.22	10.24	14.34
14	3.172E-07	3.127E-07	3.764E-07	3.655E-07	3.915E-07	3.527E-07	10.11	-10.05	-11.32	6.72	3.64	11.01
15	2.954E-07	2.851E-07	3.499E-07	3.279E-07	3.536E-07	3.224E-07	9.66	-8.38	-11.55	8.53	1.71	9.69
20	2.771E-07	2.510E-07	3.129E-07	2.898E-07	3.083E-07	2.878E-07	8.72	-3.72	-12.79	8.71	0.69	7.11
25	2.532E-07	2.373E-07	2.968E-07	2.727E-07	2.903E-07	2.701E-07	9.23	-6.25	-12.12	9.89	0.98	7.50
30	2.329E-07	2.250E-07	2.825E-07	2.589E-07	2.743E-07	2.547E-07	9.87	-8.55	-11.67	10.90	1.63	7.69
35	2.154E-07	2.134E-07	2.690E-07	2.459E-07	2.593E-07	2.406E-07	10.52	-10.48	-11.32	11.82	2.20	7.78
40	2.120E-07	2.026E-07	2.566E-07	2.338E-07	2.456E-07	2.301E-07	9.81	-7.86	-11.97	11.50	1.60	6.73

**Table 81. MOXGD. Isotopic Composition in Cell 24 Deviation from Average Value, %. Burnup=40 MWd/kgHM**

	MOXGD. Isotopic Composition in Cell 24 Deviation from Average Value, %. Burnup=40 MWd/kgHM										
	<sup>235</sup> U	<sup>236</sup> U	<sup>238</sup> U	<sup>239</sup> Pu	<sup>240</sup> Pu	<sup>241</sup> Pu	<sup>242</sup> Pu	<sup>135</sup> Xe	<sup>149</sup> Sm	<sup>155</sup> Gd	<sup>157</sup> Gd
MCU	-0.87	0.40	-0.06	1.98	-1.25	3.29	9.44	1.44	-3.77	-2.40	-7.86
TVS-M	-2.97	0.08	0.02	-2.83	5.89	-5.48	7.39	-5.17	-10.50	-5.88	-11.97
WIMS8A	1.79	-2.34	-0.07	4.43	0.86	5.39	0.59	1.92	4.68	5.75	11.50
HELIOS	1.16	3.06	0.07	-3.40	-7.15	0.25	-6.80	-0.06	4.37	1.90	1.60
MULTICELL	0.88	-1.20	0.03	-0.18	1.64	-3.44	-10.62	1.87	5.21	0.62	6.73
R.M.S. %	1.93	2.03	0.06	3.29	4.77	4.52	8.71	3.00	6.94	4.40	9.81

**Table 82. MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>235</sup>U, atoms/barn\*cm**

	MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>235</sup> U, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	3.021E-04	2.936E-04	2.853E-04	2.764E-04	2.646E-04	2.844E-04
TVS-M	2.976E-04	2.893E-04	2.794E-04	2.690E-04	2.566E-04	2.784E-04
WIMS8A	3.096E-04	3.016E-04	2.931E-04	2.836E-04	2.722E-04	2.920E-04
HELIOS	3.056E-04	2.990E-04	2.913E-04	2.829E-04	2.724E-04	2.902E-04
MULTICELL	3.090E-04	3.001E-04	2.905E-04	2.800E-04	2.676E-04	2.894E-04
Mean	3.048E-04	2.967E-04	2.879E-04	2.784E-04	2.667E-04	2.869E-04
R.M.S. %	1.64	1.73	1.93	2.15	2.44	1.93

**Table 83. MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>239</sup>Pu, atoms/barn\*cm**

	MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=40 MWd/kgHM. <sup>239</sup> Pu, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.352E-04	1.384E-04	1.439E-04	1.590E-04	2.587E-04	1.670E-04
TVS-M	1.320E-04	1.349E-04	1.400E-04	1.530E-04	2.360E-04	1.592E-04
WIMS8A	1.415E-04	1.446E-04	1.501E-04	1.648E-04	2.543E-04	1.711E-04
HELIOS	1.258E-04	1.294E-04	1.361E-04	1.524E-04	2.475E-04	1.582E-04
MULTICELL	1.671E-04	1.655E-04	1.637E-04	1.618E-04	1.595E-04	1.635E-04
Mean	1.403E-04	1.426E-04	1.468E-04	1.582E-04	2.312E-04	1.638E-04
R.M.S. %	11.40	9.79	7.36	3.45	17.72	3.29

**Table 84. MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>155</sup>Gd, atoms/barn\*cm**

	MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>155</sup> Gd, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.727E-04	1.710E-04	1.677E-04	1.594E-04	1.297E-04	1.601E-04
TVS-M	1.732E-04	1.715E-04	1.682E-04	1.595E-04	1.288E-04	1.602E-04
WIMS8A	1.721E-04	1.704E-04	1.673E-04	1.592E-04	1.276E-04	1.593E-04
HELIOS	1.721E-04	1.706E-04	1.675E-04	1.595E-04	1.293E-04	1.598E-04
MULTICELL	1.721E-04	1.705E-04	1.675E-04	1.595E-04	1.299E-04	1.599E-04
Mean	1.724E-04	1.708E-04	1.676E-04	1.594E-04	1.291E-04	1.599E-04
R.M.S. %	0.30	0.28	0.20	0.08	0.70	0.22

**Table 85. MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>157</sup>Gd, atoms/barn\*cm**

	MOXGD. Isotopic Composition in Cell 24 vs Radius, Burnup=2 MWd/kgHM. <sup>157</sup> Gd, atoms/barn*cm					
Radius, cm	0.173	0.244	0.299	0.345	0.386	
Zone No.	1	2	3	4	5	Average
MCU	1.708E-04	1.644E-04	1.513E-04	1.215E-04	5.029E-05	1.317E-04
TVS-M	1.719E-04	1.651E-04	1.518E-04	1.208E-04	4.823E-05	1.316E-04
WIMS8A	1.693E-04	1.626E-04	1.505E-04	1.220E-04	5.145E-05	1.312E-04
HELIOS	1.711E-04	1.648E-04	1.526E-04	1.237E-04	5.448E-05	1.333E-04
MULTICELL	1.713E-04	1.649E-04	1.527E-04	1.235E-04	5.095E-05	1.327E-04
Mean	1.709E-04	1.644E-04	1.518E-04	1.223E-04	5.108E-05	1.321E-04
R.M.S. %	0.56	0.61	0.61	1.03	4.43	0.68

**Table 86. MOXGD Reactivity Effects,  $100*(K_{init}-K_{fin})$**

Initial State	Final State	Comment	Burnup	MCU	TVS-M	WIMS8A	HELIOS	MULTICELL	MCNP4B	Mean	R.M.S. %
S1	S2	Xe+Sm Cb>0	0	-3.22	-3.57	-3.18	-3.28	-3.38		-3.33	-4.70
			20	-3.56	-3.31	-3.40	-3.38	-3.54		-3.44	-3.15
			40	-3.15	-2.84	-3.13	-3.10	-3.19		-3.08	-4.58
S3	S4	Boron 0.6 g/kg	0	-3.39	-3.61	-3.41	-3.45	-3.53	-3.39	-3.46	-2.57
			20	-3.79	-3.96	-3.73	-3.80	-3.89		-3.83	-2.32
			40	-4.04	-4.05	-3.85	-3.96	-4.02		-3.98	-2.10
S3	S2	T fuel Cb>0	0	1.72	1.62	1.81	1.75	1.86	1.69	1.74	4.90
			20	1.44	1.46	1.68	1.65	1.54		1.55	6.88
			40	1.39	1.30	1.46	1.51	1.36		1.40	5.76
S4	S5	T all Cb=0	0	-7.92	-7.64	-8.14	-7.98	-7.66	-8.27	-7.93	-3.18
			20	-7.34	-6.58	-7.37	-6.97	-6.90		-7.03	-4.68
			40	-5.89	-5.00	-5.75	-5.27	-5.16		-5.41	-7.14



**Table 87. UGD Variant. Fission Rates Distribution. Max. R.M.S.  
Over All the Pins (%) and Corresponding Pin N vs Burnup**

		Burnup MWd/kgHM										
		0	2	4	6	8	10	12	14	15	20	40
Mean Value	Maximal R.M.S.	1.91	2.23	2.04	1.95	1.35	0.91	0.91	1.00	0.87	0.85	1.26
	Pin N	63	35	24	24	24	1	1	1	1	19	6
	Fission Rate	0.987	0.443	0.560	0.697	0.822	1.052	1.049	1.048	1.046	0.978	0.980
MCU	Deviation from Mean Value	1.85	-0.38	-0.82	-0.88	-0.41	0.31	0.48	0.94	0.41	-1.29	-2.13
	Fission Rate	1.005	0.441	0.555	0.691	0.819	1.055	1.054	1.058	1.05	0.965	0.959
TVS-M	Deviation from Mean Value	0.63	-1.51	-1.36	-0.16	1.05	-0.54	-0.57	-0.68	-0.55	0.55	0.73
	Fission Rate	0.993	0.436	0.552	0.696	0.831	1.046	1.043	1.041	1.04	0.983	0.987
WIMS8A	Deviation from Mean Value	1.14	3.33	3.52	3.32	1.75	-1.31	-1.33	-1.41	-1.26	0.92	1.01
	Fission Rate	0.998	0.457	0.579	0.720	0.837	1.038	1.035	1.033	1.033	0.987	0.990
HELIOS	Deviation from Mean Value	-0.61	0.93	-0.07	-0.51	-0.91	0.73	0.70	0.58	0.71	-0.28	-0.08
	Fission Rate	0.981	0.447	0.559	0.694	0.815	1.059	1.056	1.054	1.053	0.975	0.979
MULTICELL	Deviation from Mean Value	-3.01	-2.37	-1.27	-1.77	-1.48	0.82	0.71	0.57	0.69	0.11	0.47
	Fission Rate	0.957	0.432	0.553	0.685	0.810	1.060	1.056	1.054	1.053	0.979	0.985

**Table 88. UGD Variant. Fission Rates Distribution. Max. R.M.S.  
Over All the Pins (%) and Corresponding Pin N for Different States**

		Burnup MWd/kgHM														
		State - S1			State - S2			State - S3			State - S4			State - S5		
		0	20	40	0	20	40	0	20	40	0	20	40	0	20	40
Mean Value	Maximal R.M.S.	1.91	0.85	1.26	2.55	0.88	1.17	2.25	1.13	1.39	2.37	0.96	1.36	2.48	1.37	1.80
	Pin N	63	19	6	35	1	6	35	64	6	35	58	6	35	1	6
	Fission Rate	0.987	0.978	0.980	0.324	1.040	0.982	0.323	1.041	0.981	0.312	0.967	0.980	0.220	1.068	0.970
MCU	Deviation from Mean Value	1.85	-1.29	-2.13	-1.75	0.77	-1.95	-0.86	2.00	-2.37	-1.38	-1.47	-2.32	-0.96	1.54	-2.82
	Fission Rate	1.005	0.965	0.959	0.318	1.048	0.963	0.32	1.062	0.958	0.308	0.953	0.957	0.218	1.084	0.943
TVS-M	Deviation from Mean Value	0.63	0.55	0.73	-1.44	-0.77	0.70	-1.48	-0.40	0.79	-1.38	0.50	0.75	-1.41	0.23	0.07
	Fission Rate	0.993	0.983	0.987	0.319	1.032	0.989	0.318	1.037	0.989	0.308	0.972	0.987	0.217	1.07	0.971
WIMS8A	Deviation from Mean Value	1.14	0.92	1.01	3.76	-1.13	0.98	3.32	-0.84	1.09	3.52	1.13	1.14	3.82	-1.67	1.53
	Fission Rate	0.998	0.987	0.990	0.336	1.028	0.992	0.333	1.032	0.992	0.323	0.978	0.991	0.229	1.050	0.985
HELIOS	Deviation from Mean Value	-0.61	-0.28	-0.08	1.52	0.63	-0.14	1.21	-0.30	-0.03	1.34	-0.11	-0.04	1.00	1.02	-0.36
	Fission Rate	0.981	0.975	0.979	0.329	1.047	0.981	0.327	1.038	0.981	0.317	0.966	0.979	0.222	1.078	0.967
MULTICELL	Deviation from Mean Value	-3.01	0.11	0.47	-2.09	0.50	0.40	-2.19	-0.45	0.52	-2.11	-0.05	0.47	-2.46	-1.13	1.58
	Fission Rate	0.957	0.979	0.985	0.317	1.045	0.986	0.316	1.037	0.986	0.306	0.967	0.984	0.215	1.056	0.986

**Table 89. MOXGD Variant. Fission Rates Distribution. Max. R.M.S.  
Over All the Pins (%) and Corresponding Pin N vs Burnup**

		Burnup MWd/kgHM										
		0	2	4	6	8	10	12	14	15	20	40
Mean Value	Maximal R.M.S.	1.82	1.65	1.49	1.51	1.86	2.41	2.93	2.97	2.89	2.19	1.59
	Pin N	1	36	36	45	35	35	35	35	35	35	35
	Fission Rate	0.991	1.093	1.100	1.119	0.521	0.590	0.664	0.730	0.756	0.828	0.954
MCU	Deviation from Mean Value	1.13	-2.29	-1.81	-1.58	-0.72	-0.42	-0.58	-0.54	-0.76	-0.28	-0.91
	Fission Rate	1.002	1.068	1.08	1.101	0.517	0.588	0.66	0.726	0.75	0.826	0.945
TVS-M	Deviation from Mean Value	-0.89	0.64	0.37	0.20	1.97	2.97	3.93	3.98	3.87	2.37	1.09
	Fission Rate	0.982	1.1	1.104	1.121	0.531	0.608	0.69	0.759	0.785	0.848	0.964
WIMS8A	Deviation from Mean Value	-2.78	-0.97	-1.04	-0.97	0.29	-0.22	-0.66	-1.07	-1.12	-1.18	-0.83
	Fission Rate	0.963	1.082	1.089	1.108	0.522	0.589	0.659	0.722	0.747	0.819	0.946
HELIOS	Deviation from Mean Value	0.92	0.64	0.45	0.00	-2.80	-3.55	-4.03	-3.94	-3.70	-2.87	-1.58
	Fission Rate	1.000	1.100	1.105	1.119	0.506	0.570	0.637	0.701	0.728	0.805	0.939
MULTICELL	Deviation from Mean Value	1.62	1.98	2.03	2.36	1.26	1.22	1.34	1.58	1.71	1.95	2.23
	Fission Rate	1.007	1.115	1.122	1.145	0.527	0.598	0.673	0.742	0.769	0.845	0.975

**Table 90. MOXGD Variant. Fission Rates Distribution. Max. R.M.S. Over All the Pins (%) and Corresponding Pin N for Different States**

		Burnup MWd/kgHM														
		State - S1			State - S2			State - S3			State - S4			State - S5		
		0	20	40	0	20	40	0	20	40	0	20	40	0	20	40
Mean Value	Maximal R.M.S.	1.82	2.19	1.59	1.79	2.19	1.60	1.87	2.07	1.47	1.83	2.09	1.57	2.21	3.20	2.99
	Pin N	1	35	35	1	35	35	45	35	35	1	35	56	1	56	56
	Fission Rate	0.991	0.828	0.954	0.990	0.827	0.954	1.109	0.827	0.955	0.999	0.823	0.909	1.031	0.902	0.918
MCU	Deviation from Mean Value	1.13	-0.28	-0.91	0.70	-0.60	-1.09	-2.90	-0.39	-0.91	0.55	-0.80	2.43	2.10	2.87	2.36
	Fission Rate	1.002	0.826	0.945	0.997	0.822	0.944	1.077	0.824	0.946	1.004	0.816	0.931	1.053	0.928	0.94
TVS-M	Deviation from Mean Value	-0.89	2.37	1.09	-0.82	2.43	1.01	0.88	2.27	0.87	-0.75	2.48	-0.76	1.03	1.65	1.82
	Fission Rate	0.982	0.848	0.964	0.982	0.847	0.964	1.119	0.846	0.963	0.991	0.843	0.902	1.042	0.917	0.935
WIMS8A	Deviation from Mean Value	-2.78	-1.18	-0.83	-2.71	-0.99	-0.62	-0.55	-0.94	-0.58	-2.77	-0.76	-0.22	-3.24	-0.91	-0.62
	Fission Rate	0.963	0.819	0.946	0.963	0.819	0.948	1.103	0.819	0.949	0.971	0.816	0.907	0.998	0.894	0.913
HELIOS	Deviation from Mean Value	0.92	-2.87	-1.58	0.99	-2.83	-1.57	0.51	-2.76	-1.50	1.07	-2.66	0.34	1.38	1.57	1.39
	Fission Rate	1.000	0.805	0.939	1.000	0.804	0.939	1.115	0.804	0.940	1.009	0.801	0.912	1.046	0.916	0.931
MULTICELL	Deviation from Mean Value	1.62	1.95	2.23	1.84	1.99	2.27	2.06	1.81	2.12	1.90	1.73	-1.80	-1.26	-5.17	-4.95
	Fission Rate	1.007	0.845	0.975	1.008	0.843	0.976	1.132	0.842	0.975	1.018	0.837	0.893	1.018	0.856	0.873

*Appendix A*

**BENCHMARK SPECIFICATION**



## LEU AND MOX VVER CALCULATIONAL BENCHMARKS SPECIFICATION

Systems to be calculated are as follows:

- Uniform LEU fuel assembly with 12 U-Gd Burnable Absorbers (BA) rods (UGD variant);
- Profiled MOX fuel assembly with 12 U-Gd BA rods (MOXGD variant).

### 1. Material specification

**Table A.1. Material description**

Material Name	Comment *	Isotopic content, (atoms/barn cm <sup>3</sup> )			
<b>Fuel materials</b>					
U1	LEU fuel of 3.7 w/o enrichment	<sup>235</sup> U	8.6264E-4	<sup>16</sup> O	4.6063E-2
		<sup>238</sup> U	2.2169E-2		
PU1	MOX fuel with 2.0 w/o of fissile Pu	<sup>235</sup> U	4.2672E-5	<sup>239</sup> Pu	4.2414E-4
		<sup>238</sup> U	2.1025E-2	<sup>240</sup> Pu	2.7250E-5
		<sup>16</sup> O	4.3047E-2	<sup>241</sup> Pu	4.5228E-6
PU2	MOX fuel with 3.0 w/o of fissile Pu	<sup>235</sup> U	4.2209E-5	<sup>239</sup> Pu	6.3621E-4
		<sup>238</sup> U	2.0797E-2	<sup>240</sup> Pu	4.0875E-5
		<sup>16</sup> O	4.3045E-2	<sup>241</sup> Pu	6.7842E-6
PU3	MOX fuel with 4.2 w/o of fissile Pu	<sup>235</sup> U	4.1652E-5	<sup>239</sup> Pu	8.9071E-4
		<sup>238</sup> U	2.0522E-2	<sup>240</sup> Pu	5.7225E-5
		<sup>16</sup> O	4.3043E-2	<sup>241</sup> Pu	9.4980E-6
GD1	LEU fuel of 3.6 w/o of <sup>235</sup> U containing 4 w/o of Gd <sub>2</sub> O <sub>3</sub>	<sup>235</sup> U	7.2875E-4	<sup>155</sup> Gd	1.8541E-4
		<sup>238</sup> U	1.9268E-2	<sup>156</sup> Gd	2.5602E-4
		<sup>16</sup> O	4.1854E-2	<sup>157</sup> Gd	1.9480E-4
		<sup>152</sup> Gd	2.5159E-6	<sup>158</sup> Gd	3.0715E-4
		<sup>154</sup> Gd	2.7303E-5	<sup>160</sup> Gd	2.6706E-4
<b>Non-fuel materials</b>					
CL1	Zirconium alloy	Zr	4.259E-2	Hf	6.597E-6
		Nb	4.225E-4		
MOD1	Moderator, 0.6 g/kg of boron, T <sub>m</sub> =575K, γ= 0.7235 g/cm <sup>3</sup>	H	4.843E-2	<sup>10</sup> B	4.794E-6
		<sup>16</sup> O	2.422E-2	<sup>11</sup> B	1.942E-5
MOD2	Moderator, without boron, T <sub>m</sub> =575K, γ= 0.7235 g/cm <sup>3</sup>	H	4.843E-2	<sup>10</sup> B	0.0
		<sup>16</sup> O	2.422E-2	<sup>11</sup> B	0.0
MOD3	Moderator, without boron, T <sub>m</sub> =300K, γ= 1.0033 g/cm <sup>3</sup>	H	6.717E-2	<sup>10</sup> B	0.0
		<sup>16</sup> O	3.358E-2	<sup>11</sup> B	0.0

\* The information in this column is given only as comments. For calculations it is necessary to use the data from "Isotopic content" column.

## 2. Geometry description

Let us specify the following geometric objects:

- $C_n$  –  $n$ -zones elementary cell;
- $K1$  – uniform assembly with 12 Gd pins (331 elementary cells of 4 types);
- $K2$  – profiled assembly with 12 Gd pins (331 elementary cells of 6 types).

*$n$ -zones elementary cell  $C_n$ :*

1-st zone –  $\text{Cyl}(r_0, r_1=0.386 \text{ cm})$ ;

$j$ -th zone –  $\text{Cyl}(r_0, r_j) \setminus \text{Cyl}(r_0, r_{j-1})$ ,  $j=1, \dots, n-1$ ;

$n$ -th zone –  $\text{Hex}(r_0, h=1.275 \text{ cm}) \setminus \text{Cyl}(r_0, r_{n-1})$ ;

where  $\text{Cyl}(r_0, r_j)$  – cylinder of radius  $r_j$  with Center at point  $r_0$ ;  
 $\text{Hex}(r_0, h=1.275 \text{ cm})$  – hexagon with Center at point  $r_0$ ; and  
 across flats dimension  $h=1.275 \text{ cm}$ .

*Assembly  $K1$  ( uniform assembly containing 12 Gd BA rods):*

It is a “geometric container”  $\text{Hex}(r_0, H=23.6 \text{ cm})$ , which contains 331 elementary cells  $C_n$  of 4 types (see Figure A.1).

*Assembly  $K2$  ( profiled assembly containing 12 Gd BA rods):*

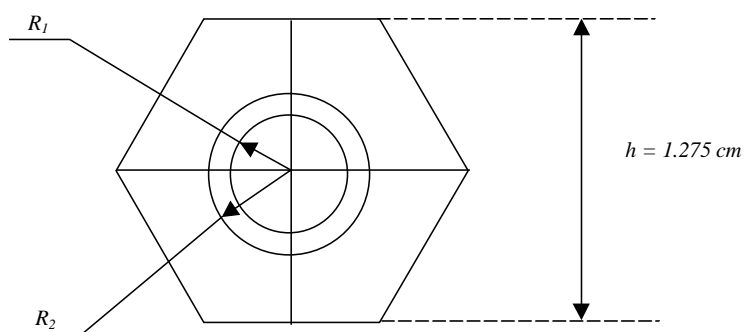
It is a “geometric container”  $\text{Hex}(r_0, H=23.6 \text{ cm})$ , which contains 331 elementary cells  $C_n$  of 6 types (see Figure A.2).

Infinite lattices of Assemblies  $K1$  and  $K2$  have assembly pitch 23.6 cm. The cell in assemblies may be as follows:

**Table A.2. Description of cell types geometry**

Cells name	Zones radius (cm)
Fuel cell	$R_1 = 0.386$ $R_2 = 0.4582$
Central tube cell	$R_1 = 0.48$ $R_2 = 0.5626$
Guide tube cell	$R_1 = 0.545$ $R_2 = 0.6323$





It should be mentioned that all cells of all types have the same outer dimension  $h=1.275$ . Fuel cell may contains one of the following materials:

- Fuel cell in UGD assembly – U1 or GD1;
- Fuel cell in MOXGD assembly – PU1, PU2, PU3 or GD1.

### 3. Description of a set of states to be calculated

Calculations of the cell and the assembly neutronic parameters should be performed for several states, which differ from each other by moderator and fuel temperature and so on. The all possible state parameters are given in Table A.3. All states from Table A.3 should be calculated for all variants is specified in Table A.4.

**Table A.3. State parameters**

State	Comment	Fuel zones temp., K	Non-fuel zones temp., K	Moderator material	$^{135}\text{Xe}$ , $^{149}\text{Sm}$
S1	Operating poisoned state	1027	575	MOD1	Eq.
S2	Operating non-poisoned state	1027	575	MOD1	0.0
S3	Hot state	575	575	MOD1	0.0
S4	Hot state without boron acid	575	575	MOD2	0.0
S5	Cold state	300	300	MOD3	0.0

Burnup calculation (with power density equalled to  $108 \text{ MWt/m}^3$ ) should be performed *for the state S1 only*. The nuclides content obtained in this calculation should be used for other states calculation (except for  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$ ,  $\rho(^{135}\text{Xe})=\rho(^{149}\text{Sm})=0$ ).

All calculations should be performed with zero current boundary conditions and zero axial leakage (infinite lattice of assemblies).

Eq. means  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  equilibrium values.

#### 4. Parameters to be calculated

For the *state S1* the following parameters should be calculated as a function of assembly average burnup (burnup step – **1 MWd/kgHM** in the interval **0-15 MWd/kgHM** and **5 MWd/kgHM** in the interval **15-40 MWd/kgHM**):

1.  $K_{inf}$ ;
2. average fuel concentrations of  $^{232}\text{U}$ ,  $^{235}\text{U}$ ,  $^{236}\text{U}$ ,  $^{238}\text{U}$ ,  $^{236}\text{Pu}$ ,  $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{241}\text{Pu}$ ,  $^{242}\text{Pu}$ ,  $^{137}\text{Ce}$ ,  $^{244}\text{Cm}$ ,  $^{135}\text{Xe}$ ,  $^{149}\text{Sm}$ , total fission products without  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  as well as  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$  (if they are contained) in the cells 1 and 24 (see Figure 3);
3. averaged over all the fuel in assembly concentrations of  $^{232}\text{U}$ ,  $^{235}\text{U}$ ,  $^{236}\text{U}$ ,  $^{238}\text{U}$ ,  $^{236}\text{Pu}$ ,  $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{241}\text{Pu}$ ,  $^{242}\text{Pu}$ ,  $^{137}\text{Ce}$ ,  $^{244}\text{Cm}$ ,  $^{135}\text{Xe}$ ,  $^{149}\text{Sm}$ , total fission products without  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$  as well as  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$  (if they are contained) in assembly (see Figure 3);
4.  $^{235}\text{U}$ ,  $^{239}\text{Pu}$ ,  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$  zone averaged concentrations in the cell 24 (5 annular zones of equal volume. Zone 1 - inner and zone 5 – outer).

In addition, the following results are required at burnups 0, 2, 4, 6, 8, 10, 12, 14, 15, 20, 40 MWd/kgHM:

1. pin by pin fission rate distribution (normalised to 1, that is sum total fission rate over assembly must be equal to 1) and local peaking factor. Pins numeration is given in Figure 3 (see below).

For *states S2-S5* only parameters mentioned in items a) and e) should be calculated at burnups 0, 20, 40 **MWd/kgHM**. States S2-S5 in 20, 40 **MWd/kgHM** burnup points should be calculated using isotopic composition obtained in burnup calculation for state S1.

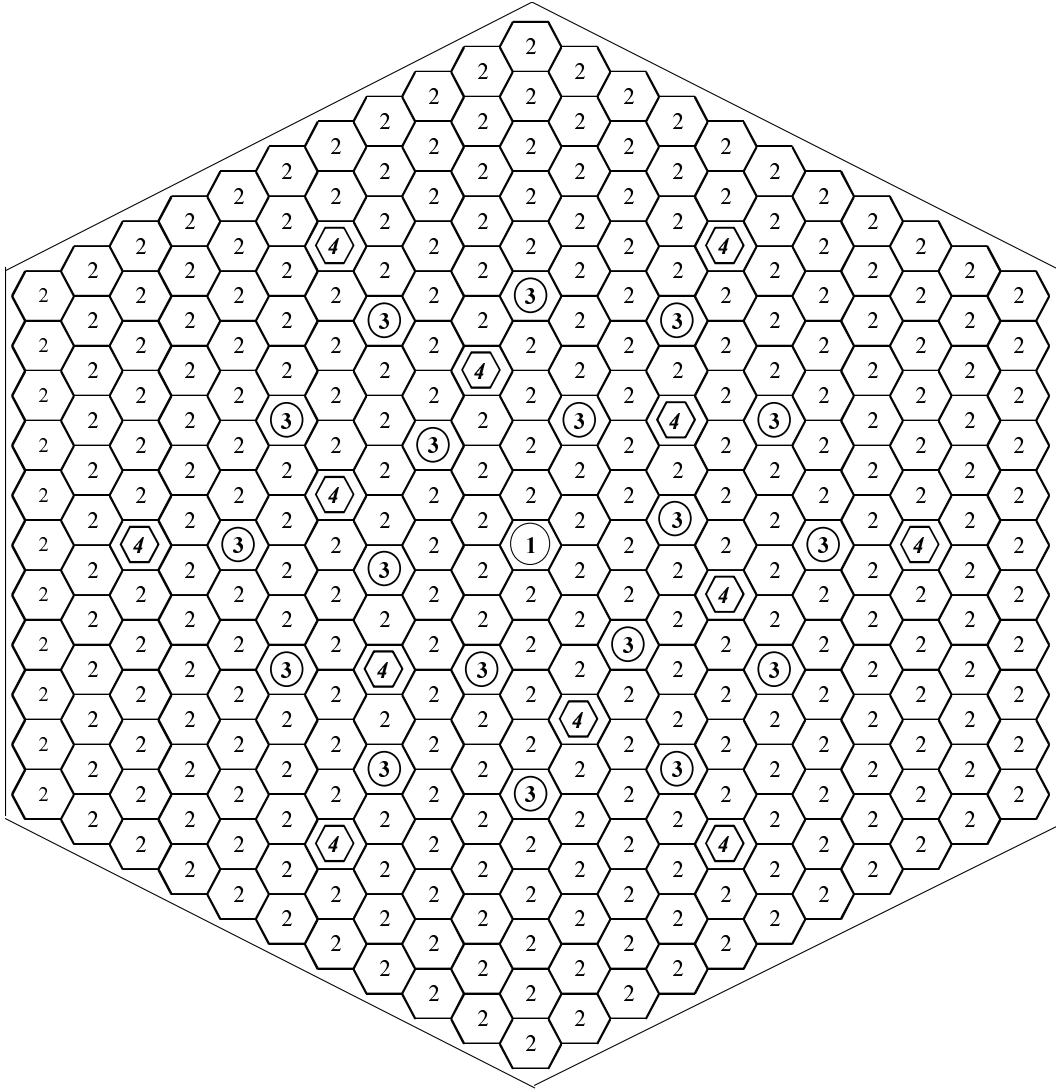
5. Description of sets of calculation variants

Table A.4. Set of calculation variants

Var	Comment	General geometry type	Cell type	Zone number	Zone material
UGD	LEU fuel assembly of 3.7 w/o enrichment containing 12 Gd pins	K1	1 – Central tube cell	1	MOD#
				2	CL1
				3	MOD#
			2 – Fuel cell (with U1)	1	U1
				2	CL1
				3	MOD#
			3 – Guide tube cell	1	MOD#
				2	CL1
				3	MOD#
			4 – Fuel cell (with GD1)	1	GD1
				2	CL1
				3	MOD#
MOXGD	Profiled MOX fuel assembly containing 12 Gd pins	K2	1 – Central tube cell	1	MOD#
				2	CL1
				3	MOD#
			2 – Fuel cell (with PU3)	1	PU3
				2	CL1
				3	MOD#
			3 – Guide tube cell	1	MOD#
				2	CL1
				3	MOD#
			4 – Fuel cell (with PU2)	1	PU2
				2	CL1
				3	MOD#
			5 – Fuel cell (with PU1)	1	PU1
				2	CL1
				3	MOD#
			6 – Fuel cell (with GD1)	1	GD1
				2	CL1
				3	MOD#

# material depends on state number and is given in Table A.3.

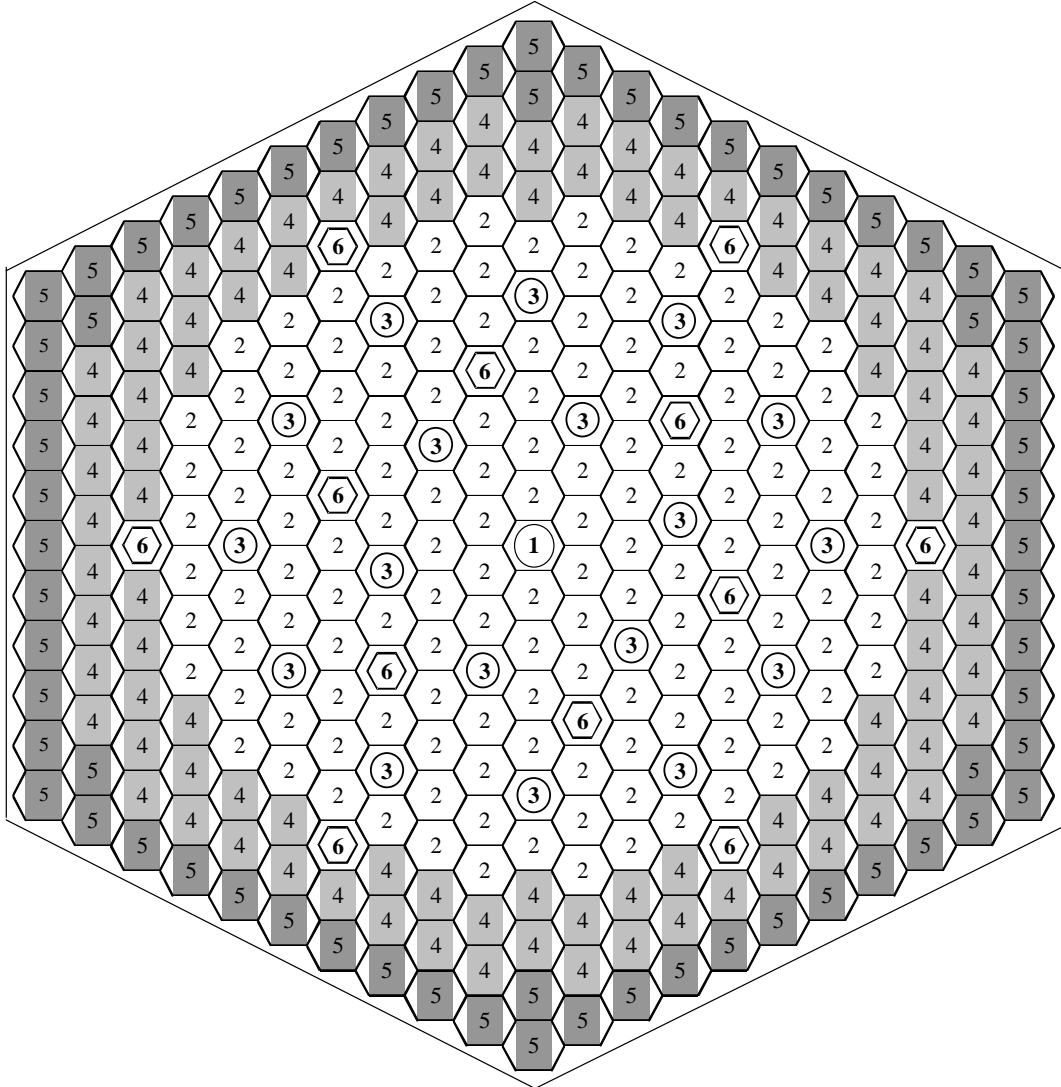
**Figure A.1. Cartogram of the Uniform LEU fuel assembly with 12 Gd BA rods.  
Assembly type K1, Variant UGD**



Cell types:

1. Central tube cell.
2. Fuel cell (with U1).
3. Guide tube cell.
4. Fuel cell (with GD1).

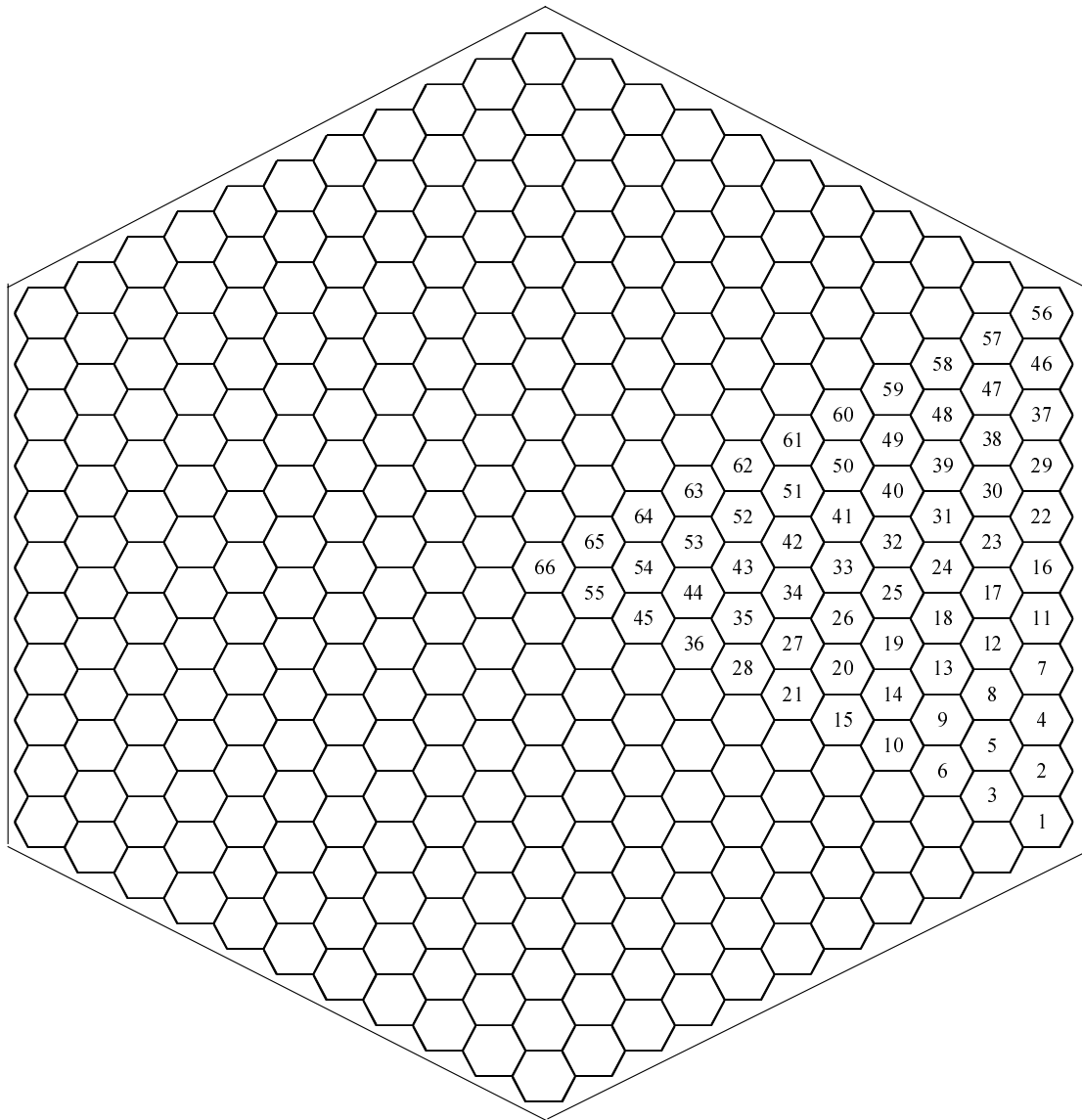
**Figure A.2. Cartogram of the Profiled MOX fuel assembly with 12 Gd BA rods.  
Assembly type K2. Variant MOXGD**



Cell types:

1. Central tube cell.
2. Fuel cell (with PU3).
3. Guide tube cell.
4. Fuel cell (with PU2).
5. Fuel cell (with PU1).
6. Fuel cell (with GD1).

**Figure A.3. Cell numeration in the fuel assemblies to presenting fission rate distribution**



*Appendix B*

**CALCULATIONAL DETAILS PROVIDED BY THE PARTICIPANTS**





## MCU-REA CODE

The MCU-REA computer code was used in the calculations.

MCU-REA is a general-purpose continuous energy Monte Carlo code for solving the neutron transport problems including the depletion ones. It is used with both pointwise and step function representations of cross sections.

For neutron-nuclear interaction modelling the code permits to take into account:

- the laws of inelastic scattering from evaluated nuclear data files;
- cross section temperature dependence in unresolved resonance region in subgroup approximation;
- Doppler broadening of resonance cross sections in resolved resonance region using infinite number of energetic points;
- scattering law  $S(\alpha, \beta)$  depending on temperature.

The geometry module of the code is the combination of the following approaches:

- combinatorial method, body technique, hierarchy description;
- special algorithm to model fuel elements with thousands of micro-spheres included in to one fuel element.

The hierarchy option permits one to describe full scale 3-D reactor model (VVER, PWR, BWR, RBMK, etc.) using only 0.25 MB of RAM.

To model the change of isotopic composition of reactor materials the special module was developed. It permits one to take into account 39 actinides and 165 fission products.

The commercially available versions of the code and library of the developer Russian Research Center “Kurchatov Institute” have been used.

More than 500 of 3D benchmark experiments published in the Handbook of International Criticality Safety Evaluation Benchmark Project and Russian literature were calculated. The discrepancy between calculation and experiment results lied inside the experiment errors estimated. The full scale 3-D models of the different reactors (transport, production, space, research, energetic VVER and RBMK) are elaborated and used widely to estimate their parameters and to verify the design codes.

MCU data libraries is DLC/MCUDAT-2.1 based on:

- ENDF/B-VI; JENDL-3.2; BROND.
- MCU group own evaluations and compilations.
- LIPAR – parameters of the fully resolved resonances.

- BFS – phonon spectra library including the ENDF data.
- KORT – cross-sections for  $E=0.0253$  eV, resonance integrals etc.

The following data processing codes were used to obtain the cross-section data used:

- NJOY.
- GRUCON (IPPE, Russia).
- MCU group elaborations.
- TERMAC – generation of the  $S(\alpha,\beta)$  multigroup library.
- STEN – generation of the  $S(\alpha,\beta)$  pointwise library.
- RAPAN – generation of the resonance cross sections.
- SET OF MODULES for evaluating and analysing the resonance parameters.

MCU  $K_{inf}$  results are calculated with statistical error less than 0.1% ( $1\sigma$ ).

## TVS-M CODE

The code is intended for generation of few-group neutron constant libraries for codes BIPR and PERMAK which include the multiparametric dependencies of cross-sections for FAs and their constituent cells (fuel rods, absorber rods, burnable absorber rods and other cells) as well as derivatives of these cross sections as functions of reactor state and fuel burnup.

### *Nuclear data libraries*

The nuclear data library is based on the same files of estimated nuclear data as precision code MCU-RFFI, which uses the Monte Carlo method.

In the epithermal energy region ( $E > 0.625$  eV) the calculation is based on slightly modified micro-cross section library BNAB (see, e.g., [1]) with 24 energy groups. The nuclide libraries can contain both the group and subgroup constants and for some nuclides with temperature dependence.

For the calculation of neutron spectrum in the energy region of resolved resonances  $E_n < 1$  keV (15 and higher BNAB group) the library includes files of resonance parameters of individual nuclides obtained on the base of the LIPAR library. For all fissile nuclei the library contains prompt and delayed neutron spectra, group  $\beta$  values and decay constants for six groups of delayed neutrons.

The thermal energy region is divided into 24 groups. For the nuclides with the “1/v” cross-section behaviour the absorption cross sections at 2200 m/s are used, for the rest ones the group values of the absorption, scattering and fission cross sections are specified. In addition, for oxygen and carbon the scattering matrices obtained in terms of gas model at 300, 373, 473, 558, 623K are given. For hydrogen bonded in water molecule the scattering matrix is obtained from the ENDF/B recommended data in terms of the Koppel model at the same temperatures.

The library contains the files of cross sections and yields of 98 fission products including  $^{135}\text{Xe}$  and  $^{149}\text{Sm}$ . The files of fission product yields are based on the ENDF/B-VI data [2].

### *Uniform lattice*

In the energy region of epithermal neutrons ( $10.5\text{MeV} < E_n < 0.625$  eV, BNAB groups 1-24) a detailed calculation of group spatial-energy distribution of neutron flux is performed. Each group is divided into an arbitrary number of intervals equal in lethargy, and then the calculation is performed at each point of group division. The of elastic scattering process is calculated without use of any approximations when the scattering is isotropic in the inertia centre system (i.e.s.), otherwise the scattering anisotropy is taken into account by the term not higher than linear in cosine of scattering angle. The slowing down due to inelastic scattering is taken into account via the matrix of inelastic transitions under the assumption of uniform energy distribution of neutrons scattering into the given group.

For nuclides with the subgroup description of cross sections the heterogeneous subgroup calculation of their micro cross sections is performed.

In the energy region of resolved resonances (groups 13-24 BNAB) for resonance nuclides the calculation of all types of cross sections is performed with the use of nuclide resonance parameters. In so doing it is possible to take into account temperature dependence of resonance cross sections.

In the thermal energy region the standard calculation technique is used. It suggests solving the multi-group equation of thermalisation with the neutron sources from the epithermal energy region formed when calculation for this energy range was performed. The model of the thermalisation matrix construction is described above.

Calculation of neutron spatial distribution is carried out by dividing the cells into an arbitrary number of annular material zones and by the use of the passing through probability (PTP) method. In the calculation the actual form of the cell boundary is taken into account.

The calculation of the point kinetics parameters  $\beta_{eff}$ ,  $\ell$  is made by the standard formulas using the value function  $\psi$  with respect to  $K_{eff}$  and with six groups of delayed neutrons.

The calculation of the fuel nuclide composition during fuel burnup is performed for heavy nuclides from  $^{232}\text{Th}$  to  $^{244}\text{Cm}$  and for 98 fission products from  $^{82}\text{Kr}$  to  $^{163}\text{Dy}$ . The burnup equations can be solved both by the Runge-Kutta method.

### ***Calculation of supercells and fuel assemblies***

For the determination of FA neutronic characteristics the code uses the diffusion fine-mesh calculation with an arbitrary number of groups from 4 to 48 and with the mesh width equal to the pitch between fuel rods in the FA. For the boundary mesh cells the compression coefficient is used. Along with the standard six-point scheme the refined scheme whose principles of construction are described in can be used. The use of this scheme permits keeping of the *accurate* (*i.e.* obtained from solving of transport equation for the cell) connection between cell averaged neutron flux and values of flux and current at the cell boundary. In this way it becomes possible to avoid errors peculiar to the standard calculation scheme associated with the finite size and heterogeneous structure of mesh points.

Each mesh point pertains to a definite type: fuel rod, cell with absorber rod, cell corresponding to the gap between FAs, etc. The constants for the background type are always calculated in the asymptotic mode, *i.e.* as for the uniform fuel cell. The constants for non-fuel cells are calculated in the mode of supercell. For the non-background fuel cells including those with the U-Gd fuel rods the calculation can be performed both in the asymptotic and supercell modes. The homogenised background cell is always considered as the external zone of supercell.

### ***References***

- [1] Abagyan, L.P., N.O. Bezazyents, N.N. Nikolaev, A.M. Tsiboulia, "Neutron Group Constants for Reactors and Shicloling Calculations", Atomizdat, Moscow, 1981.
- [2] Rose, P.F., "GNDF-201, ENDF/B-VI Summary Documentation", BNL-NSC-17541, 4<sup>th</sup> Edition, 1991.

## WIMS8A CODE

### *Name of the computer code(s) used, description of method and references*

Name: WIMS8A, developed by AEA Technology.

Type of calculation: heterogeneous calculation.

Theory used: transport.

Method used: characteristics method.

#### 1. Basic data library version:

WIMS97 library based on JEF-2.2, composed of 172 energy groups.

#### 2. Data processing code/method used to obtain the cross section data used:

WIMS97 is the default data library used by the WIMS codes.

#### 3. Spectral calculations and data reduction methods used:

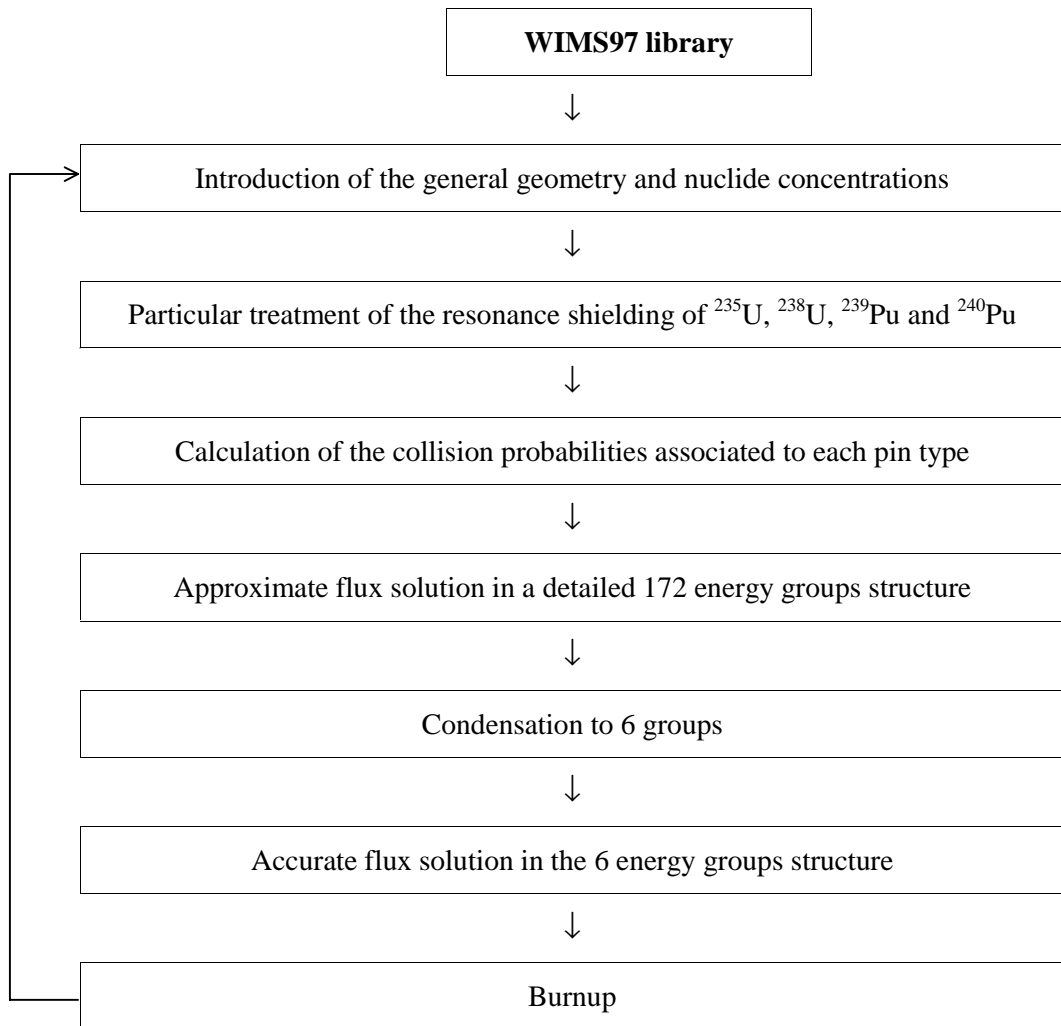
The calculation scheme is divided into seven principal modules (Figure B.1.).

### *References*

- [1] Halsall, M.J., "The WIMS Characteristics Method in a Subgroup Resonance Treatment", *Reactor Physics & Reactor Computations*, Tel Aviv, January 1994.
- [2] Halsall, M.J., and J.L. Hutton, and R.D. Fry, and C.J. Dean and D.J. Powney, "An Introduction to WIMS6", *ANS Topical Meeting*, Knoxville, April 1994.
- [3] Hutton, J.L., and A.W. Butement, and S. Watt, and S.D. Shatbolt, "Applications of a Monte Carlo Whole Core Microscopic Depletion Method" (extended version), *ANS Meeting*, Philadelphia, 1995.
- [4] Halsall, M.J., "The WIMS Subgroup Method for Resonance Absorption", *ANS Meeting*, Philadelphia, 1995.
- [5] Halsall, M.J., "WIMS7, an Overview", *PHYSOR Meeting*, Japan, 1996.
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- [7] Dean, C. J., and R.J. Perry, and A.W. Butement and J.L. Hutton, "A Comparison of UK Codes for Analysing DIMPLE S01A with JEF2.2 Data", *PHYSOR Meeting*, Japan, 1996.

- [8] Webster, E.B., “The Treatment of Fuel Depletion in the Reactor Physics Code WIMS7 and the Nuclide Inventory Code FISPIN7”, *PHYSOR Meeting*, Japan, 1996.
- [9] Powney, D.J. and B.M. Franklin, “LWR Modelling Capabilities of WIMS7 and the Application of WIMS7 and PANTHER to KALININ VVER 1000 Benchmark”, *PHYSOR Meeting*, Japan, 1996.
- [10] Halsall, M.J., “WIMS8 – Speed with Accuracy”, *PHYSOR Meeting*, Long Island, 1998.
- [11] Armishaw, M.J., and J.L. Hutton, and N.R. Smith and J. Sidell, “Features of the Monte Carlo Code MONK8”, *PHYSOR Meeting*, Long Island, 1998.
- [12] Powney, D.J. and B.M. Franklin, “Benchmarking of Square and Hexagonal Pitch Critical Assemblies Using WIMS”, *PHYSOR Meeting*, Long Island, 1998.
- [13] Dean, C.J., and D. Hanlon and R.J. Perry, “Benchmark Calculations for Uranium 235”, *PHYSOR Meeting*, Long Island, 1998.
- [14] Powney, D.J. and B.M. Franklin, “Benchmarking of the ZR-6 Critical Assemblies Using WIMS, 8<sup>th</sup> AER Symposium on VVER Reactor Physics and Reactor Safety”, September 1998.

**Figure B.1. WIMS8A. Calculation scheme for the VVER benchmarks**

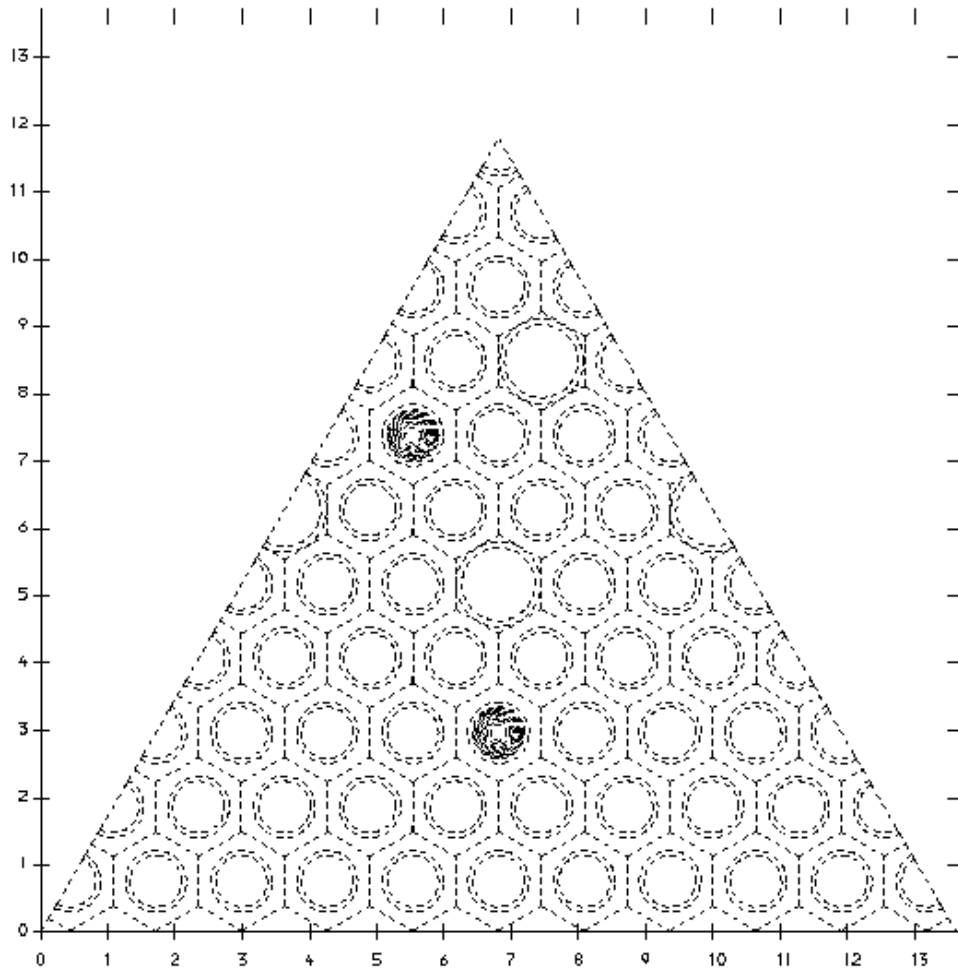


The WIMS codes allow to calculate a VVER assembly, taking advantage of the 6-fold rotational symmetry. In a first step, the global geometry is introduced and the rod types are defined: each rod type defined in the benchmark's specifications forms a rod type for the WIMS calculation, excepted for the Gd-rods which are defined as two distinct rods. That is to say that we define 5 rod types for the LEU VVER assembly (Central tube, fuel cell, guide tube, Gd rod in cell 35 and Gd rod in cell 24) and 7 rod types for the MOX VVER (Central tube, fuel cell PU3, guide tube, fuel cell PU2, fuel cell PU1, Gd rod for cell 35, Gd rod for cell 24), each rod type being characterised by its own spectrum.

A special step is devoted to the treatment of resonance shielding due to the isotopes  $^{235}\text{U}$ ,  $^{238}\text{U}$ ,  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$ .

Then the collision probabilities are calculated for each cell considered in the problem. These probabilities, along with the cross sections, permit to get an approximate flux solution in the detailed 172 energy groups structure.

**Figure B.2. WIMS8A. Explicit heterogeneous representation of the geometry, with the CACTUS module of WIMS**



A condensation of the cross sections and of the flux distribution is then performed, with the energy boundaries: 820 000; 9 118; 4.0; 0.625; 0.14 and 0 eV (usual 6 energy groups structure).

On this basis, an accurate solution of the flux distribution is calculated, by the so-called “Characteristics Method”, which is implemented through the CACTUS module of the WIMS codes.

This allows to represent explicitly the heterogeneous geometry of the problem, as showed in Figure B.2. The flux solution is finally used to deplete the materials before going back to the first step.

The burnup calculation is realised with 60 steps of 0.25 MWd/kgHM (2 substeps), followed by 20 steps of 1.25 MWd/kgHM (2 substeps), at the rating given in the specifications.

For the accurate flux solution as well as for the depletion of the materials, each cell is differentiated for the nuclide concentration, in order to catch a good picture of the peaking factor and its position all along the history of the assembly. This leads us to differentiate 59 UO<sub>2</sub> rods for the case LEU VVER, 28 PU3 rods, 18 PU2 rods and 13 PU1 rods for the case MOX VVER, as it is necessary



to distinct the half rods placed at the borders of the 1/6<sup>th</sup> assembly. Moreover the Gd rods are described in 10 annuli of equal area.

### **Number of energy groups (fast/thermal)/continuous energy**

- 172 groups for the shielding corrections and the approximate flux solution;
- 6 groups for the accurate flux solution: 820 000; 9118; 4.0; 0.625; 0.14 and 0 eV (usual 6 energy groups structure).

### **Assumptions made for the cross-sections such as (n, 2n)**

The (n, 2n) cross sections are only used in the burnup sequence of the calculation. At this step, the (n,γ) cross sections are calculated from the absorption, fission and (n, 2n) cross sections.

### **Self-shielding and mutual resonance shielding applied to each nuclide**

Each rod type defined in the benchmark's specification forms a rod type for the WIMS calculation, excepted for the Gd-rods which are defined as two distinct rods. For instance, in the case of the MOX VVER assembly, we have:

- Rod type 1: central tube cell.
- Rod type 2: fuel cell PU3.
- Rod type 3: guide tube cell.
- Rod type 4: fuel cell PU2.
- Rod type 5: fuel cell PU1.
- Rod type 6: fuel cell GD1 for cell 35.
- Rod type 7: fuel cell GD1 for cell 24.

### **Cell, lattice, etc. calculation methods used. (See also points 3, 6 and 9)**

Each UOX and MOX rod is explicitly represented with its fuel region (1 region), its cladding and its moderator (see also Figure B.2). No additional radial and azimuthal cut is applied.

The Gd rods are divided into 10 annuli of equal area in order to account for the shielding effect due to the Gd isotopes. This permits us to easily calculate the nuclides concentrations as a function of the radial position (5 regions requested).

### Other information

- Some “requested” isotopes are not present in the used WIMS97 data library. These are:  $^{152}\text{Gd}$ ,  $^{160}\text{Gd}$ ,  $^{232}\text{U}$ ,  $^{236}\text{Pu}$  and  $^{137}\text{Ce}$ . This is why some columns lack in the reported results.
- The presence of the Hf isotopes contained in the cladding are explicitly taken into account for the shielding, through the  $^{174}\text{Hf}$  (0.16 w/o),  $^{176}\text{Hf}$  (5.20 w/o),  $^{177}\text{Hf}$  (18.60 w/o),  $^{178}\text{Hf}$  (27.30 w/o),  $^{179}\text{Hf}$  (13.63 w/o) and  $^{180}\text{Hf}$  (35.11 w/o).
- The  $^{10}\text{B}$  isotope is supposed to be unburnable (constant atomic concentration).

## HELIOS CODE

### *Name of computer code(s) used*

1. Name: HELIOS (version 1.4) developed by Studsvik ScandPower.

Methods based on current coupling and collision probability for neutron transport and subgroup method for resonance treatment.

### *Description of method*

2. Basic data library version: ENDF/B-VI with adjustments to the  $^{238}\text{U}$  absorption cross section (The  $^{238}\text{U}$  resonance integral has been reduced by 3.4% to match integral experiments).
3. Data processing code/method used to obtain the cross-section data used: Basic library obtained using NJOY and RABBLE along with other utility codes.
4. Spectral calculations and data reduction methods used: None.
5. Number of groups (fast, thermal)/continuous energy: 190 (128 fast, 62 thermal).
6. Assumptions made for some cross-sections such as (n,2n): HELIOS-1.4 has n,2n cross sections for only the following isotopes: 90 232, 92 233, 92 238, 96 244.
7. Self shielding and mutual resonance shielding applied to which nuclides.
8. 31 Resonance isotopes, mutual resonance shielding applied to all resonance nuclides:
  - $^{95\text{m}}\text{Mo}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{108\text{m}}\text{Pd}$ ,  $^{107}\text{Ag}$ ,  $^{109}\text{Ag}$ ,  $^{113}\text{In}$ ,  $^{115}\text{In}$ ,  $^{131\text{m}}\text{Xe}$ ,  $^{133\text{m}}\text{Cs}$ ,  $^{155}\text{Gd}$ ,  $^{156}\text{Gd}$ ,  $^{157}\text{Gd}$ ,  $^{158}\text{Gd}$ ,  $^{166}\text{Er}$ ,  $^{167}\text{Er}$ ,  $^{169}\text{Tm}$ ,  $^{170}\text{Tm}$ ,  $^{176}\text{Hf}$ ,  $^{177}\text{Hf}$ ,  $^{178}\text{Hf}$ ,  $^{179}\text{Hf}$ ,  $^{180}\text{Hf}$ ,  $^{232}\text{Th}$ ,  $^{233}\text{U}$ ,  $^{235}\text{U}$ ,  $^{236}\text{U}$ ,  $^{238}\text{U}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{241}\text{Pu}$ ,  $^{242}\text{Pu}$ .
9. Cell, lattice, etc. calculation method used: See item 3 above.
10. Other information that would be helpful to identify possible sources of discrepancies, especially deviations (hopefully none) from the specification:
  - These calculations were performed with the adjusted ENDF/B-VI library.
  - HELIOS does not compute equilibrium samarium-149 concentration. Therefore, calculation at 0 MWd/kgHM has no  $^{149}\text{Sm}$ .
  - HELIOS-1.4 does not have the necessary n,2n reactors required for the production of  $^{232}\text{U}$  and  $^{236}\text{Pu}$ . The concentrations have been set to zero.
  - Reported  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$  include contributions from the burnable absorber and fission products.

- Made assumption that request for  $^{137}\text{Ce}$  in benchmark specifications was a typographical error.  $^{137}\text{Cs}$  values are given.

### **References**

- [1] Casal, J.J. *et. al*, “HELIOS: Geometric Capabilities of a New Fuel-Assembly Program”, *Proc. Int. Topl. Mtg. Advances in Mathematics, Computations, and Reactor Physics*, Pittsburgh, Pennsylvania, April 28-May 2, 1991, Vol. 2, p. 10.2.1-1.
- [2] Villarino, E.A., and R.J.J. Stamm’ler, and A.A. Ferri, and J.J. Casal, “HELIOS: Angularly Dependent Collision Probabilities”, *Nuc. Sci. Eng.*, 112, 16-31, (1992).
- [3] “FMS: The Scandpower Fuel Management System, HELIOS Documentation”, Scandpower A/S (1995).

## MCNP-4B CODE

### *Name of the computer code used including description of method and reference*

*Name:* Winfried Zwermann

*Organisation:* Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH

Part of the calculations were performed in the framework of the “French – German – Russian Trilateral Project on Civil Uses of Plutonium from Dismantled Russian Nuclear Weapons Subject to Arms Reduction”, sponsored by the German Foreign Office.

### *Description:*

Code System: MCNP-4B

Transport Code – Version 4B, LA-12625-M, March 1997.

### *Cross Section Data:*

Point data generated by IKE Stuttgart with NJOY mainly from JEF 2.2:  $^1\text{H}$ ,  $^{16}\text{O}$ ,  $^{\text{nat}}\text{Zr}$ ,  $^{152}\text{Gd}$ : ENDF/B-VI.4.

All other materials: JEF-2.2.

Spectral Calculations etc.: None.

Energy Groups: Continuous.

Special assumptions: None.

Assembly Calculations: Monte Carlo transport, continuous energy, 1,000,000 histories, fresh fuel states only.

### *Other Information*

Nuclear data are available at certain temperatures (293, 600, 900, 1200 K). When another temperature (here: 575, 1027 K) is required, each isotope is mixed from the corresponding data at the next lower and the next higher temperatures with appropriate weighting factors.

Calculated cases (UOX and MOX):

- S2: T-fuel = 1027 K, T-mod = 575 K, no Xe/Sm, 600 ppm Boron;
- S3: T-fuel = 575 K, T-mod = 575 K, no Xe/Sm, 600 ppm Boron;
- S4: T-fuel = 575 K, T-mod = 575 K, no Xe/Sm, 0 ppm Boron;

- S5: T-fuel = 293 K, T-mod = 293 K, no Xe/Sm, 0 ppm Boron.

### *Reference*

- [1] Briesmeister J.F. (Editor), "MCNP – A General Monte Carlo N-Particle".

## MULTICELL CODE

### *Name of the computer code used including reference and description of method*

*Name:* Cs. Maráczy.

*Organisation:* KFKI Atomic Energy Research Institute.

*Method:* MULTICELL collision probability transport code tested against measurements on the ZR6 critical assembly [1, 2].

*Basic data library version:* ENDF/B-VI.

*Codes:* NJOY [3] and PEACO [4] codes.

The thermal scattering is described by the Nelkin-model. The cross sections of three resonance isotopes and the Bell-factors are tabulated as a function of the dilution cross section of a homogeneous material and the temperature. The equivalence theory is used for the calculation of the shielded multigroup cross sections for the heterogeneous case, where the Dancoff factor is determined from the first flight collision probabilities.

35 epithermal and 35 thermal energy groups, thermal cut-off: 1.84eV

The (n,2n) reaction is taken into account in the cross sections, but no (n,2n) burnup chains.

$^{235}\text{U}$ ,  $^{238}\text{U}$ ,  $^{239}\text{Pu}$ . The  $^{240}\text{Pu}$  resonance is treated explicitly in the thermal region taking into account the Doppler broadening.

Spectral calculations: multigroup collision probability equations. The collision probabilities are obtained as a combination of the cell transmission and escape probabilities and the collision probabilities inside the cylindrical cells. Fuel burnup calculations: 18 actinide and 145 fission product isotopes.

The MULTICELL code can be used for periodic boundary condition problems. Though the specified 0 current boundary condition in the benchmark does not correspond to the periodic one, the error originating from this deviation is negligible. The radial concentration distribution of the  $^{239}\text{Pu}$  isotope in the UGd pin does not show the rim effect because the fuel pin treated as one region from the point of view of resonances. (For fuel behaviour calculations a special version of the code is used with fine energy groups in the resonance region which allows to calculate the rim effect.)

### **References**

- [1] Gady, *et al.*, "KARATE — A Code for VVER-440 Core Calculation", Transactions of ANS Winter Meeting, Washington DC, November 13-17, 1994, p. 485, Vol. 71.
- [2] Gy. Hegyi, *et al.*, "Benchmark on Integral Parameters and Pin-Wise Energy Distributions of Heterogeneous Lattices", Proc. of the third Symposium of AER, Piestany, Slovakia, 27 September — 1 October 1993, p. 241.

- [3] MacFarlane, D. and W. Muir, “The NJOY Nuclear Data Processing System”, LA-12740-M, 1994.
- [4] Ishiguro, Y. and H. Takano, “PEACO – A Code for Calculation of Group Constants of Resonance Energy Region in Heterogeneous Systems”, JAERI 1219 Report, 1971.



*Appendix C*

**ADDITIONAL RESULTS**



**Table C.1 UGD Variant.  $K_{inf}$ . States S1, S2, S3, S4, S5.  
Burnup=0, 20, 40 MWd/kgHM**

	S1	S2	S3	S4	S5
MCU					
0	1.1353	1.1779	1.1899	1.2499	1.3197
20	1.0403	1.0809	1.0950	1.1496	1.2192
40	0.9091	0.9432	0.9562	1.0063	1.0632
TVS					
0	1.1353	1.1768	1.1900	1.2504	1.3213
20	1.0405	1.0781	1.0928	1.1484	1.2138
40	0.9025	0.9325	0.9460	0.9954	1.0470
WIMS8A					
0	1.1328	1.1695	1.1845	1.2433	1.3122
20	1.0383	1.0781	1.0941	1.1477	1.2173
40	0.9088	0.9422	0.9566	1.0041	1.0604
HELIOS					
0	1.1355	1.1750	1.1894	1.2490	1.3181
20	1.0436	1.0828	1.0988	1.1535	1.2198
40	0.9092	0.9422	0.9572	1.0063	1.0577
MCNP4B					
0		1.1800	1.1925	1.2531	1.3235
20					
40					
MULTICELL					
0	1.1363	1.1776	1.1919	1.2518	1.3164
20	1.0427	1.0835	1.0989	1.1543	1.2192
40	0.9029	0.9368	0.9509	1.0005	1.0505

**Table C.2 MOXGD Variant.  $K_{inf}$ . States S1, S2, S3, S4, S5.  
Burnup=0, 20, 40 MWd/kgHM**

	S1	S2	S3	S4	S5
MCU					
0	1.1551	1.1873	1.2045	1.2384	1.3176
20	1.0126	1.0482	1.0626	1.1005	1.1739
40	0.9075	0.9390	0.9529	0.9933	1.0522
TVS					
0	1.1585	1.1942	1.2104	1.2465	1.3229
20	1.0148	1.0479	1.0625	1.1021	1.1679
40	0.8931	0.9215	0.9345	0.9750	1.0249
WIMS8A					
0	1.1494	1.1811	1.1993	1.2334	1.3148
20	1.0127	1.0467	1.0635	1.1008	1.1745
40	0.9048	0.9360	0.9506	0.9891	1.0465
HELIOS					
0	1.1595	1.1923	1.2098	1.2443	1.3241
20	1.0220	1.0558	1.0723	1.1103	1.1801
40	0.9065	0.9375	0.9526	0.9922	1.0449
MCNP4B					
0		1.1922	1.2091	1.2430	1.3256
20					
40					
MULTICELL					
0	1.1606	1.1944	1.213	1.2483	1.3249
20	1.0178	1.0532	1.0686	1.1075	1.1765
40	0.8958	0.9277	0.9413	0.9815	1.0331

**Table C.3 UGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	IMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL
1	1.145	1.142	1.133	1.154	1.154	1.190	1.158	1.142	1.133	1.154	1.160	1.190	1.159	1.147	1.138	1.160	1.169	1.197	1.205	1.192	1.168	1.201	1.211	1.221
2	1.116	1.116	1.113	1.121	1.125	1.156	1.126	1.117	1.113	1.121	1.123	1.157	1.131	1.121	1.117	1.126	1.138	1.162	1.146	1.150	1.136	1.151	1.160	1.179
3	1.068	1.071	1.076	1.070	1.078	1.102	1.064	1.071	1.076	1.070	1.078	1.103	1.063	1.074	1.079	1.073	1.079	1.106	1.056	1.069	1.083	1.068	1.067	1.110
4	1.102	1.101	1.096	1.103	1.115	1.134	1.103	1.102	1.097	1.103	1.103	1.134	1.107	1.105	1.100	1.106	1.114	1.138	1.125	1.132	1.116	1.130	1.135	1.154
5	1.044	1.052	1.057	1.046	1.055	1.075	1.048	1.052	1.058	1.046	1.062	1.076	1.051	1.054	1.059	1.048	1.049	1.078	1.040	1.043	1.059	1.038	1.044	1.079
6	1.028	1.031	1.039	1.025	1.036	1.047	1.019	1.031	1.039	1.025	1.030	1.047	1.032	1.032	1.040	1.026	1.029	1.048	1.003	1.013	1.034	1.009	1.012	1.044
7	1.083	1.086	1.079	1.084	1.095	1.111	1.082	1.086	1.080	1.084	1.094	1.112	1.085	1.089	1.082	1.087	1.095	1.115	1.104	1.117	1.097	1.112	1.117	1.131
8	1.034	1.036	1.039	1.029	1.037	1.053	1.029	1.036	1.040	1.029	1.039	1.053	1.032	1.037	1.041	1.030	1.033	1.054	1.019	1.027	1.039	1.021	1.023	1.055
9	1.013	1.018	1.025	1.009	1.025	1.028	1.012	1.018	1.025	1.009	1.017	1.028	1.015	1.018	1.026	1.009	1.018	1.028	0.997	0.999	1.018	0.992	1.004	1.024
10	1.007	1.015	1.023	1.009	1.015	1.020	1.003	1.015	1.023	1.009	1.018	1.021	1.000	1.015	1.023	1.009	1.022	1.020	0.992	0.998	1.015	0.993	0.999	1.015
11	1.059	1.069	1.059	1.061	1.067	1.086	1.060	1.069	1.059	1.061	1.069	1.087	1.065	1.071	1.061	1.063	1.076	1.088	1.083	1.099	1.075	1.089	1.101	1.105
12	1.002	1.011	1.015	1.005	1.008	1.019	1.007	1.011	1.015	1.005	1.006	1.020	1.009	1.011	1.015	1.004	1.006	1.019	0.997	1.002	1.013	0.994	0.997	1.021
13	0.993	0.999	1.004	0.988	0.993	1.001	0.988	0.999	1.005	0.988	0.996	1.001	0.992	0.998	1.004	0.987	0.997	1.000	0.973	0.981	0.996	0.971	0.978	0.997
14	1.002	1.008	1.014	0.999	1.008	1.008	1.002	1.009	1.014	0.999	1.009	1.009	1.001	1.008	1.013	0.998	1.010	1.008	0.994	0.995	1.007	0.987	0.997	1.004
15	1.032	1.035	1.036	1.032	1.038	1.033	1.032	1.035	1.036	1.032	1.041	1.033	1.032	1.035	1.036	1.032	1.040	1.033	1.031	1.044	1.040	1.039	1.052	1.036
16	1.052	1.060	1.049	1.054	1.051	1.073	1.056	1.060	1.049	1.054	1.056	1.074	1.052	1.061	1.050	1.056	1.064	1.075	1.079	1.088	1.065	1.079	1.093	1.092
17	0.946	0.964	0.969	0.948	0.943	0.961	0.947	0.964	0.969	0.948	0.955	0.961	0.947	0.962	0.968	0.946	0.953	0.959	0.925	0.944	0.960	0.929	0.937	0.961
18	0.931	0.946	0.955	0.933	0.938	0.936	0.930	0.946	0.955	0.933	0.941	0.936	0.925	0.944	0.953	0.930	0.948	0.933	0.902	0.920	0.942	0.906	0.905	0.931
19	0.981	0.989	0.994	0.983	0.991	0.982	0.982	0.989	0.994	0.983	0.984	0.982	0.982	0.988	0.993	0.981	0.989	0.980	0.979	0.978	0.988	0.970	0.979	0.979
20	1.020	1.024	1.020	1.018	1.020	1.016	1.017	1.024	1.020	1.018	1.026	1.016	1.018	1.024	1.020	1.017	1.028	1.016	1.030	1.036	1.026	1.028	1.038	1.020
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	1.059	1.069	1.059	1.061	1.068	1.087	1.062	1.069	1.059	1.061	1.068	1.087	1.061	1.071	1.061	1.063	1.074	1.089	1.085	1.099	1.075	1.089	1.103	1.105
23	0.947	0.964	0.969	0.948	0.958	0.961	0.945	0.964	0.969	0.948	0.955	0.961	0.942	0.963	0.968	0.946	0.945	0.960	0.928	0.945	0.961	0.929	0.933	0.962
24	0.317	0.317	0.336	0.327	0.332	0.325	0.318	0.316	0.333	0.325	0.331	0.324	0.307	0.306	0.323	0.315	0.319	0.313	0.218	0.217	0.229	0.223	0.225	0.224
25	0.957	0.965	0.967	0.952	0.955	0.948	0.950	0.965	0.967	0.952	0.963	0.948	0.948	0.963	0.965	0.949	0.959	0.946	0.950	0.962	0.963	0.948	0.953	0.951
26	1.003	1.009	1.005	1.001	1.000	0.994	1.001	1.009	1.005	1.001	1.003	0.994	1.002	1.008	1.004	1.000	1.002	0.993	1.017	1.022	1.010	1.011	1.020	0.999
27	0.966	0.982	0.977	0.967	0.977	0.958	0.973	0.982	0.977	0.967	0.985	0.958	0.966	0.981	0.975	0.965	0.970	0.957	0.973	0.986	0.978	0.970	0.978	0.961
28	0.952	0.987	0.968	0.969	0.975	0.959	0.951	0.987	0.967	0.969	0.979	0.958	0.957	0.986	0.966	0.968	0.972	0.957	0.960	0.991	0.970	0.973	0.981	0.960
29	1.092	1.087	1.080	1.085	1.094	1.112	1.087	1.087	1.080	1.085	1.083	1.112	1.092	1.090	1.082	1.087	1.082	1.115	1.114	1.117	1.098	1.112	1.117	1.131
30	1.005	1.012	1.017	1.005	1.011	1.020	1.003	1.012	1.017	1.005	1.009	1.021	1.002	1.012	1.017	1.005	1.014	1.020	1.000	1.002	1.014	0.995	1.004	1.022
31	0.928	0.948	0.957	0.934	0.942	0.938	0.936	0.948	0.957	0.934	0.942	0.938	0.932	0.946	0.955	0.931	0.938	0.935	0.906	0.922	0.944	0.908	0.906	0.933

**Table C.3 UGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM (continued)**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	IMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL
32	0.958	0.968	0.969	0.954	0.957	0.952	0.952	0.968	0.969	0.954	0.961	0.952	0.949	0.966	0.968	0.952	0.962	0.950	0.949	0.965	0.967	0.951	0.959	0.955
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.966	0.980	0.978	0.969	0.974	0.953	0.973	0.979	0.977	0.969	0.970	0.952	0.969	0.978	0.976	0.968	0.975	0.951	0.973	0.983	0.980	0.970	0.976	0.955
35	0.318	0.319	0.336	0.329	0.335	0.317	0.320	0.318	0.333	0.327	0.332	0.316	0.308	0.308	0.323	0.317	0.320	0.306	0.218	0.217	0.229	0.222	0.226	0.215
36	0.968	0.990	0.972	0.978	0.983	0.953	0.969	0.989	0.971	0.978	0.981	0.952	0.963	0.989	0.970	0.977	0.986	0.951	0.960	0.992	0.972	0.979	0.989	0.950
37	1.103	1.102	1.097	1.103	1.111	1.134	1.102	1.102	1.098	1.103	1.106	1.134	1.105	1.105	1.101	1.107	1.114	1.138	1.139	1.132	1.117	1.130	1.135	1.154
38	1.029	1.037	1.042	1.030	1.039	1.053	1.026	1.037	1.042	1.030	1.033	1.054	1.035	1.038	1.043	1.031	1.032	1.055	1.017	1.028	1.041	1.022	1.039	1.055
39	0.990	1.000	1.007	0.990	0.998	1.003	0.989	1.001	1.007	0.990	0.996	1.003	0.988	1.000	1.007	0.989	0.997	1.003	0.978	0.982	0.999	0.973	0.980	0.999
40	0.989	0.995	0.999	0.988	0.999	0.988	0.985	0.995	1.000	0.988	0.993	0.989	0.981	0.994	0.999	0.987	0.998	0.987	0.977	0.984	0.995	0.976	0.980	0.985
41	1.023	1.026	1.020	1.016	1.019	1.015	1.021	1.026	1.020	1.017	1.025	1.015	1.020	1.026	1.020	1.016	1.027	1.014	1.031	1.042	1.029	1.032	1.041	1.020
42	1.023	1.025	1.020	1.021	1.030	1.005	1.017	1.024	1.020	1.021	1.021	1.005	1.021	1.024	1.019	1.021	1.031	1.004	1.036	1.043	1.031	1.035	1.045	1.009
43	0.973	0.986	0.980	0.971	0.983	0.952	0.973	0.985	0.980	0.971	0.981	0.951	0.974	0.984	0.979	0.970	0.971	0.950	0.973	0.989	0.984	0.973	0.979	0.950
44	0.975	0.994	0.985	0.978	0.991	0.954	0.980	0.993	0.985	0.978	0.981	0.954	0.977	0.993	0.984	0.976	0.979	0.953	0.979	0.995	0.987	0.979	0.986	0.950
45	1.030	1.045	1.029	1.040	1.046	1.010	1.036	1.045	1.029	1.040	1.043	1.010	1.037	1.045	1.029	1.041	1.048	1.010	1.049	1.060	1.038	1.053	1.059	1.006
46	1.122	1.116	1.115	1.122	1.128	1.157	1.124	1.117	1.116	1.122	1.132	1.157	1.121	1.121	1.120	1.126	1.138	1.162	1.153	1.150	1.139	1.152	1.161	1.179
47	1.046	1.052	1.058	1.047	1.058	1.076	1.050	1.052	1.058	1.047	1.052	1.076	1.048	1.054	1.060	1.049	1.056	1.078	1.031	1.043	1.059	1.039	1.049	1.079
48	1.014	1.019	1.026	1.010	1.016	1.029	1.010	1.019	1.027	1.011	1.013	1.029	1.006	1.019	1.027	1.011	1.020	1.029	0.994	1.000	1.019	0.993	0.997	1.025
49	1.009	1.011	1.015	1.004	1.006	1.012	1.003	1.011	1.016	1.004	1.015	1.012	1.000	1.011	1.015	1.003	1.011	1.011	0.990	0.998	1.010	0.991	0.999	1.007
50	1.029	1.036	1.033	1.034	1.033	1.030	1.032	1.036	1.033	1.034	1.045	1.030	1.036	1.036	1.033	1.034	1.037	1.029	1.050	1.050	1.041	1.045	1.054	1.034
51	1.024	1.035	1.030	1.026	1.026	1.019	1.026	1.035	1.030	1.027	1.029	1.019	1.027	1.035	1.030	1.026	1.033	1.019	1.047	1.054	1.042	1.044	1.059	1.024
52	1.019	1.024	1.020	1.017	1.023	0.997	1.013	1.023	1.020	1.017	1.020	0.996	1.012	1.023	1.020	1.016	1.015	0.996	1.036	1.040	1.032	1.030	1.033	0.998
53	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
54	1.051	1.054	1.043	1.045	1.060	1.020	1.045	1.054	1.043	1.045	1.059	1.020	1.051	1.055	1.044	1.046	1.050	1.021	1.068	1.071	1.055	1.060	1.082	1.015
55	1.073	1.074	1.062	1.068	1.080	1.041	1.070	1.074	1.062	1.068	1.088	1.040	1.064	1.076	1.064	1.070	1.069	1.042	1.084	1.094	1.077	1.086	1.102	1.035
56	1.151	1.142	1.144	1.154	1.154	1.190	1.155	1.142	1.145	1.154	1.160	1.190	1.151	1.147	1.150	1.160	1.169	1.197	1.201	1.192	1.177	1.201	1.211	1.221
57	1.069	1.071	1.076	1.070	1.078	1.102	1.066	1.071	1.077	1.070	1.078	1.103	1.072	1.074	1.080	1.073	1.079	1.106	1.060	1.069	1.083	1.068	1.067	1.110
58	1.025	1.031	1.039	1.025	1.036	1.047	1.025	1.031	1.039	1.025	1.030	1.047	1.026	1.032	1.040	1.026	1.029	1.048	1.008	1.013	1.033	1.009	1.012	1.044
59	1.013	1.015	1.021	1.009	1.015	1.020	1.006	1.015	1.021	1.009	1.018	1.021	1.013	1.015	1.022	1.009	1.022	1.020	0.996	0.998	1.015	0.993	0.999	1.015
60	1.027	1.035	1.033	1.032	1.038	1.033	1.039	1.035	1.033	1.032	1.041	1.033	1.034	1.035	1.033	1.032	1.040	1.033	1.032	1.044	1.038	1.039	1.052	1.036
61	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

**Table C.3 UGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM (continued)**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	IMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	CU	TVS-M	IMS	ELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	ELIOS	MCNP	MULTI CELL
62	0.991	0.987	0.998	0.969	0.975	0.959	0.982	0.987	0.998	0.969	0.979	0.958	0.982	0.986	0.997	0.968	0.972	0.957	0.987	0.991	1.002	0.973	0.981	0.960
63	0.999	0.990	0.998	0.978	0.983	0.953	0.998	0.989	0.998	0.978	0.981	0.952	0.993	0.989	0.997	0.977	0.986	0.951	1.007	0.992	1.006	0.979	0.989	0.950
64	1.047	1.045	1.042	1.040	1.046	1.010	1.046	1.045	1.042	1.040	1.043	1.010	1.049	1.045	1.042	1.041	1.048	1.010	1.065	1.060	1.054	1.053	1.059	1.006
65	1.066	1.074	1.057	1.068	1.080	1.041	1.074	1.074	1.057	1.068	1.088	1.040	1.078	1.076	1.058	1.070	1.069	1.042	1.080	1.094	1.072	1.086	1.102	1.035
66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pin N	56	1	56	56	1	56	1	1	56	56	1	56	1	1	56	56	1	56	1	1	56	56	1	56

**Table C.4 MOXGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	WIMS	ELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL
1	0.997	0.982	0.963	1.000	1.004	1.008	0.994	0.983	0.963	1.000	0.990	1.007	1.004	0.991	0.971	1.009	1.004	1.018	1.053	1.042	0.998	1.046	1.053	1.018
2	0.943	0.946	0.931	0.949	0.952	0.958	0.947	0.946	0.931	0.949	0.952	0.957	0.951	0.953	0.937	0.956	0.965	0.965	0.984	0.992	0.955	0.983	0.982	0.967
3	0.866	0.878	0.869	0.865	0.864	0.871	0.862	0.878	0.869	0.865	0.867	0.870	0.869	0.883	0.874	0.870	0.871	0.877	0.878	0.898	0.883	0.881	0.886	0.880
4	0.912	0.922	0.903	0.918	0.920	0.926	0.918	0.923	0.903	0.918	0.918	0.925	0.919	0.928	0.908	0.924	0.913	0.933	0.952	0.963	0.923	0.947	0.956	0.935
5	1.068	1.067	1.074	1.069	1.087	1.076	1.067	1.068	1.074	1.070	1.079	1.074	1.076	1.072	1.079	1.075	1.088	1.081	1.089	1.075	1.090	1.080	1.088	1.087
6	0.998	1.006	1.011	1.000	1.012	1.000	1.009	1.006	1.011	1.000	0.997	0.999	0.996	1.009	1.014	1.003	1.014	1.003	0.994	1.001	1.019	0.998	1.001	1.010
7	0.901	0.908	0.887	0.901	0.904	0.909	0.897	0.909	0.887	0.901	0.904	0.908	0.905	0.914	0.891	0.906	0.900	0.914	0.934	0.948	0.904	0.930	0.935	0.916
8	1.025	1.039	1.040	1.034	1.038	1.040	1.035	1.039	1.041	1.035	1.044	1.038	1.044	1.042	1.044	1.038	1.053	1.044	1.044	1.043	1.053	1.042	1.050	1.050
9	0.957	0.969	0.972	0.952	0.963	0.955	0.953	0.969	0.972	0.952	0.961	0.954	0.957	0.970	0.973	0.953	0.962	0.956	0.947	0.959	0.973	0.946	0.950	0.963
10	0.911	0.935	0.934	0.914	0.923	0.915	0.903	0.936	0.935	0.914	0.914	0.914	0.906	0.935	0.935	0.913	0.912	0.914	0.905	0.923	0.932	0.904	0.904	0.922
11	0.889	0.899	0.876	0.890	0.896	0.897	0.895	0.899	0.876	0.890	0.904	0.896	0.897	0.903	0.880	0.894	0.896	0.901	0.919	0.937	0.891	0.917	0.924	0.902
12	1.019	1.021	1.021	1.016	1.018	1.018	1.020	1.021	1.021	1.016	1.031	1.017	1.013	1.024	1.024	1.019	1.024	1.020	1.015	1.023	1.029	1.021	1.024	1.025
13	0.926	0.947	0.945	0.926	0.945	0.928	0.926	0.947	0.946	0.927	0.926	0.927	0.925	0.947	0.946	0.927	0.927	0.928	0.920	0.935	0.943	0.917	0.918	0.933
14	1.089	1.100	1.125	1.093	1.096	1.096	1.095	1.100	1.125	1.093	1.089	1.098	1.095	1.098	1.124	1.091	1.085	1.097	1.074	1.076	1.117	1.077	1.092	1.101
15	1.125	1.122	1.138	1.122	1.129	1.126	1.129	1.122	1.139	1.122	1.131	1.128	1.118	1.120	1.137	1.120	1.112	1.125	1.120	1.115	1.137	1.119	1.126	1.132
16	0.883	0.895	0.871	0.887	0.893	0.892	0.881	0.895	0.871	0.887	0.896	0.890	0.895	0.899	0.874	0.891	0.894	0.896	0.907	0.932	0.885	0.913	0.927	0.896
17	0.992	0.998	0.997	0.990	0.997	0.991	0.987	0.998	0.997	0.990	1.011	0.989	0.994	1.000	0.999	0.992	0.992	0.992	0.985	0.991	0.997	0.985	1.001	0.991
18	0.906	0.923	0.919	0.903	0.901	0.901	0.899	0.923	0.919	0.903	0.917	0.900	0.903	0.922	0.918	0.902	0.902	0.899	0.882	0.903	0.910	0.883	0.895	0.898
19	1.082	1.085	1.104	1.076	1.083	1.078	1.085	1.085	1.104	1.076	1.082	1.080	1.075	1.082	1.102	1.074	1.095	1.077	1.052	1.060	1.094	1.058	1.069	1.079
20	1.107	1.112	1.118	1.110	1.126	1.114	1.104	1.112	1.118	1.110	1.114	1.116	1.107	1.109	1.116	1.107	1.121	1.112	1.108	1.106	1.116	1.106	1.111	1.117
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.892	0.899	0.876	0.890	0.895	0.897	0.884	0.899	0.876	0.890	0.898	0.896	0.887	0.903	0.880	0.894	0.888	0.901	0.915	0.937	0.891	0.917	0.932	0.902
23	0.994	0.998	0.996	0.990	0.999	0.991	0.988	0.998	0.996	0.990	1.002	0.990	0.985	1.000	0.998	0.992	0.998	0.992	0.987	0.991	0.997	0.985	1.008	0.991
24	0.306	0.304	0.314	0.308	0.315	0.305	0.307	0.303	0.312	0.306	0.314	0.302	0.300	0.297	0.306	0.300	0.307	0.297	0.227	0.226	0.234	0.229	0.234	0.228
25	1.096	1.101	1.113	1.100	1.100	1.101	1.101	1.100	1.113	1.100	1.101	1.103	1.099	1.097	1.110	1.097	1.102	1.099	1.081	1.084	1.101	1.083	1.083	1.096
26	1.105	1.108	1.113	1.103	1.108	1.109	1.105	1.108	1.113	1.103	1.110	1.111	1.102	1.104	1.110	1.100	1.129	1.107	1.100	1.102	1.108	1.099	1.111	1.110
27	1.084	1.092	1.094	1.086	1.093	1.095	1.089	1.091	1.094	1.086	1.094	1.097	1.084	1.087	1.090	1.082	1.098	1.091	1.070	1.081	1.084	1.075	1.092	1.090
28	1.082	1.093	1.083	1.084	1.095	1.098	1.075	1.092	1.083	1.084	1.103	1.100	1.075	1.088	1.079	1.080	1.090	1.093	1.067	1.083	1.073	1.075	1.094	1.092
29	0.902	0.908	0.887	0.901	0.900	0.909	0.903	0.909	0.888	0.901	0.916	0.908	0.911	0.914	0.892	0.906	0.917	0.914	0.927	0.948	0.904	0.930	0.933	0.916
30	1.013	1.021	1.022	1.016	1.020	1.018	1.012	1.021	1.022	1.016	1.020	1.017	1.016	1.024	1.024	1.019	1.021	1.021	1.017	1.023	1.029	1.021	1.033	1.025
31	0.890	0.923	0.919	0.903	0.911	0.901	0.907	0.923	0.919	0.903	0.901	0.900	0.895	0.922	0.919	0.902	0.902	0.899	0.882	0.904	0.910	0.883	0.884	0.899



**Table C.4 MOXGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM (continued)**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	WIMS	ELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL
32	1.101	1.102	1.113	1.101	1.111	1.102	1.107	1.101	1.113	1.101	1.116	1.104	1.094	1.099	1.110	1.097	1.111	1.101	1.089	1.085	1.102	1.084	1.089	1.097
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	1.090	1.091	1.092	1.089	1.098	1.095	1.088	1.091	1.092	1.089	1.064	1.096	1.085	1.087	1.088	1.085	1.099	1.090	1.075	1.081	1.085	1.077	1.087	1.089
35	0.303	0.300	0.308	0.301	0.310	0.304	0.300	0.299	0.306	0.300	0.307	0.301	0.295	0.293	0.300	0.293	0.304	0.294	0.227	0.224	0.230	0.226	0.229	0.227
36	1.063	1.093	1.074	1.091	1.092	1.101	1.063	1.093	1.073	1.091	1.092	1.102	1.063	1.088	1.068	1.086	1.092	1.095	1.044	1.084	1.066	1.081	1.071	1.093
37	0.918	0.923	0.905	0.918	0.915	0.926	0.914	0.923	0.905	0.918	0.922	0.925	0.923	0.929	0.910	0.924	0.913	0.933	0.953	0.964	0.923	0.947	0.954	0.935
38	1.038	1.039	1.042	1.035	1.035	1.040	1.037	1.039	1.042	1.035	1.040	1.039	1.036	1.043	1.046	1.038	1.044	1.044	1.045	1.043	1.053	1.042	1.054	1.050
39	0.934	0.947	0.947	0.927	0.929	0.929	0.931	0.948	0.947	0.927	0.940	0.928	0.926	0.948	0.948	0.927	0.932	0.928	0.912	0.936	0.945	0.918	0.931	0.934
40	1.078	1.087	1.106	1.078	1.087	1.080	1.071	1.087	1.106	1.078	1.088	1.083	1.069	1.085	1.104	1.075	1.077	1.080	1.052	1.063	1.097	1.060	1.067	1.083
41	1.117	1.115	1.121	1.109	1.126	1.118	1.116	1.115	1.121	1.109	1.118	1.120	1.108	1.112	1.118	1.106	1.125	1.115	1.105	1.111	1.118	1.108	1.120	1.120
42	1.107	1.113	1.116	1.110	1.117	1.119	1.122	1.113	1.116	1.110	1.116	1.120	1.117	1.110	1.112	1.106	1.120	1.115	1.104	1.113	1.115	1.110	1.118	1.119
43	1.087	1.092	1.096	1.085	1.093	1.099	1.097	1.092	1.095	1.085	1.098	1.100	1.082	1.088	1.091	1.081	1.095	1.093	1.074	1.083	1.086	1.076	1.063	1.091
44	1.085	1.095	1.094	1.085	1.104	1.103	1.087	1.094	1.093	1.085	1.101	1.104	1.086	1.090	1.088	1.080	1.093	1.097	1.074	1.086	1.084	1.077	1.077	1.095
45	1.094	1.119	1.103	1.115	1.132	1.131	1.077	1.119	1.103	1.115	1.121	1.132	1.089	1.115	1.099	1.111	1.110	1.125	1.092	1.121	1.104	1.118	1.110	1.129
46	0.947	0.946	0.934	0.949	0.950	0.958	0.946	0.946	0.934	0.949	0.953	0.957	0.953	0.953	0.940	0.956	0.953	0.966	0.996	0.992	0.957	0.983	0.986	0.967
47	1.062	1.067	1.074	1.070	1.073	1.076	1.072	1.068	1.075	1.070	1.082	1.074	1.081	1.073	1.080	1.075	1.084	1.081	1.089	1.075	1.090	1.080	1.086	1.088
48	0.956	0.969	0.972	0.952	0.958	0.955	0.963	0.970	0.972	0.953	0.971	0.954	0.957	0.971	0.974	0.954	0.967	0.956	0.952	0.960	0.973	0.946	0.957	0.963
49	1.096	1.101	1.124	1.095	1.109	1.097	1.098	1.101	1.124	1.095	1.102	1.100	1.092	1.099	1.123	1.093	1.107	1.098	1.076	1.077	1.117	1.079	1.085	1.103
50	1.109	1.116	1.122	1.116	1.114	1.119	1.113	1.116	1.123	1.116	1.122	1.121	1.106	1.114	1.120	1.114	1.111	1.118	1.104	1.112	1.123	1.113	1.126	1.124
51	1.116	1.117	1.120	1.112	1.116	1.123	1.114	1.117	1.120	1.112	1.107	1.124	1.110	1.113	1.117	1.108	1.120	1.119	1.117	1.117	1.121	1.113	1.117	1.125
52	1.107	1.111	1.115	1.107	1.099	1.119	1.110	1.111	1.115	1.106	1.107	1.120	1.100	1.107	1.111	1.102	1.101	1.114	1.106	1.111	1.116	1.107	1.110	1.117
53	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
54	1.124	1.123	1.124	1.116	1.121	1.136	1.121	1.123	1.123	1.116	1.117	1.137	1.116	1.119	1.119	1.112	1.132	1.130	1.123	1.126	1.126	1.120	1.127	1.135
55	1.123	1.133	1.136	1.128	1.126	1.149	1.126	1.133	1.136	1.128	1.132	1.150	1.121	1.130	1.132	1.124	1.129	1.143	1.139	1.138	1.141	1.135	1.143	1.149
56	0.993	0.982	0.982	1.000	1.004	1.008	0.995	0.983	0.982	1.000	0.990	1.007	1.006	0.991	0.990	1.009	1.004	1.018	1.046	1.042	1.010	1.046	1.053	1.018
57	0.868	0.878	0.870	0.865	0.864	0.871	0.868	0.878	0.871	0.865	0.867	0.870	0.869	0.883	0.875	0.870	0.871	0.877	0.886	0.898	0.883	0.881	0.886	0.880
58	0.998	1.006	1.013	1.000	1.012	1.000	0.992	1.006	1.013	1.000	0.997	0.999	1.003	1.009	1.016	1.003	1.014	1.003	0.999	1.001	1.019	0.998	1.001	1.010
59	0.912	0.935	0.932	0.914	0.923	0.915	0.911	0.936	0.932	0.914	0.914	0.914	0.914	0.935	0.933	0.913	0.912	0.914	0.903	0.923	0.931	0.904	0.904	0.922
60	1.123	1.122	1.129	1.122	1.129	1.126	1.118	1.122	1.129	1.122	1.131	1.128	1.122	1.120	1.127	1.120	1.112	1.125	1.121	1.115	1.130	1.119	1.126	1.132
61	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

**Table C.4 MOXGD. Variant. Fission Rate Distribution. States S2, S3, S4, S5. Burnup=0MWd/kgHM (continued)**

	State 2						State 3						State 4						State 5					
	MCU	TVS-M	WIMS	ELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL	MCU	TVS-M	WIMS	HELIOS	MCNP	MULTI CELL
62	1.102	1.093	1.111	1.084	1.095	1.098	1.094	1.092	1.111	1.084	1.103	1.100	1.098	1.088	1.107	1.080	1.090	1.093	1.084	1.083	1.103	1.075	1.094	1.092
63	1.124	1.093	1.110	1.091	1.092	1.101	1.114	1.093	1.110	1.091	1.092	1.102	1.118	1.088	1.105	1.086	1.092	1.095	1.110	1.084	1.108	1.081	1.071	1.093
64	1.134	1.119	1.133	1.115	1.132	1.131	1.130	1.119	1.132	1.115	1.121	1.132	1.127	1.115	1.128	1.111	1.110	1.125	1.138	1.121	1.136	1.118	1.110	1.129
65	1.127	1.133	1.127	1.128	1.126	1.149	1.128	1.133	1.127	1.128	1.132	1.150	1.130	1.130	1.122	1.124	1.129	1.143	1.130	1.138	1.132	1.135	1.143	1.149
66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pin N	64	55	15	65	45	65	64	55	15	65	55	65	65	55	15	65	54	65	55	55	55	65	55	65

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