CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

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1. Purpose

This study is prepared by the Mined Geologic Disposal System (MGDS) Waste Package Development Department (WPDD) to provide input to a separate evaluation on the probability of criticality in the far-field environment. These calculations are performed in sufficient detail to provide conservatively bounding configurations to support separate probabilistic analyses. The objective of this evaluation is to provide input to a risk analysis which will show that criticalities involving commercial spent nuclear fuel (SNF) are not credible, or indicate additional measures that are required for the Engineered Barrier Segment (EBS) to make such events incredible. Minimum critical volumes and masses of $\text{UO}_2/\text{H}_2\text{O}$ /tuff mixtures are determined without application of regulatory safety limits. This study does not address or demonstrate compliance with regulatory limits.

2. Quality Assurance

The work performed for this analysis is covered by a Waste Package Development (WPD) Quality Assurance Procedure (QAP)-2-0 work control Activity Evaluation entitled "Perform Criticality, Thermal, Structural, and Shielding Analyses" (Ref. 5.1). The QAP-2-0 evaluation determined that such activities are subject to Quality Assurance Requirements and Description (QARD) (Ref. 5.2) controls. Applicable procedural controls are listed in the activity evaluation. The waste package is on the Q-List (Ref. 5.3) by direct inclusion by the Department of Energy (DOE) as are the natural barriers of the Topopah Spring Welded (TSw) Hydrogeologic Unit, the Calico Hills Nonwelded (CHn) Hydrogeologic Unit, and the Saturated Zone (SZ) barrier; a QAP-2-3 evaluation has yet to be conducted.

The work reported in this document is part of the neutronic analysis for the preliminary design; thus, design inputs include unqualified data and unconfirmed assumptions. These design inputs will require subsequent qualification (or superseding inputs) as the waste package design proceeds. This document will not directly support any construction, fabrication, or procurement activity and, therefore, does not require initiation of a TBV (to be verified) number for tracking purposes. However, use of any data or output from this analysis for input into documents supporting procurement, fabrication, or construction is required to be controlled as TBV in accordance with appropriate procedures.

3. Method

The SAS2H sequence in SCALE 4.3 (Ref. 5.4) is used to calculate the isotopic composition, as a function of time, for the pressurized water reactor (PWR) criticality design basis fuel assembly. The prime module of this sequence is the ORIGEN-S code. This code does a point depletion of a selected fuel type with user specified irradiation conditions. At the completion of the depletion calculation, decay of the irradiated fuel with user specified time intervals is computed.

Number densities for subsequent MCNP cases are calculated using LOTUS 1-2-3 spreadsheets using the ORIGEN-S output.

The multiplication factor (k_{eff}) of the fissile material accumulations is determined using the Monte Carlo neutron transport technique implemented in the MCNP (Ref. 5.5) computer program. The resulting k_{eff} values for a variety of configurations are then provided for subsequent evaluation of the criticality potential of the disposal package and the acceptability of the design in meeting design requirements and criteria using probabilistic methods.

4. Design Inputs

The design inputs identified in this document are for preliminary design and shall be treated as unqualified data; these design input will require subsequent qualification (or superseding inputs) as the waste package design proceeds. This document will not directly support any construction, fabrication, or procurement activity and therefore is not required to be procedurally controlled as TBV.

The dimensions listed in this section and throughout this analysis are in the metric units used directly in the neutronics codes to facilitate checking and preclude errors in input.

4.1 Design Parameters

The composition and characteristics of the far-field tuff are shown in Table 4.1-1 (Ref. 5.7, p. 16 unless otherwise noted).

Table 4.1-1 CALICO HILLS/PROW PASS NONWELDED-ZEOLITIC TUFF

<u>Parameter</u>	<u>Value</u>
Mean Density 198 samples	1.746 g/cm ³ *
Mean Porosity 127 samples (Max = 0.470)	0.306*
SiO ₂ Wt.-frac.	69.1
TiO ₂ Wt.-frac.	0.11
Al ₂ O ₃ Wt.-frac.	13.4
Fe ₂ O ₃ Wt.-frac.	1.13
MnO Wt.-frac.	0.05
MgO Wt.-frac.	0.94
CaO Wt.-frac.	3.22
Na ₂ O Wt.-frac.	1.23
K ₂ O Wt.-frac.	2.64
P ₂ O ₅ Wt.-frac.	0.01
LOI (volatile) Wt.-frac.	8.90
Total Wt.-frac.	100.7

* Ref. 5.6, p. 7-11

In addition to the above major-element concentrations, 25 trace-element concentrations were identified by parts per million by weight (Ref. 5.7, Appendix C). Some of these trace elements have high absorption cross sections, for example, Eu, Hf, Sm, etc. The impact of these trace elements were evaluated for possible incorporation into the Tuff concentrations. As noted in Section 7.3.3, it was

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judged that no element contained sufficient concentrations with an adequate confidence in the nominal value to be included.

The atomic weights of isotopes used are listed in Table 4.1-2 (Ref 5.8, pp. 941-978).

Table 4.1-2 List of Isotope Atomic Weights

(Ref 5.8, pp. 941-978)

<u>Z</u>	<u>Element</u>	<u>Symbol</u>	<u>Isotope</u>	<u>MCNP ID</u>	<u>Atomic Weight</u>
1	Hydrogen	H	H-1	1001.50C	1.00782519
		D	H-2	1002.55C	2.01410222
		T	H-3	1003.50C	3.01604971
6	Carbon	C	natural	6000.50C	12.01115
		C	C-12	6012.50C	12.0000
8	Oxygen	O	O-16	8016.50C	15.994915
8	Oxygen	O	natural		15.999325*
11	Sodium	Na	Na-23	11023.50C	22.9897707
12	Magnesium	Mg	natural	12000.50C	24.312
13	Aluminum	Al	Al-27	13027.50C	26.9815389
14	Silicon	Si	natural	14000.50C	28.086
19	Potassium	K	natural	19000.50C	39.102
20	Calcium	Ca	natural	20000.50C	40.08
22	Titanium	Ti	natural	22000.50C	47.9
25	Manganese	Mn	Mn-55	25055.50C	54.9380503
26	Iron	Fe	natural	26000.55C	55.847
92	Uranium	U	U-233	92233.50C	233.039522
		U	U-234	92234.50C	234.040904
		U	U-235	92235.50C	235.043915
		U	U-236	92236.50C	236.045637
		U	U-238	92238.50C	238.05077
93	Neptunium	Np	Np-237	93237.55C	237.048056
94	Plutonium	Pu	Pu-238	94238.50C	238.049511
		Pu	Pu-239	94239.55C	239.052146
		Pu	Pu-240	94240.50C	240.053882
		Pu	Pu-241	94241.50C	241.056737
		Pu	Pu-242	94242.50C	242.058725
		Pu	Pu-243	94243.35C	243.061972
95	Americium	Am	Am-241	95241.50C	241.056714
		Am	Am-242m	95242.50C	242.059502
		Am	Am-243	95243.50C	243.061367
96	Curium	Cm	Cm-243	96243.35C	243.06137
		Cm	Cm-245	96245.35C	245.065371
		Cm	Cm-248	96248.35C	248.0722

* Calculated from atomic weights and abundances shown below.

In addition, the atomic weights of O-17 and O-18 are 16.9991314 and 17.999160, respectively (Ref. 5.9). The atom percent abundances of O-16, O-17 and O-18 are 99.76, 0.04 and 0.20, respectively (Ref. 5.9).

The atomic weight data listed above comes from handbooks and textbooks (Ref. 5.8, Ref. 5.9) that are utilized industry-wide. The data is taken to be established fact that requires no additional qualification.

The theoretical density of UO_2 is 10.96 g/cm^3 (Ref. 5.4, Table M8.2.1).

Avogadro's Number $[N_A] = 0.602252 \text{ (g-mol)}^{-1} \times 10^{24}$ (Ref. 5.8, p. 933). A physical constant is taken to be established fact that requires no additional qualification.

4.2 Criteria

This design analysis provides input for consequence analyses which evaluate whether waste package designs meet the repository criticality control design criteria from requirement documents. The *Engineered Barrier Design Requirements Document* (EBDRD, Ref. 5.10) has requirements which pertain to criticality analyses. These requirements apply to accumulations of fissile material in the far-field because far-field consequences can have an impact on the WP design. The WP is the source for material in the far-field and mitigation of significant consequences in the far-field may require some modification of the WP (Engineered Barrier) design. The requirements cited in Reference 5.10 that have bearing on this analysis include the following:

4.2.1 From the EBDRD (Ref. 5.10);

"3.2.2.6 CRITICALITY PROTECTION

- A. The Engineered Barrier Segment shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor must be sufficiently below unity to show at least a five percent margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the methods of calculation.

[MGDS-RD 3.2.2.6.A][10CFR60.131(b)(7)]

- B. To mitigate the potential for nuclear criticality, the Engineering Barrier Segment shall be designed and constructed to comply with the nuclear criticality requirements specified by DOE order 6430.1A, 1300-4.

[MGDS-RD 3.2.2.6.B] [DOE Order 6430.1A, 1300-4]"

The present DOE and Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O) management position is that the requirements cited in the above criteria based on 10CFR60.131(b)7, being primarily of a deterministic nature, is not appropriate for postclosure

disposal criticality analysis. Instead, the probability or risk based approach has been recommended to the U.S. Nuclear Regulatory Commission (NRC) in the following two letters:

- 4.2.2 From Ronald A. Milner, Director, Office of Program Management and Integration, Office of Civilian Radioactive Waste Management (OCRWM), to the NRC, Docketing and Service Branch, dated June 16, 1995 (Ref. 5.11), which included the specific recommendation to apply the above requirements only to preclosure, and create the following new requirement for postclosure criticality:

"Postclosure criticality safety. The engineered barrier system shall be designed such that the probability and consequences of nuclear criticality provide reasonable assurance that the performance objective of §60.112 is met." (Ref. 5.11)

- 4.2.3 From Stephan J. Brocoum, Assistant Manager for Suitability and Licensing, OCRWM, to Michael J. Bell, Chief, Engineering and Geosciences Branch, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, NRC (Ref. 5.18), which referred to the above referenced letter, and specifically commented as follows:

"The DOE, therefore, requests that consideration be given to the DOE's proposed revision to 10CFR60.131(b)7 that would allow disposal criticality to be evaluated with risk-based methods." (Ref. 5.18)

The analyses in this document are intended to provide input to consequence analyses whose output will be used as part of TSPA-VA to demonstrate compliance with the performance objective of §60.112. This study focuses on supporting a probabilistic analysis which will evaluate the probability of criticality of these accumulations rather than conformance with regulatory limits. Therefore, no regulatory safety margins are applied in calculating critical parameters in this study. This document will not directly support any construction, fabrication, or procurement activity.

4.3 Assumptions

- 4.3.1 Principal Isotope (PI) burnup credit is an acceptable criticality control mechanism for the waste package. (CDA Key 009) (Ref. 5.12). This assumption is used throughout Section 7.
- 4.3.2 Water infiltration has provided the mechanism for waste package and SNF degradation, as well as the mechanism for actinide transport to the far-field environment. This assumption is used throughout Section 7.
- 4.3.3 Only uranium and neptunium oxide accumulations are investigated. The transport of material from the waste package will likely occur over hundreds of thousands of years in which time the plutonium would have decayed to uranium or neptunium and an unknown fraction of the fission products would have been stripped away. This assumption is used throughout Section 7.
- 4.3.4 The fresh fuel bias and uncertainty for MCNP is approximately 0.015. This uncertainty was used in a prior unqualified analysis (Ref. 5.13, p. 6-221) and is appropriate for application to accumulations of U(Np)O₂. This assumption is used throughout Section 7.4.

- 4.3.5 The material compositions for tuff in the far-field is assumed to be represented by the major constituents of Calico Hills/Prow Pass nonwelded-zeolitic tuff taken from References 5.6 and 5.7. Portions of these formations fall within the saturated zone. This assumption is used throughout Section 7.
- 4.3.6 The accumulation of UO_2 in saturated tuff is assumed to be represented by a spherical homogeneous mixture of UO_2 /tuff/water. This is a reasonable geometry given that fracture distributions and densities in the tuff, size and density of potential uranium deposits, and presence and composition of reducing zones within the tuff are unknown. This assumption is used throughout Section 7.
- 4.3.7 The U(Np)O_2 is accumulated at the theoretical maximum density of UO_2 (natural U) of 10.96 g/cm^3 (Ref. 5.4, Table M8.2.1). This is conservative because the least amount of other material is displaced. This assumption is used throughout Section 7.

4.4 Codes and Standards

American National Standard on "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors", ANSI/ANS-8.17, 1984.

5. References

- 5.1 "Perform Criticality, Thermal, Structural, and Shielding Analyses," Document Identifier (DI) #: BB0000000-01717-2200-00025 REV 02, Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O).
- 5.2 "Quality Assurance Requirements and Description (QARD)," DOE/RW-0333P Rev 5, U. S. Department of Energy (USDOE) Office of Civilian Radioactive Waste Management (OCRWM).
- 5.3 "Yucca Mountain Site Characterization Project Q-List," YMP/90-55Q, REV 3, Yucca Mountain Site Characterization Project.
- 5.4 SCALE 4.3, RSIC Computer Code Collection, CCC-545, Oak Ridge National Laboratory, October 1995.
- 5.5 MCNP 4A - Monte Carlo N-Particle Transport Code System, RSIC Computer Code Collection, CCC-200, Oak Ridge National Laboratory, February 1994.
- 5.6 "Total-System Performance Assessment for Yucca Mountain - SNL Second Iteration (TSPA-1993)", Volume 1, Michael L. Wilson, et al., SAND93-2675, April 1994, pp. 7-11.
- 5.7 "Chemistry of Diagenetically Altered Tuffs at a Potential Nuclear Waste Repository, Yucca Mountain, Nye County, Nevada", David E. Broxton, et al., LA-10802-MS, October 1986, pp. 16, 52.

- 5.8 Nuclear Chemical Engineering, 2nd Edition, Manson Benedict, Thomas H. Pigford, and Hans W. Levi, McGraw-Hill Book Company, New York NY, 1981.
- 5.9 Nuclides and Isotopes, Fourteenth Edition, GE Nuclear Energy, 1989.
- 5.10 *Engineered Barrier Design Requirements Document*, YMP/CM-0024, REV 0, ICN 1, Yucca Mountain Site Characterization Project.
- 5.11 Letter, R.A. Milner to Secretary, U.S. NRC Docketing and Service Branch, Transmitting DOE comments regarding NRC-proposed revisions to 10 CFR Part 60 Regulations for Design Basis Events, June 16, 1995.
- 5.12 "Controlled Design Assumptions (CDA) Document," DI#: B00000000-01717-4600-00032 REV 03, CRWMS M&O.
- 5.13 "Initial Summary Report for Repository/Waste Package Advanced Conceptual Design," DI#: B00000000-01717-5705-00015 REV 00, CRWMS M&O, p. 6-221.
- 5.14 "SCALE4.3 and MCNP4A Installation," Interoffice Correspondence LV.WP.JWD.06/96.135, J. Wesley Davis, June 11, 1996, CRWMS M&O
- 5.15 American National Standard on "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors", ANSI/ANS-8.17, 1984.
- 5.16 "SAS2H Generated Isotopic Concentrations for B&W 15x15 PWR Assembly," DI#: BBA000000-01717-0200-00012 REV 00, CRWMS M&O.
- 5.17 "Probabilistic External Criticality Evaluation," DI#: BB0000000-01717-0200-00037 REV 00, CRWMS M&O.
- 5.18 Letter, S.J. Brocoum to M.J. Bell, Providing DOE acknowledgment of receipt of NRC comments on the Annotated Outline for the Disposal Criticality Analysis Topical Report, April 12, 1996.

6. Use of Computer Software

6.1 Scientific and Engineering Software

SCALE 4.3 has not been qualified according to QA procedures. The results of this analysis, therefore, shall be treated as unqualified data. SCALE 4.3 was run on HP Series 735 Workstations.

SCALE 4.3 is an appropriate tool to be utilized to determine the composition and characteristics of PWR spent fuel and has been demonstrated to run correctly on the HP 735 Workstations (Ref. 5.14).

MCNP4A was not qualified when this analysis began but was in the process of being qualified. The results from MCNP4A shall be treated as unqualified data. MCNP4A was run on HP 735 Workstations.

MCNP4A is utilized to determine the criticality potential of fissile material accumulations in the far-field environment external to the repository and is an appropriate tool for this purpose (Ref. 5.14).

There are biases and uncertainties associated with a criticality calculation. How these biases and uncertainties are treated in criticality calculations is covered in the American National Standard on "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors" (Ref. 5.15). The fresh fuel bias and uncertainty for MCNP is approximately 0.015. The fresh fuel bias and uncertainty is appropriate for application to the external accumulations of fissile material investigated in this analysis.

6.2 Computational Support Software

LOTUS 1-2-3, Release 4.01 for Windows was used to calculate the isotopic number densities for the tuff/water/ UO_2 mixtures investigated. Details of the equations used in the spreadsheet are provided in Section 7.3.3.

SLIDEWRIGHT PLUS V. 3.0 for WINDOWS was used for plotting the results. The plots with curvefitting are included in this report.

7. Design Analysis

This study was performed to determine the critical masses and concentrations of actinides released from breached waste packages in the far-field environment. This study will provide input to a risk analysis which will show to what extent the SNF waste package concept, in conjunction with the rest of the Engineered Barrier Segment (EBS), meets the regulatory requirements or indicate additional measures that are required for the EBS.

7.1 Background

The modeling of the SNF for evaluations of criticality and reactivity in the far-field is integrated with the scenarios for transport and deposit. The scenarios for SNF transport and deposit begin with the parameter of time. For SNF transport, the WP and fuel cladding must be breached and the fuel released from the repository with the transport mechanism. As noted in the assumptions, the time frame for the analysis is 100,000 years or more, after closure of the repository. In the 100,000 year period, it is assumed (Assumption 4.3.2) that water in some form has completely degraded the fuel container and degraded the fuel into elemental (molecular) forms. The water that causes the degradation of the container is assumed to be the transport mechanism that carries the fuel to the far-field. The water is also assumed to provide the mechanism for separating the actinides (uranium and neptunium) from the stable fission products and daughters of fission product decay.

7.2 Evaluation Procedure

The evaluation procedure is broken into two major tasks, with subtasks in each. The general procedure is as follows:

1) Material Composition Generation

- a) SAS2H Cases
- b) U(Np)O₂ isotopic composition calculation
- c) Number density calculations for Tuff/Water/UO₂ mixtures using spreadsheet

2) MCNP Criticality Cases

- a) k_{∞} cases for various burnup/enrichment pairs in various Tuff/Water/UO₂ mixtures which are plotted to identify the optimum (highest k_{∞}) mixtures.
- b) k_{eff} cases for optimum mixtures identified in previous subtask which are plotted to identify minimum critical sizes and masses of mixtures
- c) k_{eff} cases for nominal mixtures identified in previous subtask which are plotted to identify nominal critical sizes and masses of mixtures
- d) k_{∞} and k_{eff} cases for highest porosity tuff which are plotted to identify optimum moderator volume fractions and indicate magnitude of any positive effects due to reducing water volume fraction
- e) k_{∞} and k_{eff} cases specifically requested to support a separate probabilistic analysis

The results of task 1 and task 2 are listed in Sections 7.3 and 7.4, respectively.

7.3 Material Composition Generation

SAS2H calculations were first run on six fuel burnup/enrichment pairs to generate compositions in the form of grams/assembly. The six burnup/enrichment pairs were chosen to provide an indication of the effect of reduced effective enrichment on the critical masses to be calculated in this study. The actinides from the SAS2H calculations were then converted to the uranium or Np-237 isotopes into which they decay and number densities for the resulting oxide were calculated. These fuel number densities along with the compositions for tuff and water were then entered into a spreadsheet which was used to calculate homogenized number densities for the water/tuff/UO₂ mixtures to be investigated.

7.3.1 SAS2H Calculations

The base input for the SAS2H cases was taken from a previous QAP-3-9 analysis (Ref. 5.16) for a B&W 15x15 fuel assembly with 3% enrichment and 20 GWd/MTU burnup. The burnup conditions used are the most stressing in order to produce the most reactive burned fuel. Only the minor changes to the base model will be discussed in the current calculation.

In order to cover a wide range of the SNF inventory, six different burnup/enrichment pairs (five different enrichments) were run. The isotopic distribution of the uranium is determined by the given initial

enrichment and the following empirical relationship (Ref. 5.16):

$$\begin{aligned}\text{wt}\%_{234} &= 0.007731(\text{wt}\%_{235})^{1.0837}, \\ \text{wt}\%_{236} &= 0.0046\text{wt}\%_{235}, \\ \text{wt}\%_{238} &= 100\% - \text{wt}\%_{234} - \text{wt}\%_{235} - \text{wt}\%_{236}\end{aligned}$$

Using this formulation, the fresh fuel isotopics for selected U_{235} enrichments were calculated as shown in Table 7.3.1-1.

Table 7.3.1-1 Isotopic Makeup of Uranium of Selected U-235 Enrichments

U-235 Enrichment	3.0%	3.5%	4.0%	4.2%	4.5%
ISOTOPE	WT%				
U-234	2.54E-2*	3.00E-2	3.47E-2	3.66E-2	3.95E-2
U-236	1.38E-2	1.61E-2	1.84E-2	1.93E-2	2.07E-2
U-238	96.9608*	96.4539	95.9469	95.7441	95.4398

* The base case in Ref. 5.16 had a minor error in the U-234 and U-238 wt% calculations - actual values used in Ref. 5.16 and this analysis for consistency are 2.40E-2 and 96.9622 for U-234 and U-238, respectively.

Block 4 of the input has Zircaloy-4 entered as an arbitrary material rather than using the predefined zircaloy as listed in Reference 5.16 because the 44-group cross sections used with SCALE4.3 does not support this predefined material.

The EFPD entered in data block 8 (burn=) of the input is a function of burnup as indicated by the following equation:

$$\text{EFPD} = \text{Burnup (MWd/MTU)} \times (\text{MTU/Assembly}) / (\text{MW/Assembly})$$

From Reference 5.16, the MTU/Assembly is 0.464 and the MW/Assembly is 7.25. The EFPD calculated for each burnup is shown in Table 7.3.1-2. All other input is the same as that developed in Reference 5.16.

The input and relevant output from each of the six burnup/enrichment pair SAS2H cases are listed in Attachments II-VII.

Table 7.3.1-2 Burnup and Associated EFPD

BURNUP GWd/MTU	20	30	40	45	53
EFPD	1280	1920	2560	2880	3392

A simplistic identification of the fuel characteristics is expressed by the weight fractions of U-235 and Pu-239 relative to the total amount of metal (versus oxide) fuel material. The expression for determining the weight fraction of an isotope (I) of the metal fuel is:

$$\text{Weight Fraction(I)} = \text{Atom Fraction(I)} * \text{Atomic Weight(A}^i\text{)} / \text{Metal Atomic Weight}$$

Table 7.3.1-3 below gives the weight fractions of U-235, Pu-239 and (U-235 + Pu-239) after 1826.25 days of decay for three of the six SNF fuel burnup/enrichment pairs. The atom fractions are calculated by dividing the “gm-atoms” for a given isotope by the total “gm-atoms” from the SAS2H output included in Attachments II-VII.

Table 7.3.1-3 U-235 and Pu-239 Weight Fractions

Fuel Characteristics 1826.25 Day (5 Year) Decay	Weight Fraction in Fuel Metal		
	<u>U-235</u>	<u>Pu-239</u>	<u>U-235 + Pu-239</u>
3.0 Initial U-235 20 GWd Burnup	0.01397	0.00541	0.01938
3.5 Initial U-235 30 GWd Burnup	0.01242	0.00631	0.01873
4.0 Initial U-235 40 GWd Burnup	0.01122	0.00699	0.01821

7.3.2 U(Np)O₂ Isotopic Compositions

The uranium and neptunium isotopic compositions in the far-field originate with the six fuel burnup/enrichment pairs that are described above in Section 7.3.1. Attachments II-VII give the SAS2H results for the actinide isotopic fractions after decaying for 1826.25 days (5 years). For time periods of 100,000 years, the actinides decay to the asymptotic daughter products as shown below in Table 7.3.2-1. The decay chains shown in Table 7.3.2-1 were constructed from data in Reference 5.9. Atomic weights are not required in construction of the decay chains so isotopes may appear in Table 7.3.2-1 which are not listed in Table 4.1-2.

The resulting atom fractions of U-234, U-235, U-236, U-238 and Np-237 for each fuel-burnup type are applied to the constant atomic concentration of cubic crystalline UO₂ to determine the appropriate number density for each fuel isotope as shown in Table 7.3.2-2. The atom fractions are calculated by dividing the “gm-atoms” for a given isotope by the total “gm-atoms” for 5 years decay from the SAS2H output included in Attachments II-VII. These calculations are shown in the spreadsheet included in Attachment I.

The fuel characteristics when deposited in the far-field are modeled as a cubic crystalline UO₂-NpO₂ structure at 100% UO₂ density (10.96 g/cm³) in solid solution (molecular mixture) with the tuff material. Only the uranium and neptunium are included in the transport modeling. This provides a simplistic and more reactive fuel material but eliminates the complexity and the requirements to develop the model and probabilities that various amounts of other materials will be transported with the fuel. The reactivity of the fuel material is limited by the assumptions that (1) the fuel is a molecular mixture (homogeneous mixture, Assumption 4.3.6) with the tuff and not a particulate mixture, and (2) it does not contain water

in any physical or chemical form, only the tuff contains water (Assumption 4.3.7).

Table 7.3.2-1 Actinide Transmutation Chains

The density of the fuel deposited in the far-field is bounded by the maximum cubic crystalline density of UO_2 , 10.96 g/cm³ for natural uranium concentrations. Lower fuel densities are assumed not to have any open porosity. Therefore, the modeling parameter for fuel density is simply fixed at 100% theoretical for cubic crystalline UO_2 . Under these conditions, lower density fuel only includes voided space which decreases reactivity for finite systems and has no effect on infinite systems.

Table 7.3.2-2 Isotopic Concentrations In The Far-Field

Fuel Type	Asymptotic Transmutations ($\approx 100,000$ Years) Cubic Crystalline Concentrations				
	U-234	U-235	U-236	U-238	Np-237
3.0E-20GWd Atom Fraction Number Density (atoms/barn-cm)	.00024 5.868062 - 6	.01956 4.781608 - 4	.00468 1.144148 - 4	.97440 2.381875 - 2	.00112 2.728657 - 5
3.5E-30GWd Atom Fraction Number Density	.00036 8.691609 - 6	.01893 4.628167 - 4	.00653 1.597173 - 4	.97239 2.376949 - 2	.00179 4.376500 - 5
4.0E-40GWd Atom Fraction Number Density	.00051 1.246889 - 5	.01847 4.515723 - 4	.00825 2.017600 - 4	.97035 2.371969 - 2	.00241 5.898417 - 5
4.2E-45GWd Atom Fraction Number Density	.00060 1.463431 - 5	.01791 4.378063 - 4	.00902 2.204533 - 4	.96977 2.370558 - 2	.00270 6.599715 - 5
4.0E-45GWd Atom Fraction Number Density	.00059 1.444231 - 5	.01676 4.097444 - 4	.00881 2.153653 - 4	.97114 2.373895 - 2	.00270 6.597651 - 5
4.5E-53GWd Atom Fraction Number Density	.00076 1.865720 - 5	.01704 4.164425 - 4	.01012 2.473902 - 4	.96895 2.368540 - 2	.00313 7.658723 - 5

Note that the number densities were calculated with the spreadsheet values (no roundoff) for atom fractions.

The cubic structure of UO_2 results in the atomic concentration (atom / barn-cm) being a constant with the maximum value for 100% theoretical density. The 100% theoretical density and atom fractions of natural UO_2 are used to determine the maximum (constant) atomic concentrations as follows:

$$\text{Natural } \text{UO}_2 \text{ (100\% Theoretical Density)} = 10.96 \text{ gm / cm}^3$$

<u>Atom Fractions</u>	
U-234	= 0.000055
U-235	= 0.0072
U-238	= 0.992745

<u>Atomic Weights (g/mole)</u>	
A^{234}	= 234.040904
A^{235}	= 235.043915
A^{238}	= 238.05077

The molecular weight for UO_2 is calculated from the atomic weights of U and O (x 2).

<u>Molecules</u>	<u>Atomic Weights (g/mole)</u>
$U = 1.0$	$A^U = 238.028900$
$O = 2.0$	$A^O = 15.999325$
$UO_2 = 1.0$	$A^{UO_2} = 270.02755$

$$\text{Maximum Number Density } UO_2 \{ND(UO_2)\} = \frac{10.96 \text{ g/cm}^3 * 0.602252 \text{ molecules/mole}}{270.02755 \text{ g/mole}}$$

$$\text{Maximum } ND(UO_2) = .0244444758 \text{ molecules/b-cm}$$

$$ND(O) = .04888895 \text{ atoms/b-cm}$$

$$ND(U-234 + U-235 + U-236 + U-238 + Np-237) = .0244444758 \text{ atoms/b-cm}$$

The UO_2 number density (ND) and atomic weight are used in Attachment I calculations.

7.3.3 Tuff/Water/ UO_2 Mixture Number Densities

As discussed above in Section 7.3.2, the composition of the fuel is uranium dioxide and neptunium dioxide. This composition does not exist as an independent material in the far-field but as a solid solution (molecular mixture) with the tuff.

The far-field characteristics that involve increasing reactivity as fuel is deposited in with the tuff are (1) the composition of the tuff, and (2) the open porosity for water saturation. The far-field is composed of Prow Pass nonwelded-zeolitic tuff from the Crater Flat group of the Calico Hills formation (Ref. 5.6 and 5.7). The average density and porosity of the tuff along with the weight percent of the compounds are listed in Table 4.1-1. In addition to the average porosity of 30.6%, upper bounds of 47% (which may be anomalous datum) and 40% porosity are included as modeling parameters for the tuff. These increases in porosity are modeled with the appropriate reductions in density. The water that could saturate the tuff has a maximum density of H_2O (1.0 g/cm^3) and is modeled to fill the 47% and 40% of the open porosity in the upper bounding porosity models. The nominal porosity is modeled to be saturated with 30% of the total volume filled with water (0.6% left void). Evaluations of tuff dry-out were evaluated with 20% of the total volume filled with water (10.6% left void) in the nominal model, and a range of water from 47% to 15% in the bounding porosity model.

The atomic concentrations of hydrogen and oxygen in the water are determined as follows.

<u>Molecules</u>	<u>Atomic Weights (g/mole)</u>
$H = 2.0$	$A^H = 1.00782519$
$O = 1.0$	$A^O = 15.999325$
$H_2O = 1.0$	$A^{H_2O} = 18.014975$

$$\text{Number Density } H_2O \{ND(H_2O)\} = \frac{1.00 \text{ g/cm}^3 * .602252 \text{ molecules/mole}}{18.014975 \text{ g/mole}}$$

$$ND(H) = 6.686126 - 2$$

$$ND(O) = 3.343063 - 2$$

The nominal density and porosity of the tuff in the far-field are shown in Table 7.3.3-1 along with the weight fractions (Wt.-frac.) of the major constituents. The weight fractions of the constituents were converted from Table 4.1-1 by eliminating minor and volatile constituents and renormalizing. This conversion was performed in the spreadsheet included in Attachment I.

Table 7.3.3-1 Far-Field Dry Tuff Model
(Converted from Table 4.1-1)

<u>Parameter</u>	<u>Value</u>
Mean Density (Dry)	1.746 g/cm ³
Porosity (Mean)	0.306
SiO ₂ (Wt.-frac.)	0.754
Al ₂ O ₃ (Wt.-frac.)	0.146
Fe ₂ O ₃ (Wt.-frac.)	0.012
MgO (Wt.-frac.)	0.010
CaO (Wt.-frac.)	0.035
Na ₂ O (Wt.-frac.)	0.013
K ₂ O (Wt.-frac.)	<u>0.029</u>
Total Wt.-frac.	0.999

The number densities for the isotopic concentrations of the dry tuff were performed in the spreadsheet included in Attachment I and are evaluated as follows:

$$\text{Number Density } x \{ND(x)\} = \frac{1.746 * \text{Wt.-frac.}^x * .602252}{\text{Atomic Weight } (A^x)}$$

<u>Number Density (atoms/b-cm)</u>	<u>Atomic Weights (atoms/mole)</u>
$ND(O) = 2.638683E-2$	$A^O = 15.999325$
$ND(Si) = 1.319341E-2$	$A^{Si} = 28.086$
$ND(SiO_2) = 1.319341E-2$	$A^{SiO_2} = 60.08465$
$ND(O) = 4.523081E-3$	$A^O = 15.999325$
$ND(Al) = 3.015387E-3$	$A^{Al} = 26.9815389$
$ND(Al_2O_3) = 1.507694E-3$	$A^{Al_2O_3} = 101.9610528$
$ND(O) = 2.435338E-4$	$A^O = 15.999325$
$ND(Fe) = 1.623559E-4$	$A^{Fe} = 55.847$
$ND(Fe_2O_3) = 8.117793E-5$	$A^{Fe_2O_3} = 159.691975$
$ND(O) = 2.675121E-4$	$A^O = 15.999325$
$ND(Mg) = 2.675121E-4$	$A^{Mg} = 24.312$
$ND(MgO) = 2.675121E-4$	$A^{MgO} = 40.311325$
$ND(O) = 6.587122E-4$	$A^O = 15.999325$
$ND(Ca) = 6.587122E-4$	$A^{Ca} = 40.08$
$ND(CaO) = 6.587122E-4$	$A^{CaO} = 56.079325$
$ND(O) = 2.276691E-4$	$A^O = 15.999325$
$ND(Na) = 4.553382E-4$	$A^{Na} = 22.9897707$
$ND(Na_2O) = 2.276691E-4$	$A^{Na_2O} = 61.9788664$
$ND(O) = 3.214995E-4$	$A^O = 15.999325$
$ND(K) = 6.429990E-4$	$A^K = 39.102$
$ND(K_2O) = 3.214995E-4$	$A^{K_2O} = 94.203325$

In addition to the above major constituents, trace elements of thorium, samarium, europium, et cetera, were noted to also be constituents of the tuff. These trace elements would reduce the reactivity of the tuff. However, evaluating the effects of 20 parts-per-million (ppm) of thorium and 5 ppm of samarium with engineering judgement indicated that the negative reactivity effects were too small to accurately quantify. Therefore, the trace elements were not included in the tuff model.

When the porosity of the tuff is increased to 40% or 47%, the density is reduced. For example, with a density of 1.746 g/cm³ and a porosity of 0.306 for nominal tuff, a porosity of 0.47 has a density of

$$\text{Density (.47 porosity tuff)} = \frac{1.746 \text{ gm / cm}^3}{1.0 - .306} * (1.0 - .47)$$

$$\text{Density (.47 porosity tuff)} = 1.3334 \text{ gm / cm}^3$$

The (heterogeneous) isotopic concentrations computed above for the tuff, water and fuel (Section 7.3.2) are for each material as if it existed separately in the far-field. The UO₂ - NpO₂ fuel however is deposited with some resulting (molecular) mixture volume fraction with the tuff-water. The (homogeneous) isotopic concentrations for the mixture of far-field fuel and tuff-water are determined using a LOTUS 1-2-3 spreadsheet (Attachment VIII). An example of the spread sheet expression to compute the isotopic concentrations follows assuming (a) a fuel volume fraction of 0.185, (b) with a complementary tuff-water volume fraction of (1.0 - 0.185 =) 0.815, and (c) a tuff porosity of 0.47 that is completely saturated with water.

$$\text{Far - Field ND (UO}_2\text{ - NpO}_2\text{)}_{\text{Homogeneous}} = .185 * \text{ND (UO}_2\text{ - NpO}_2\text{)}_{\text{Heterogeneous}}$$

$$\text{Far - Field ND (Tuff Materials)}_{\text{Homogeneous}} = .815 * \text{ND (Tuff Materials)}_{\text{Heterogeneous}}$$

$$\text{Far - Field ND (Water)}_{\text{Homogeneous}} = .815 * .47 * \text{ND (Water)}_{\text{Heterogeneous}}$$

The spreadsheet listing all of the mixtures analyzed is included in Attachment VIII.

7.4 MCNP Criticality Cases

The analytical modeling of SNF in the far-field has the objective of determining the reactivity and the minimum critical mass. To determine the most reactive conditions and the configurations with the minimal critical mass, the analytical modeling employed separation of spatial and spectral variables. MCNP was used to determine the most reactive fuel and water-tuff conditions for the various fuel-burnup types in an infinite configuration. These optimal conditions of fuel-tuff-water were modeled in various MCNP configurations to determine the minimum critical mass.

The results from MCNP cases are reported as $k_{\text{eff}} \pm 2\sigma$. k_{eff} is the final estimated combined collision/absorption/track-length k_{eff} reported in MCNP. 2σ is twice the standard deviation of the calculated value and approximately represents the 95% confidence interval of the result.

All material fractions or percents reported in this Section are by volume unless otherwise noted.

7.4.1 Optimum Mixtures of Tuff/Water/ UO_2

Optimum mixtures of tuff/water/ UO_2 for various burnup/enrichment pairs are identified by running k_{∞} cases (reflected sphere) for the mixtures and plotting the results. A curve is fit to the points and the peak is identified from the curve.

Four water volume variations as described in Section 7.3.3 were run in the MCNP model for the 3.00% enrichment/20 GWd/MTU fuel form. The case inputs and relevant outputs are included in Attachments IX-XXXIII. These case descriptions and results are listed in Table 7.4.1-1. The results are plotted in Figure 7.4.1-1. Three cases for an additional mixture of 30% water and 35% C (50% of tuff replaced by C) were run to demonstrate the reactivity effect of the C. The results for the three additional cases are included in Table 7.4.1-1 and on Figure 7.4.1-1.

The optimum UO_2 volume percent for each of the four water volume variations was determined by reading off the UO_2 volume percent corresponding to the peak k_{∞} value from the curves on Figure 7.4.1-1. The optimum UO_2 volume percents are 18.5, 17.0, 15.0, and 11.6 for 47%, 40%, 30%, and 20% water in tuff, respectively.

Nine additional cases were run to identify the minimum water volume fraction required for criticality to occur. Criticality was defined as follows:

$$\text{CRITICAL} \equiv 1 - 0.015 - 2\sigma$$

Three cases each for 12%, 10%, and 8% UO_2 in a Tuff/Water mixture were run with the results listed in Table 7.4.1-2 and shown Figure 7.4.1-2. In the lower water volume fraction range the 10.0% UO_2 case has the highest values of k_{∞} . Using the relation listed above to define criticality and reading off Figure 7.4.1-2, 16.4% water is identified as the lowest volume percent for criticality for 30.6% porosity tuff.

Table 7.4.1-1 Results of 3.00% Enrichment/20 GWd/MTU Fuel Form Mixture Variation k_{∞} Cases

47% Water			40% Water			30% Water		20% Water			30% Water/ 35% C		
UO ₂ %	Att. #	k _∞ ± 2σ	Att. #	k _∞ ± 2σ	Att. #	k _∞ ± 2σ	UO ₂ %	Att. #	k _∞ ± 2σ	UO ₂ %	Att. #	k _∞ ± 2σ	
5	IX	0.8805 ± .0025	XV	0.8932 ± .0026	XXI	0.9072 ± .0017	5	XXVI	0.9285 ± .0019	3.6	XXXI	0.8970 ± .0022	
8	X	1.0096 ± .0023	XVI	1.0155 ± .0027	-	-	8	XXVII	0.9950 ± .0031	5	XXXII	0.9848 ± .0028	
10	XI	1.0559 ± .0029	XVII	1.0580 ± .0029	XXII	1.0371 ± .0021	10	XXVIII	1.0057 ± .0029	8	XXXIII	1.0704 ± .0035	
15	XII	1.1070 ± .0036	XVIII	1.0902 ± .0033	XXIII	1.05465 ± .0023	11.6	XXIX	1.0090 ± .0041	-	-	-	
20	XIII	1.1112 ± .0029	XIX	1.0893 ± .0034	XXIV	1.0393 ± .0024	15	XXX	0.9965 ± .0030	-	-	-	
25	XIV	1.0988 ± .0039	XX	1.0694 ± .0028	XXV	1.0073 ± .0024	-	-	-	-	-	-	

Table 7.4.1-2 3.00% Enrichment 20 GWd/MTU Minimum Water Volume Fraction For Criticality (k_{∞}) in Tuff with 30.6% Porosity

20% Water			18% Water		16% Water	
UO ₂ %	Att. #	k _∞ ± 2σ	Att. #	k _∞ ± 2σ	Att. #	k _∞ ± 2σ
8	XXXIV	0.9960 ± .0021	XXXVII	0.9904 ± .0022	XL	0.9777 ± .0020
10	XXXV	1.0078 ± .0022	XXXVIII	0.9948 ± .0022	XLI	0.9803 ± .0023
12	XXXVI	1.0089 ± .0023	XXXIX	0.9931 ± .0023	XLII	0.9729 ± .0023

Far-Field External Criticality Analysis

3.0% / 20 GWd/MTU UO_2 in Tuff/Water

○ 30% H_2O △ 20% H_2O ◇ 47% H_2O ▽ 30% H_2O / 35% C. □ 40% H_2O

FIGURE 7.4.1-1

FIGURE 7.4.1-2

Optimum mixtures of tuff/water/ UO_2 were identified using the method described above for:

- 3.5% enrichment, 30 GWd/MTU, for 30% and 20% water;
- 4.0% enrichment, 40 GWd/MTU, for 30% water;
- and 4.2% enrichment, 45 GWd/MTU, for 30% water.

The remaining burnup/enrichment pairs discussed in Section 7.3.1 were not run because these cases were sufficient to establish the reactivity trend of these results and the trend indicated that the last two pairs would be subcritical at all UO_2 volume percents at the nominal water concentration of 30%. The case inputs and relevant outputs are included in Attachments XLIII-LXI. These case descriptions and results are listed in Table 7.4.1-3. The results are plotted in Figure 7.4.1-3.

The optimum UO_2 volume percent for each of the four burnup/enrichment/water volume variations was determined by reading off the UO_2 volume percent corresponding to the peak k_{∞} value from the curves on Figure 7.4.1-3. The optimum UO_2 volume percents are 14.0, 12.0, 15.0, and 15.0 for 3.5% enrichment, 30 GWd/MTU, 30% water in tuff; 3.5% enrichment, 30 GWd/MTU, 20% water in tuff; 4.0% enrichment, 40 GWd/MTU, 30% water in tuff; and 4.2% enrichment, 45 GWd/MTU, 30% water in tuff, respectively.

Table 7.4.1-3 Results of Lower Reactivity Fuel Form Mixture Variation k_{∞} Cases

3.5% U-235/ 30 GWd/MTU 30% Water			3.5% U-235/ 30 GWd/MTU 20% Water			4.0% U-235/ 40 GWd/MTU 30% Water			4.2% U-235/ 45 GWd/MTU 30% Water		
UO_2 %	Att. #	$k_{\infty} \pm 2\sigma$	UO_2 %	Att. #	$k_{\infty} \pm 2\sigma$	UO_2 %	Att. #	$k_{\infty} \pm 2\sigma$	UO_2 %	Att. #	$k_{\infty} \pm 2\sigma$
5	XLIII	$0.8872 \pm .0033$	5	IL	$0.9065 \pm .0026$	5	LIII	$0.8689 \pm .0023$	10	LIX	$0.9809 \pm .0023$
8.8	XLIV	$0.9990 \pm .0034$	10	L	$0.9794 \pm .0031$	10	LIV	$0.9966 \pm .0027$	15	LX	$0.9935 \pm .0026$
10	XLV	$1.0125 \pm .0040$	12	LI	$0.9861 \pm .0040$	12	LV	$1.0058 \pm .0030$	20	LXI	$0.9744 \pm .0022$
14	XLVI	$1.0316 \pm .0037$	14	LII	$0.9804 \pm .0032$	14	LVI	$1.0091 \pm .0035$	-	-	-
15	XLVII	$1.0309 \pm .0031$	-	-	-	16	LVII	$1.0092 \pm .0025$	-	-	-
16	XLVIII	$1.0268 \pm .0037$	-	-	-	18	LVIII	$1.0034 \pm .0029$	-	-	-

FIGURE 7.4.1-3

7.4.2 Optimum Critical Sizes and Masses

Multiple k_{eff} cases were run for each of the optimum UO_2 volume percents identified for the four water volume variations of the 3.00% enrichment/20 GWd/MTU fuel form. These cases were run in order to identify the minimum sphere radius (and corresponding mass) at which these mixtures would be critical. These cases were modeled with an inner spherical region containing the tuff/water/ UO_2 mixture and an outer reflector region of at least 60 cm thick containing a tuff/water mixture. The results for these cases are shown in Table 7.4.2-1. The source distribution for these cases (large thermal systems) take a large number of cycles to reach equilibrium. As a result, most of the cases were run two or more times using the SRCTP file from the prior run until the statistical check in the output indicated the source distribution had reached equilibrium. The initial run of most of these cases used a starting source distribution from a SRCTP file for a case of similar size.

The minimum radius and associated minimum UO_2 mass are determined by plotting the results and fitting a second order polynomial to the results as shown in Figure 7.4.5-1 through 7.4.5-4. The critical radius value is then determined by identifying the point on the curve that meets the following relation:

$$\text{CRITICAL} = 1 - 0.015 - 2\sigma$$

The corresponding critical mass is calculated by multiplying the volume of the critical sphere ($4/3\pi r^3$) by the density of UO_2 (10.96 g/cm^3) and the volume percent of UO_2 in the mixture. The critical radii and UO_2 masses are shown in Table 7.4.2-2.

Table 7.4.2-1 Results of 3.00% Enrichment/20 GWd/MTU Fuel Form Optimum Mixture k_{eff} Cases

47% Water / 18.5% UO_2 47% Porosity			40% Water / 17% UO_2 40% Porosity			30% Water / 15% UO_2 30.6% Porosity			20% Water / 11.6% UO_2 30.6% Porosity		
r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$
57	LXII	$0.9787 \pm .0029$	60	LXVI	$0.9578 \pm .0014$	59	LXXII	$0.8980 \pm .0018$	180	LXXVIII	$0.9755 \pm .0019$
61	LXIII	$0.9950 \pm .0027$	65	LXVII	$0.9747 \pm .0014$	97.86	LXXIII	$0.9846 \pm .0018$	220	LXXIX	$0.9849 \pm .0017$
70	LXIV	$1.0202 \pm .0032$	70	LXVIII	$0.9873 \pm .0015$	103	LXXIV	$0.9893 \pm .0027$	250	LXXX	$0.9887 \pm .0019$
77	LXV	$1.0290 \pm .0024$	75	LXIX	$0.9986 \pm .0014$	113.15	LXXV	$0.9985 \pm .0024$	300	LXXXI	$0.9952 \pm .0019$
-	-	-	80	LXX	$1.0100 \pm .0014$	114.51	LXXVI	$0.9993 \pm .0025$	325	LXXXII	$0.9975 \pm .0019$
-	-	-	85	LXXI	$1.0158 \pm .0014$	123.15	LXXVII	$1.0088 \pm .0023$	345	LXXXIII	$1.0004 \pm .0017$
-	-	-	-	-	-	-	-	-	365	LXXXIV	$0.9987 \pm .0020$
-	-	-	-	-	-	-	-	-	385	LXXXV	$1.0020 \pm .0018$

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 18.5 vol% UO₂

+ 47% Water in Tuff

FIGURE 7.4.2-1

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 17 vol% UO₂

+ 40% Water in Tuff

FIGURE 7.4.2-2

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 15 vol% UO₂

+ 30% Water in Tuff

FIGURE 7.4.2-3

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 11.6 vol% UO_2

+ 20% Water in Tuff

FIGURE 7.4.2-4

Table 7.4.2-2 Critical Parameters for 3.00% Enrichment/20 GWd/MTU Optimum Mixtures

Critical Parameter	47% Water / 18.5% UO ₂ 47% Porosity	40% Water / 17% UO ₂ 40% Porosity	30% Water / 15% UO ₂ 30.6% Porosity	20% Water / 11.6% UO ₂ 30.6% Porosity
Radius (cm)	57.4	68.5	98	218
Mass (MT)	1.6	2.5	6.5	55.2

In order to demonstrate that the optimum compositions identified in Section 7.4.1 are applicable to the current calculations, two additional cases were run for the 61 cm radius sphere containing 47% water with 15% and 20% UO₂. The results are shown in the Table 7.4.2-3 with those for the optimum case at 18.5% UO₂. These results indicate that the optimum UO₂ volume fraction identified in the infinite calculations is applicable to the finite calculations.

Table 7.4.2-3 Confirmation of Optimum UO₂ Volume Percent for k_{eff} Cases.

47% Water / R=61 cm 47% Porosity 3.00% Enrichment/20 GWd/MTU		
UO ₂ Vol%	Att. #	$k_{eff} \pm 2\sigma$
15	LXXXVI	$0.9879 \pm .0030$
18.5	LXIII	$0.9950 \pm .0027$
20	LXXXVII	$0.9925 \pm .0031$

Multiple k_{eff} cases were also run for each of the optimum UO₂ volume percents for the following burnup/enrichment pair and water volume percent cases to demonstrate increasing critical mass requirements:

- 3.5% enrichment, 30 GWd/MTU, for 30% water;
- 4.0% enrichment, 40 GWd/MTU, for 30% water.

The results for these cases are listed in Table 7.4.2-4 and the results are plotted in Figures 7.4.2-5 and 7.4.2-6. The method described above was used to determine the critical radius and calculate the critical mass. The critical parameters are listed in Table 7.4.2-5.

Table 7.4.2-4 Results of Lower Reactivity Fuel Form Optimum Mixture k_{eff} Cases

3.5% U-235/ 30 GWd/MTU 30% Water/ 14% UO_2 30.6% Porosity			4.0% U-235/ 40 GWd/MTU 30% Water/ 15% UO_2 30.6% Porosity		
r (cm)	Att. #	$k_{eff} \pm 2\sigma$	r (cm)	Att. #	$k_{eff} \pm 2\sigma$
120	LXXXVIII	$0.9821 \pm .0029$	160	XCVII	$0.9806 \pm .0018$
130	LXXXIX	$0.9877 \pm .0021$	187	XCVIII	$0.9873 \pm .0017$
134	XC	$0.9901 \pm .0025$	219.08	IC	$0.9943 \pm .0019$
140	XCI	$0.9946 \pm .0026$	275.35	C	$0.9987 \pm .0019$
150	XCII	$0.9971 \pm .0030$	280	CI	$0.9989 \pm .0018$
151	XCIII	$0.9970 \pm .0041$	284.32	CII	$0.9993 \pm .0019$
152	XCIV	$0.9955 \pm .0034$	293.22	CIII	$1.0012 \pm .0020$
153	XCV	$0.9994 \pm .0037$	310	CIV	$1.0017 \pm .0017$
154.9	XCVI	$1.0013 \pm .0040$	-	-	-

Table 7.4.2-5 Critical Parameters for Lower Reactivity Fuel Form Optimum Mixtures

Critical Parameter	3.5% U-235/ 30 GWd/MTU 30% Water/ 14% UO_2 30.6% Porosity	4.0% U-235/ 40 GWd/MTU 30% Water/ 15% UO_2 30.6% Porosity
Radius (cm)	120	165
Mass (MT)	11.1	30.9

Far-Field External Criticality Analysis

3.5% Enriched, 30 GWd/MTU, 14 vol% UO_2

+ 30% Water in Tuff

FIGURE 7.4.2-5

Far-Field External Criticality Analysis

4.0% Enriched, 40 GWd/MTU, 15 vol% UO_2

+ 30% Water in Tuff

FIGURE 7.4.2-6

7.4.3 Nominal Critical Sizes and Masses

The optimum UO_2 volume fractions identified previously are much higher than could likely be achieved by natural processes. In order to demonstrate the effect of less conservative assumptions, lower volume percent UO_2 cases (nominal) were run for the tuff/water mixtures run for the 3.0% enrichment/20 GWd/MTU fuel form. Multiple k_{eff} cases were run for each mixture to demonstrate increasing critical mass requirements from the optimum mixture results.

The results for these cases are listed in Table 7.4.3-1 and the results are plotted in Figures 7.4.3-1 through 7.4.3-4. The method described in Section 7.4.2 was used to determine the critical radius and calculate the critical mass. The critical parameters are listed in Table 7.4.3-2.

Table 7.4.3-1 Results of 3.00% Enrichment/20 GWd/MTU Fuel Form Nominal Mixture k_{eff} Cases

47% Water / 8% UO_2 47% Porosity			40% Water / 8% UO_2 40% Porosity			30% Water / 10% UO_2 30.6% Porosity			30% Water / 8% UO_2 30.6% Porosity		
r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$	r (cm)	Att. #	$k_{\text{eff}} \pm 2\sigma$
115	CV	$0.9684 \pm .0022$	140	CXIII	$0.9819 \pm .0016$	115	CXXI	$0.9791 \pm .0032$	180	CXXVI	$0.9833 \pm .0020$
150	CVI	$0.9855 \pm .0021$	150	CXIV	$0.9867 \pm .0015$	125	CXXII	$0.9909 \pm .0035$	220	CXXVII	$0.9905 \pm .0022$
160	CVII	$0.9908 \pm .0020$	160	CXV	$0.9892 \pm .0016$	140	CXXIII	$0.9997 \pm .0029$	280	CXXVIII	$0.9963 \pm .0022$
175	CVIII	$0.9915 \pm .0018$	175	CXVI	$0.9901 \pm .0017$	155	CXXIV	$1.0046 \pm .0028$	300	CXXIX	$0.9978 \pm .0021$
190	CIX	$0.9967 \pm .0017$	190	CXVII	$0.9976 \pm .0013$	170	CXXV	$1.0096 \pm .0031$	335	CXXX	$0.9995 \pm .0028$
205	CX	$0.9979 \pm .0023$	205	CXVIII	$0.9960 \pm .0018$	-	-	-	345	CXXXI	$0.9981 \pm .0029$
220	CXI	$0.9974 \pm .0015$	220	CXIX	$0.9991 \pm .0014$	-	-	-	355	CXXXII	$1.0020 \pm .0020$
235	CXII	$1.0020 \pm .0022$	235	CXX	$1.0035 \pm .0016$	-	-	-	365	CXXXIII	$1.0021 \pm .0028$

Table 7.4.3-2 Critical Parameters for 3.00% Enrichment/20 GWd/MTU Nominal Mixture Cases

Critical Parameter	47% Water / 8% UO_2 47% Porosity	40% Water / 8% UO_2 40% Porosity	30% Water / 10% UO_2 30.6% Porosity	30% Water / 8% UO_2 30.6% Porosity
Radius (cm)	140	140	117	170
Mass (MT)	10.1	10.1	7.4	18.0

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2

+ 47% Water in Tuff

FIGURE 7.4.3-1

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2

+ 40% Water in Tuff

FIGURE 7.4.3-2

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 10 vol% UO₂

+ 30% Water in Tuff

FIGURE 7.4.3-3

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2

+ 30% Water in Tuff

FIGURE 7.4.3-4

7.4.4 Moderator Volume Fraction Effects

The results shown in Table 7.4.2-1 indicate that there are various far-field combinations of (a) asymptotically transmuted SNF without fission products or fission product daughters, and (b) tuff with water that would be critical. In addition, the results shown in Table 7.4.1-1 indicate that there is a reactivity dependency on the water moderation. Depending on the volume fraction of $\text{UO}_2\text{-NpO}_2$ that is assumed to be deposited in a combined mass of fuel and tuff with water, increasing the water volume fraction in the open porosity of the tuff can both increase and decrease reactivity. Consequently, it is feasible that a positive moderator void coefficient would exist in a subcritical mass of $\text{UO}_2\text{-NpO}_2$ fuel. The evaluations performed to determine the combinations of fuel, tuff and water necessary to have a positive moderator void coefficient are explained in this section. The conclusions are that (1) the nominal tuff with 30.6% porosity will not have a positive void coefficient, (2) the most porous tuff (47%) could possibly have a positive coefficient, and (3) the effects of the positive coefficient could hypothetically produce a dynamic fissioning system and a limited neutron - thermal transient. The consequences of the hypothetical transient and dynamic system are not addressed in this document.

Figure 7.4.4-1 and Table 7.4.4-1 summarize results which show that large configurations (infinite) have a very positive moderator void coefficient if the tuff contains the maximum porosity (47%) that has been observed, and the open porosity is completely saturated. The magnitude of the moderator void coefficient is increased by having both the greatest amount of water, and the least amount of $\text{UO}_2\text{-NpO}_2$ in the fuel-tuff-water mixture.

Table 7.4.4-1 Positive Reactivity From Moderator Voids

3.00 Wt. % Initial Enrichment 20 GWd/MTU Burnup 8% $\text{UO}_2\text{-NpO}_2$ 92% Tuff-Water 47% Tuff Porosity				
Water %	Att. #	$K_{\infty} \pm 2\sigma$	Att. #	$K_{\text{eff}} \pm 2\sigma$
47	CXXXIV	$1.01025 \pm .0018$	CXLI	$.98706 \pm .0013$
40	CXXXV	$1.02854 \pm .0018$	CXLII	$.99684 \pm .0014$
35	CXXXVI	$1.03566 \pm .0019$	CXLIII	$1.00242 \pm .0015$
30	CXXXVII	$1.04272 \pm .0019$	CXLIV	$1.00163 \pm .0016$
25	CXXXVIII	$1.04320 \pm .0020$	CXLV	$.99189 \pm .0016$
20	CXXXIX	$1.03318 \pm .0022$	CXLVI	$.97117 \pm .0016$
15	CXL	$1.00676 \pm .0022$	CXLVII	$.93067 \pm .0018$

Figures 7.4.1-1 and 7.4.3-1 indicate that 8% $\text{UO}_2\text{-NpO}_2$ by volume with the 47% saturated tuff would be around the lowest practical amount of fuel. The reactivity (ρ) increase with these optimal conditions

of maximum water and minimum fuel is 0.0025 $\Delta \rho$ per percent void in an infinite configuration. Consequently, only 2% to 3% voiding would result in a prompt critical system.

For configurations with the minimum size, and minimum amount of fuel that would achieve criticality in the far-field, the leakage effects on reactivity produce a large reduction in the positive moderator void coefficient. A 150 cm radius sphere was found to have a leakage of 2.35% in reactivity. The k_{eff} for this high leakage configuration is 0.987 as shown in Figure 7.4.4-1 and Table 7.4.4-1. The leakage effects reduce the positive void coefficient to 0.0014 $\Delta \rho$ per percent void. While this is a significant reduction from 0.0025 $\Delta \rho$ / % Void the positive void coefficient still needs to be addressed in the future because 4% to 5% voiding could create a prompt critical system, although the magnitude of a power transient would be extremely limited in the unlikely event that one started in the first place. It should be noted that for a finite system the k_{eff} drops sharply from the peak of the curve as the water volume fraction is reduced. This would tend to quickly shutdown any transients which may be started.

In order for a significant increase in power to occur, a mechanism for introducing the reactivity increase (moderator volume percent decrease) instantaneously would be required. If the reactivity is inserted (water removed) over a time scale of seconds or greater then the temperature feedback effects of increasing power would likely compensate and keep the system relatively stable and at low power.

FIGURE 7.4.4-1

7.4.5 Additional Cases

Several cases were specifically requested to support separate probabilistic analyses. These cases are documented in this section. All cases in this section are based on the 3.0% enrichment/ 20 GWd/MTU actinide isotopics. These cases include:

2 fuel zone cases to demonstrate the effect of reduced density UO_2 in second zone, cylindrical configuration (log simulation).

Two sets of cases were requested to demonstrate the reactivity effect of a secondary fuel shell around the primary sphere in support of methodology development for probabilistic analyses (Ref. 5.17). The primary fuel zone contains 18.5 volume percent UO_2 based on the 3.0% enrichment/ 20 GWd/MTU pair. The tuff porosity is 47% and is assumed completely filled with water. The secondary shell is twice the radius of the primary sphere. The average (two region) UO_2 volume fraction specified for the two sets of cases is 9.2% and 4.6% with corresponding volume fractions in the outer shell of 7.87% and 2.61%, respectively. The volume fractions in the secondary shell correspond to approximately 3/7 and 1/7 of the primary sphere volume fraction, respectively. The mixture number densities are calculated in a spreadsheet as described in Section 7.3.3 and included in Attachment VIII. Multiple k_{eff} cases were run for each of these two mixtures in order to identify the minimum sphere radius (and corresponding mass) at which these mixtures would be critical. The results for these cases are shown in Table 7.4.5-1. The minimum radius and associated minimum UO_2 mass are determined by plotting the results as shown in Figures 7.4.5-1 and 7.4.5-2 and performing the operations previously described in Section 7.4.2. The critical radii and UO_2 masses for the inner spherical fuel zone are 39.4 cm (0.52 MT) and 54.2 cm (1.4 MT) for 9.2 % and 4.6% UO_2 , respectively. The total critical mass for the primary and secondary zones is 2.1 MT and 2.7 MT for 9.2% and 4.6% UO_2 , respectively. The minimum critical mass for the single fuel zone case calculated in Section 7.4.2 is 1.6 MT.

Table 7.4.5-1 Results for 2 Fuel Zone Cases to Determine Critical Radii

9.2 Average Volume % for UO_2			4.6 Average Volume % for UO_2		
Inner Radius (cm)	Attachment #	$k_{\text{eff}} \pm 2\sigma$	Inner Radius (cm)	Attachment #	$k_{\text{eff}} \pm 2\sigma$
40	CXLVIII	$0.9847 \pm .0018$	53	CLI	$0.9762 \pm .0017$
50	CIL	$1.0140 \pm .0018$	55	CLII	$0.9870 \pm .0018$
57.4	CL	$1.0301 \pm .0019$	57.4	CLIII	$0.9939 \pm .0018$

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 47 vol% Water in Tuff

+ 2 Zones, 18.5 vol% UO₂ Center / 9.2 Vol% Average

FIGURE 7.4.5-1

Far-Field External Criticality Analysis

3.0% Enriched, 20 GWd/MTU, 47 vol% Water in Tuff

+ 2 Zones, 18.5 vol% UO₂ Center / 4.6 Vol% Average

FIGURE 7.4.5-2

The highest local uranium ore concentrations in the United States are found in the Uravan Mineral Belt in southwestern Colorado and southeastern Utah. These are up to 21.5% U_3O_8 by weight and are found in fossilized logs along pre-historic riverbeds (Ref. 5.17, Attachment II). The maximum values of log parameters were determined to be:

radius=61 cm,
length= 24.4 m (80 ft),
 UO_2 weight fraction= 0.215 (4.6 volume %).

These parameters (Ref. 5.17) were used for a 40% volume percent water in tuff mixture to demonstrate a low k_{eff} for this configuration (infinite length). This resulting k_{eff} for this case is $0.7926 \pm .0015$. The input and relevant output for this case is included in Attachment CLIV.

8. Conclusions

The results of this study should be treated as unqualified data and not be used for procurement, fabrication, or construction unless properly identified, tracked as TBV, and controlled by the appropriate procedures.

The major results are summarized below:

CRITICALITY DEFINED as $k_{eff} = \{1.0 - .015 \text{ (bias and uncertainty)} - 2\sigma\}$ from Curves

The water volume percents quoted throughout this report have been the volume percent water in a tuff/water mixture. The UO_2 volume percent quoted displaces the tuff/water mixture such that the water volume fraction in the tuff/water/ UO_2 mixture is reduced by the factor $(1 - UO_2 \text{ volume fraction})$. The volume fraction of water in the tuff/water/ UO_2 mixture is reported next to the UO_2 volume fraction in the mixture.

3.0% Enrichment/ 20 GWd/MTU

47% water in Tuff

Minimum critical radius/mass at 18.5 vol% UO_2 / 38.3 vol% water - $R=57.4$ cm,

UO_2 mass=1.6 MT, UO_2 $\rho=2.028$ g/cm³

8 vol% UO_2 / 43.2 vol% water - $R=140$ cm, UO_2 mass=10.1, UO_2 $\rho=0.877$ g/cm³

Minimum UO_2 vol%/density for criticality ($k_{\infty}=0.982$) - 7.2 vol% / 0.789 g/cm³

40% water in Tuff

Minimum critical radius/mass at 17 vol% UO_2 / 33.2 vol% water - $R=68.5$ cm,

UO_2 mass=2.5 MT, UO_2 $\rho=1.863$ g/cm³

8 vol% UO_2 / 36.8 vol% water - $R=140$ cm, UO_2 mass=10.1, UO_2 $\rho=0.877$ g/cm³

Minimum UO_2 vol%/density for criticality ($k_{\infty}=0.982$) - 7.1 vol% / 0.778 g/cm³

30% water in Tuff

Minimum critical radius/mass at 15 vol% UO_2 / 25.5 vol% water - R=98 cm,

UO_2 mass=6.5 MT, UO_2 ρ =1.644 g/cm³

10 vol% UO_2 / 27.0 vol% water - R=117 cm, UO_2 mass=7.4 MT,

UO_2 ρ =1.096 g/cm³

8 vol% UO_2 / 27.6 vol% water - R=170 cm, UO_2 mass=18.0 MT,

UO_2 ρ =0.877 g/cm³

Minimum UO_2 vol%/density for criticality (k_{∞} =.982) - 7.0 vol% / 0.767 g/cm³

20% water in Tuff

Minimum critical radius/mass at 11.6 vol% UO_2 / 17.7 vol% water - R=218 cm,

UO_2 mass=55.2 MT, UO_2 ρ =1.271 g/cm³

Minimum UO_2 vol%/density for criticality (k_{∞} =.982) - 7.2 vol% / 0.789 g/cm³

≤16.4% water in Tuff - subcritical

3.5% Enrichment/ 30 GWd/ MTU**30% water in Tuff**

Minimum critical radius/mass at 14 vol% UO_2 / 25.8 vol% water - R=120 cm,

UO_2 mass=11.1 MT, UO_2 ρ =1.534 g/cm³

Minimum UO_2 vol%/density for criticality (k_{∞} =.982) - 7.6 vol% / 0.833 g/cm³

≤20% water in Tuff - subcritical

4.0% Enrichment/ 40 GWd/ MTU**30% water in Tuff**

Minimum critical radius/mass at 15 vol% UO_2 / 25.5 vol% water - R=165 cm,

UO_2 mass=30.9 MT, UO_2 ρ =1.644 g/cm³

Minimum UO_2 vol%/density for criticality (k_{∞} =.982) - 8.6 vol% / 0.943 g/cm³

≤20% water in Tuff - subcritical

3.0% Enrichment/ 20 GWd/ MTU, 47% Porosity, 8.0 volume% UO_2

Peak k_{∞} =1.044 at 27 volume% water, Δk from 47% water = 0.034

Peak k_{eff} =1.003 at 33 volume% water for 150 cm sphere, Δk from 47% water = 0.017

The evaluations performed to determine the combinations of fuel, tuff and water necessary to have a positive moderator void coefficient provide the following conclusions: (1) the nominal tuff with 30.6% porosity will not have a positive void coefficient, (2) the most porous tuff (47%) could possibly have a positive coefficient, and (3) the effects of the positive coefficient could hypothetically produce a dynamic fissioning system and a limited neutron-thermal transient. The consequences of the hypothetical transient and dynamic system are not addressed in this document.

9. Attachments

The following Attachments are case output files as listed. The name of the file is listed in parenthesis.

- I. LOTUS 1-2-3 Spreadsheet for Base number densities (atomden.wk3 sheet A), 9/3/96, 2 pages

Cases for Section 7.3.1

- II. SAS2H Case - 3.0% Enrichment, 20 GWd/MTU (o3020.res), 4/5/96, 6 pages
- III. SAS2H Case - 3.5% Enrichment, 30 GWd/MTU (o3530.res), 4/5/96, 5 pages
- IV. SAS2H Case - 4.0% Enrichment, 40 GWd/MTU (o4040.res), 4/8/96, 6 pages
- V. SAS2H Case - 4.0% Enrichment, 45 GWd/MTU (o4045.res), 4/5/96, 6 pages
- VI. SAS2H Case - 4.2% Enrichment, 45 GWd/MTU (o4245.res), 4/5/96, 6 pages
- VII. SAS2H Case - 4.5% Enrichment, 53 GWd/MTU (o4553.res), 4/5/96, 6 pages
- VIII. LOTUS 1-2-3 Spreadsheet for Mixture number densities (lespher2.wk4 sheet B), 8/27/96, 11 pages

Cases for Section 7.4.1

- IX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 5% UO₂ (i3020md.sum), 6/5/96, 1 page
- X. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO₂ (i3020mf.sum), 5/21/96, 1 page
- XI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 10% UO₂ (i3020me.sum), 5/21/96, 1 page
- XII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 15% UO₂ (i3020ma.sum), 5/21/96, 1 page
- XIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 20% UO₂ (i3020mb.sum), 5/21/96, 1 page
- XIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 25% UO₂ (i3020mc.sum), 5/21/96, 1 page
- XV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 5% UO₂ (i3020oa.sum), 5/21/96, 1 page
- XVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO₂ (i3020ob.sum), 5/21/96, 1 page
- XVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 10% UO₂ (i3020oc.sum), 5/21/96, 1 page
- XVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 15% UO₂ (i3020od.sum), 5/21/96, 1 page
- XIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 20% UO₂ (i3020oe.sum), 5/21/96, 1 page
- XX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 25% UO₂ (i3020of.sum), 5/21/96, 1 page
- XXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 5% UO₂ (I1-3.0E-20GWd-30W05U), 5/20/96, 2 pages
- XXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO₂

- (I2-3.0E-20GWd-30W10U), 5/20/96, 2 pages
- XXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2
(I3-3.0E-20GWd-30W15U), 5/20/96, 2 pages
- XXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 20% UO_2
(I4-3.0E-20GWd-30W20U), 5/20/96, 2 pages
- XXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 25% UO_2
(I5-3.0E-20GWd-30W25U), 5/20/96, 2 pages
- XXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 5% UO_2
(I1-3.0E-20GWd-20W05U), 5/20/96, 2 pages
- XXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 8% UO_2
(I2-3.0E-20GWd-20W08U), 5/20/96, 2 pages
- XXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 10% UO_2
(I3-3.0E-20GWd-20W10U), 5/20/96, 2 pages
- XXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2
(I4-3.0E-20GWd-20W12U), 5/20/96, 2 pages
- XXX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 15% UO_2
(I5-3.0E-20GWd-20W15U), 5/20/96, 2 pages
- XXXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 35% C, 3.6% UO_2
(i3020of.sum), 6/5/96, 1 page
- XXXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 35% C, 5% UO_2
(i3020of.sum), 6/5/96, 1 page
- XXXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 35% C, 8% UO_2
(i3020of.sum), 6/5/96, 1 page
- XXXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 8% UO_2
(IMW-3.0E-20GWd-20W08U), 6/7/96, 2 pages
- XXXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 10% UO_2
(IMW-3.0E-20GWd-20W10U), 6/7/96, 2 pages
- XXXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 12% UO_2
(IMW-3.0E-20GWd-20W12U), 6/7/96, 2 pages
- XXXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 18% Water, 8% UO_2
(IMW-3.0E-20GWd-18W08U), 6/7/96, 2 pages
- XXXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 18% Water, 10% UO_2
(IMW-3.0E-20GWd-18W10U), 6/7/96, 2 pages
- XXXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 18% Water, 12% UO_2
(IMW-3.0E-20GWd-18W12U), 6/7/96, 2 pages
- XL. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 16% Water, 8% UO_2
(IMW-3.0E-20GWd-16W08U), 6/7/96, 2 pages
- XLI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 16% Water, 10% UO_2
(IMW-3.0E-20GWd-16W10U), 6/7/96, 2 pages
- XLII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 16% Water, 12% UO_2
(IMW-3.0E-20GWd-16W12U), 6/7/96, 2 pages
- XLIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 5% UO_2 (i3530f.sum),
5/22/96, 1 page

- XLIV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 8.8% UO_2 (i3530e.sum), 5/21/96, 1 page
- XLV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 10% UO_2 (i3530d.sum), 5/21/96, 1 page
- XLVI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2 (i3530c.sum), 5/21/96, 1 page
- XLVII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 15% UO_2 (i3530a.sum), 5/21/96, 1 page
- XLVIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 16% UO_2 (i3530b.sum), 5/21/96, 1 page
- IL. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 20% Water, 5% UO_2 (i3530j.sum), 5/22/96, 1 page
- L. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 20% Water, 10% UO_2 (i3530i.sum), 5/22/96, 1 page
- LI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 20% Water, 12% UO_2 (i3530g.sum), 5/22/96, 1 page
- LII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 20% Water, 14% UO_2 (i3530h.sum), 5/22/96, 1 page
- LIII. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 5% UO_2 (i4040f.sum), 5/22/96, 1 page
- LIV. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 10% UO_2 (i4040d.sum), 5/22/96, 1 page
- LV. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 12% UO_2 (i4040b.sum), 5/22/96, 1 page
- LVI. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 14% UO_2 (i4040a.sum), 5/22/96, 1 page
- LVII. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 16% UO_2 (i4040c.sum), 5/22/96, 1 page
- LVIII. MCNP Case - 4.0% Enrichment, 30 GWd/MTU, 20% Water, 18% UO_2 (i4040e.sum), 5/22/96, 1 page
- LIX. MCNP Case - 4.2% Enrichment, 45 GWd/MTU, 30% Water, 10% UO_2 (i4245a.sum), 8/27/96, 1 pages
- LX. MCNP Case - 4.2% Enrichment, 45 GWd/MTU, 30% Water, 15% UO_2 (i4245b.sum), 8/27/96, 1 pages
- LXI. MCNP Case - 4.2% Enrichment, 45 GWd/MTU, 30% Water, 20% UO_2 (i4245c.sum), 8/27/96, 1 pages

Cases for Section 7.4.2

- LXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 18.5% UO_2 , r=57 (s3020me.sum), 5/23/96, 2 pages
- LXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 18.5% UO_2 , r=61 (s3020md.sum), 5/23/96, 2 pages
- LXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 18.5% UO_2 , r=70 (s3020mb.sum), 5/23/96, 2 pages

- LXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 18.5% UO_2 , $r=77$
(s3020ma.sum), 5/23/96, 2 pages
- LXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=60$
(s3020oa.sum), 5/23/96, 2 pages
- LXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=65$
(s3020ob.sum), 5/23/96, 2 pages
- LXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=70$
(s3020oc.sum), 5/23/96, 2 pages
- LXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=75$
(s3020od.sum), 5/23/96, 2 pages
- LXX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=80$
(s3020oe.sum), 5/23/96, 2 pages
- LXXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 17% UO_2 , $r=85$
(s3020of.sum), 5/23/96, 2 pages
- LXXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=59$
(C1-3.0E-20GWd-30W15U), 5/20/96, 2 pages
- LXXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=97.86$
(C2-3.0E-20GWd-30W15U), 5/17/96, 2 pages
- LXXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=103$
(S3020a.sum), 6/10/96, 2 pages
- LXXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=113.15$
(C4-3.0E-20GWd-30W15U), 5/20/96, 2 pages
- LXXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=114.51$
(C5-3.0E-20GWd-30W15U), 5/20/96, 2 pages
- LXXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 15% UO_2 , $r=123.15$
(C6-3.0E-20GWd-30W15U), 5/20/96, 2 pages
- LXXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=180$
(s30e12h.sum), 6/7/96, 2 pages
- LXXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=220$
(s30e12g.sum), 6/7/96, 2 pages
- LXXX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=250$
(s30e12f.sum), 6/7/96, 2 pages
- LXXXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=300$
(s30e12e.sum), 6/7/96, 2 pages
- LXXXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=325$
(s30e12b.sum), 6/7/96, 2 pages
- LXXXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=345$
(s30e12a.sum), 6/7/96, 2 pages
- LXXXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=365$
(s30e12c.sum), 6/7/96, 2 pages
- LXXXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 11.6% UO_2 , $r=385$
(s30e12d.sum), 6/7/96, 2 pages
- LXXXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 15% UO_2 , $r=61$

- (s3020mh.sum), 6/6/96, 2 pages
- LXXXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 20% UO₂, r=61
(s3020mi.sum), 6/6/96, 2 pages
- LXXXVIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=120
(s3530i.sum), 5/24/96, 2 pages
- LXXXIX. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=130
(s3530h.sum), 5/24/96, 2 pages
- XC. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=134
(s3530g.sum), 5/24/96, 2 pages
- XCI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=140
(s3530f.sum), 5/23/96, 2 pages
- XCII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=150
(s3530b.sum), 5/24/96, 2 pages
- XCIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=151
(s3530c.sum), 5/23/96, 2 pages
- XCIV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=152
(s3530d.sum), 5/23/96, 2 pages
- XCV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=153
(s3530e.sum), 5/23/96, 2 pages
- XCVI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO₂, r=154.9
(s3530a.sum), 5/23/96, 2 pages
- XCVII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=160
(C1-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- XCVIII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=187
(C2-4.0E-40GWd-30W15U), 5/20/96, 2 pages
- IC. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=219.08
(C3-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- C. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=275.35
(C4-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- CI. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=280
(C5-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- CII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=284.32
(C6-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- CIII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=293.22
(C7-4.0E-40GWd-30W15U), 5/21/96, 2 pages
- CIV. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO₂, r=310
(C8-4.0E-40GWd-30W15U), 5/20/96, 2 pages

Cases for Section 7.4.3

- CV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO₂, r=115
(s3020nh.sum), 5/24/96, 2 pages
- CVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO₂, r=150
(s3020ni.sum), 5/24/96, 2 pages
- CVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO₂, r=160

- (s3020nb.sum), 5/24/96, 2 pages
- CVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $r=175$
(s3020nc.sum), 5/24/96, 2 pages
- CIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $r=190$
(s3020nd.sum), 5/24/96, 2 pages
- CX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $r=205$
(s3020ne.sum), 5/24/96, 2 pages
- CXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $r=220$
(s3020nf.sum), 5/24/96, 2 pages
- CXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $r=235$
(s3020ng.sum), 8/27/96, 2 pages
- CXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=140$
(s3020ph.sum), 5/24/96, 2 pages
- CXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=150$
(s3020pa.sum), 5/24/96, 2 pages
- CXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=160$
(s3020pb.sum), 5/24/96, 2 pages
- CXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=175$
(s3020pc.sum), 5/24/96, 2 pages
- CXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=190$
(s3020pd.sum), 5/24/96, 2 pages
- CXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=205$
(s3020pe.sum), 5/24/96, 2 pages
- CXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=220$
(s3020pf.sum), 5/24/96, 2 pages
- CXX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $r=235$
(s3020pg.sum), 5/24/96, 2 pages
- CXXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2 , $r=115$
(s3020be.sum), 5/24/96, 2 pages
- CXXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2 , $r=125$
(s3020ba.sum), 5/24/96, 2 pages
- CXXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2 , $r=140$
(s3020bb.sum), 5/24/96, 2 pages
- CXXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2 , $r=155$
(s3020bc.sum), 5/24/96, 2 pages
- CXXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2 , $r=170$
(s3020bd.sum), 5/24/96, 2 pages
- CXXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=180$
(s3020ah.sum), 5/24/96, 2 pages
- CXXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=220$
(s3020ag.sum), 5/24/96, 2 pages
- CXXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=280$
(s3020af.sum), 5/24/96, 2 pages

- CXXXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=300$
(s3020ae.sum), 5/24/96, 2 pages
- CXXX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=335$
(s3020ad.sum), 5/24/96, 2 pages
- CXXXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=345$
(s3020ac.sum), 5/13/96, 2 pages
- CXXXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=355$
(s3020ab.sum), 5/24/96, 2 pages
- CXXXIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $r=365$
(s3020aa.sum), 5/24/96, 2 pages

Cases for Section 7.4.4

- CXXXIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , k_{∞}
(P47I7-3.0E-20GWd-47W08U), 5/21/96, 2 pages
- CXXXV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , k_{∞}
(P47I6-3.0E-20GWd-40W08U), 5/21/96, 2 pages
- CXXXVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 35% Water, 8% UO_2 , k_{∞}
(P47I5-3.0E-20GWd-35W08U), 5/21/96, 2 pages
- CXXXVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , k_{∞}
(P47I4-3.0E-20GWd-30W08U), 5/21/96, 2 pages
- CXXXVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 25% Water, 8% UO_2 , k_{∞}
(P47I3-3.0E-20GWd-25W08U), 5/21/96, 2 pages
- CXXXIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 8% UO_2 , k_{∞}
(P47I2-3.0E-20GWd-20W08U), 5/21/96, 2 pages
- CXL. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 15% Water, 8% UO_2 , k_{∞}
(P47I1-3.0E-20GWd-15W08U), 5/21/96, 2 pages
- CXLI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 , $R=150$
(P47C7-3.0E-20GWd-47W08U), 5/21/96, 2 pages
- CXLII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 , $R=150$
(P47C6-3.0E-20GWd-40W08U), 5/21/96, 2 pages
- CXLIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 35% Water, 8% UO_2 , $R=150$
(P47C5-3.0E-20GWd-35W08U), 5/21/96, 2 pages
- CXLIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 8% UO_2 , $R=150$
(P47C4-3.0E-20GWd-30W08U), 5/21/96, 2 pages
- CXLV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 25% Water, 8% UO_2 , $R=150$
(P47C3-3.0E-20GWd-25W08U), 5/21/96, 2 pages
- CXLVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 20% Water, 8% UO_2 , $R=150$
(P47C2-3.0E-20GWd-20W08U), 5/21/96, 2 pages
- CXLVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 15% Water, 8% UO_2 , $R=150$
(P47C1-3.0E-20GWd-15W08U), 5/21/96, 2 pages

Cases for Section 7.4.5

- CXLVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 9.2% Average
 UO_2 , $r=40(80)$ (s3020mz.sum), 6/7/96, 2 pages
- CIL. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 9.2% Average

- UO₂, r=50(100) (s3020my.sum), 6/7/96, 2 pages
- CL. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 9.2% Average
UO₂, r=57.4(114.8) (s3020mx.sum), 6/7/96, 2 pages
- CLI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 4.6% Average
UO₂, r=53(106) (s3020ms.sum), 6/7/96, 2 pages
- CLII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 4.6% Average
UO₂, r=55(110) (s3020mr.sum), 6/7/96, 2 pages
- CLIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 2 Zone 4.6% Average
UO₂, r=57.4(114.8) (s3020mq.sum), 6/7/96, 2 pages
- CLIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, Cylinder, 4.6% UO₂,
r=61, (c3020nb.sum), 6/7/96, 2 pages

isotopic concentrations in gm-atoms for each enrich./burnup pair						
isotope	3/20	3.5/30	4/40	4/45	4.2/45	4.5/53
he 4	3.650000E-02	1.080000E-01	2.290000E-01	3.230000E-01	3.110000E-01	4.720000E-01
th230	7.520000E-06	9.200000E-06	1.020000E-05	9.670000E-06	1.040000E-05	1.060000E-05
th232	1.250000E-06	1.980000E-06	2.820000E-06	3.140000E-06	3.260000E-06	3.980000E-06
pa231	1.300000E-06	2.600000E-06	4.080000E-06	4.480000E-06	4.780000E-06	5.840000E-06
u232		1.760000E-06	3.560000E-06	4.650000E-06	4.710000E-06	6.840000E-06
u233	4.140000E-06	6.420000E-06	8.600000E-06	9.090000E-06	9.570000E-06	1.110000E-05
u234	3.430000E-01	3.800000E-01	3.990000E-01	3.770000E-01	4.020000E-01	4.080000E-01
u235	2.700000E+01	2.380000E+01	2.120000E+01	1.750000E+01	1.960000E+01	1.700000E+01
u236	5.980000E+00	8.230000E+00	1.030000E+01	1.070000E+01	1.120000E+01	1.240000E+01
u238	1.860000E+03	1.840000E+03	1.810000E+03	1.800000E+03	1.800000E+03	1.780000E+03
np236		1.120000E-06	2.320000E-06	3.140000E-06	3.110000E-06	4.670000E-06
np237	4.840000E-01	8.390000E-01	1.220000E+00	1.390000E+00	1.410000E+00	1.710000E+00
pu236			6.380000E-07	8.250000E-07	8.200000E-07	1.150000E-06
pu238	1.140000E-01	2.900000E-01	5.480000E-01	7.130000E-01	7.040000E-01	9.880000E-01
pu239	1.030000E+01	1.190000E+01	1.300000E+01	1.320000E+01	1.330000E+01	1.380000E+01
pu240	2.950000E+00	4.110000E+00	5.030000E+00	5.520000E+00	5.440000E+00	6.020000E+00
pu241	1.240000E+00	1.890000E+00	2.400000E+00	2.630000E+00	2.620000E+00	2.920000E+00
pu242	3.330000E-01	7.080000E-01	1.130000E+00	1.430000E+00	1.360000E+00	1.740000E+00
am241	4.070000E-01	6.590000E-01	8.800000E-01	9.800000E-01	9.790000E-01	1.120000E+00
am242m	1.310000E-03	3.060000E-03	5.040000E-03	5.920000E-03	6.010000E-03	7.450000E-03
am243	4.600000E-02	1.400000E-01	2.790000E-01	3.920000E-01	3.670000E-01	5.250000E-01
cm242	7.590000E-06	1.790000E-05	2.930000E-05	3.540000E-05	3.510000E-05	4.390000E-05
cm243	1.480000E-04	5.070000E-04	1.050000E-03	1.450000E-03	1.390000E-03	1.970000E-03
cm244	6.220000E-03	2.850000E-02	7.550000E-02	1.230000E-01	1.120000E-01	1.900000E-01
cm245	1.830000E-04	1.160000E-03	3.770000E-03	6.630000E-03	6.050000E-03	1.130000E-02
cm246	1.230000E-05	1.140000E-04	4.890000E-04	1.030000E-03	8.920000E-04	2.010000E-03
cm247		1.770000E-06	9.900000E-06	2.360000E-05	2.010000E-05	5.260000E-05
cm248			1.050000E-06	2.950000E-06	2.460000E-06	7.830000E-06
total	1.910000E+03	1.890000E+03	1.870000E+03	1.860000E+03	1.860000E+03	1.840000E+03

gm atoms at approx. 100,000 yrs

calculated by summing components of chains listed in Table 7.3.2-1

U234	4.583176E-01	6.730779E-01	9.520693E-01	1.095955E+00	1.112045E+00	1.403494E+00
U235	3.734615E+01	3.584051E+01	3.448006E+01	3.109347E+01	3.326841E+01	3.132702E+01
U236	8.936220E+00	1.236850E+01	1.540550E+01	1.634300E+01	1.675200E+01	1.861001E+01
U238	1.860333E+03	1.840708E+03	1.811130E+03	1.801431E+03	1.801361E+03	1.781742E+03
Np237	2.131183E+00	3.389160E+00	4.503770E+00	5.006630E+00	5.015050E+00	5.761300E+00
TOTAL	1.909205E+03	1.892979E+03	1.866472E+03	1.854970E+03	1.857508E+03	1.838844E+03

atom fractions at approx. 100,000 yrs

Calculated by dividing gm-atoms above by total gm-atoms

U234	2.400568E-04	3.55564E-04	5.100904E-04	5.908211E-04	5.986757E-04	7.632480E-04
U235	1.956110E-02	1.893339E-02	1.847339E-02	1.676225E-02	1.791023E-02	1.703626E-02
U236	4.680598E-03	6.53380E-03	8.25380E-03	8.81038E-03	9.01853E-03	1.012049E-02
U238	9.744020E-01	9.72386E-01	9.703497E-01	9.711375E-01	9.697727E-01	9.689469E-01
Np237	1.116267E-03	1.790384E-03	2.412986E-03	2.699035E-03	2.699880E-03	3.133110E-03

Density of UO2 (g/cc)

10.96 = p

Atomic Wt UO2

270.02755 = A

Number densities in atoms/barn-cm

N=(atom frac.*p*0.602252)/A

U234	5.868062E-06	8.691609E-06	1.246889E-05	1.444231E-05	1.463431E-05	1.865720E-05
U235	4.781608E-04	4.628167E-04	4.515723E-04	4.097444E-04	4.378063E-04	4.164425E-04
U236	1.144148E-04	1.597173E-04	2.017600E-04	2.153653E-04	2.204533E-04	2.473902E-04
U238	2.381875E-02	2.376949E-02	2.371969E-02	2.373895E-02	2.370558E-02	2.368540E-02
Np237	2.728657E-05	4.376500E-05	5.898417E-05	6.597651E-05	6.599715E-05	7.658723E-05
O	2.444448E-02	2.444448E-02	2.444448E-02	2.444448E-02	2.444448E-02	2.444448E-02

Tuff Density (g/cc)	Nominal		Renormalized		Atomic Wts (g/mole)
	Weight fractions	Minerals used	Wt. Fractions		
Tuff Porosity	0.306				
Tuff Composition					
SiO2	0.691	0.691	0.753873	0.490017455814968	60.08465
TiO2	0.0011				
Al2O3	0.134	0.134	0.146192	0.095025092734017	101.9610528
Fe2O3	0.0113	0.0113	0.012328	0.008013310058913	159.691975
MnO	0.0005				
MgO	0.0094	0.0094	0.010255	0.006665839341043	40.311325
CaO	0.0322	0.0322	0.035130	0.022834387955488	56.079325
Na2O	0.0123	0.0123	0.013419	0.008722452542003	61.9788664
K2O	0.0264	0.0264	0.028802	0.018721361553568	94.20332500000001
P2O5	0.0001				

LOI	0.089				
C	1.0073	0.9166	1.000	0.35 1	12.01115

Number densities	atom/barn-cm Normal	(tuff density*normalized min. wt. frac.*0.602252)/min. atomic wt. 35 w% carbon
SiO2	1.31934127E-02	8.57571828E-03
Al2O3	1.50769372E-03	9.80000915E-04
Fe2O3	8.11779330E-05	5.27656564E-05
MgO	2.67512092E-04	1.73882860E-04
CaO	6.58712237E-04	4.28162954E-04
Na2O	2.27669115E-04	1.47984925E-04
K2O	3.21499523E-04	2.08974690E-04
Si	1.319341274E-02	
Al	3.015387431E-03	
Fe	1.623558660E-04	
Mg	2.675120920E-04	
Ca	6.587122370E-04	
Na	4.553382308E-04	
K	6.429990451E-04	
O	3.262883339E-02	

```

=sas2h      parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 3.00wt%, 20gwd/mtu burn High Temp
44group     latticecell
/
/ mixtures of fuel-pin-unit-cell:
/   den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 3.00 92234 0.0240 92236 0.0138 92238 96.9622 end
kr-83      1 0 1-20 975 end
kr-85      1 0 1-20 975 end
sr-90      1 0 1-20 975 end
y-89       1 0 1-20 975 end
mo-95      1 0 1-20 975 end
zr-93      1 0 1-20 975 end
zr-94      1 0 1-20 975 end
zr-95      1 0 1-20 975 end
nb-94      1 0 1-20 975 end
tc-99      1 0 1-20 975 end
rh-103     1 0 1-20 975 end
rh-105     1 0 1-20 975 end
ru-101     1 0 1-20 975 end
ru-106     1 0 1-20 975 end
pd-105     1 0 1-20 975 end
pd-108     1 0 1-20 975 end
ag-109     1 0 1-20 975 end
sb-124     1 0 1-20 975 end
xe-131     1 0 1-20 975 end
xe-132     1 0 1-20 975 end
xe-135     1 0 1-20 975 end
xe-136     1 0 1-20 975 end
cs-134     1 0 1-20 975 end
cs-135     1 0 1-20 975 end
cs-137     1 0 1-20 975 end
ba-136     1 0 1-20 975 end
la-139     1 0 1-20 975 end
pr-141     1 0 1-20 975 end
pr-143     1 0 1-20 975 end
ce-144     1 0 1-20 975 end
nd-143     1 0 1-20 975 end
nd-145     1 0 1-20 975 end
pm-147     1 0 1-20 975 end
pm-148     1 0 1-20 975 end
nd-147     1 0 1-20 975 end
sm-147     1 0 1-20 975 end
sm-149     1 0 1-20 975 end
sm-150     1 0 1-20 975 end
sm-151     1 0 1-20 975 end
sm-152     1 0 1-20 975 end
gd-155     1 0 1-20 975 end
eu-153     1 0 1-20 975 end
eu-154     1 0 1-20 975 end
eu-155     1 0 1-20 975 end
h2o        3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4  6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
              40000 98.18 2 1.0 650.0 end
/
/ 1050 ppm boron
/ -----
end comp
/

```



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/
/
/ fuel-pin-cell geometry:
squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/
/
/ assembly and cycle parameters:
npin/assm=208 fuelngth=360.172 ncycles=1 nlib/cyc=8
printlevel=5 inplevel=2 numztotat=4 end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=1280 down=1826.25
end
end

```

```

1
sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp
0 power= 7.25mw, burnup= 1160.mwd, flux= 1.76E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly
charge 40.0 d 80.0 d 120.0 d 160.0 d 160.0 d
he 4 .00E+00 1.38E-06 5.44E-06 1.23E-05 2.24E-05 2.24E-05
th226 .00E+00 2.83E-21 8.37E-21 1.49E-20 2.22E-20 2.22E-20
th227 .00E+00 6.59E-18 4.59E-17 1.38E-16 2.99E-16 2.99E-16
th228 .00E+00 8.49E-13 3.41E-12 7.75E-12 1.40E-11 1.40E-11
th229 .00E+00 4.18E-14 1.68E-13 3.82E-13 6.84E-13 6.84E-13
th230 .00E+00 1.45E-07 2.84E-07 4.20E-07 5.51E-07 5.51E-07
th231 .00E+00 3.64E-10 4.77E-10 5.84E-10 6.87E-10 6.85E-10
th232 .00E+00 1.32E-09 3.52E-09 6.55E-09 1.04E-08 1.04E-08
th233 .00E+00 1.09E-15 2.87E-15 5.30E-15 8.34E-15 6.26E-15
th234 .00E+00 1.91E-08 2.51E-08 2.70E-08 2.76E-08 2.76E-08
pa231 .00E+00 7.58E-09 1.83E-08 3.16E-08 4.74E-08 4.75E-08
pa232 .00E+00 5.90E-12 1.41E-11 2.42E-11 3.61E-11 3.60E-11
pa233 .00E+00 4.87E-11 2.00E-10 4.13E-10 6.68E-10 6.68E-10
pa234m .00E+00 6.43E-13 8.46E-13 9.10E-13 9.30E-13 9.30E-13
pa234 .00E+00 2.90E-13 3.90E-13 4.32E-13 4.57E-13 4.56E-13
pa235 .00E+00 .00E+00 .00E+00 .00E+00 .00E+00 .00E+00
u230 .00E+00 2.74E-18 8.11E-18 1.45E-17 2.16E-17 2.16E-17
u231 .00E+00 1.24E-16 2.72E-16 4.25E-16 5.88E-16 5.88E-16
u232 .00E+00 1.60E-09 3.29E-09 5.14E-09 7.19E-09 7.19E-09
u233 .00E+00 1.70E-07 3.31E-07 4.83E-07 6.28E-07 6.28E-07
u234 4.76E-01 4.71E-01 4.66E-01 4.61E-01 4.56E-01 4.56E-01
u235 5.92E+01 5.78E+01 5.63E+01 5.50E+01 5.36E+01 5.36E+01
u236 2.71E-01 5.45E-01 8.09E-01 1.06E+00 1.31E+00 1.31E+00
u237 .00E+00 1.49E-03 1.77E-03 2.02E-03 2.25E-03 2.25E-03
u238 1.89E+03 1.89E+03 1.89E+03 1.89E+03 1.89E+03 1.89E+03
u239 .00E+00 4.78E-04 4.74E-04 4.70E-04 4.67E-04 3.55E-04
u240 .00E+00 .00E+00 1.51E-38 1.15E-36 2.50E-35 2.50E-35
u241 .00E+00 .00E+00 .00E+00 .00E+00 .00E+00 .00E+00
np235 .00E+00 3.56E-12 1.82E-11 4.55E-11 8.60E-11 8.60E-11
np236m .00E+00 2.28E-11 5.65E-11 9.44E-11 1.36E-10 1.36E-10
np236 .00E+00 9.59E-11 5.02E-10 1.28E-09 2.47E-09 2.47E-09
np237 .00E+00 4.40E-03 1.10E-02 1.85E-02 2.68E-02 2.68E-02
np238 .00E+00 5.87E-06 1.45E-05 2.43E-05 3.50E-05 3.50E-05

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np239	.00E+00	6.91E-02	6.84E-02	6.78E-02	6.74E-02	6.74E-02
np240m	.00E+00	.00E+00	1.29E-40	9.85E-39	2.14E-37	2.14E-37
np240	.00E+00	1.16E-06	1.14E-06	1.12E-06	1.11E-06	9.99E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	1.26E-10	6.65E-10	1.69E-09	3.24E-09	3.24E-09
pu237	.00E+00	2.30E-10	8.10E-10	1.59E-09	2.50E-09	2.50E-09
pu238	.00E+00	2.88E-05	1.55E-04	3.99E-04	7.72E-04	7.72E-04
pu239	.00E+00	7.13E-01	1.43E+00	2.08E+00	2.67E+00	2.67E+00
pu240	.00E+00	1.15E-02	4.35E-02	9.15E-02	1.52E-01	1.52E-01
pu241	.00E+00	4.47E-04	3.28E-03	1.02E-02	2.25E-02	2.25E-02
pu242	.00E+00	2.40E-06	3.46E-05	1.63E-04	4.79E-04	4.79E-04
pu243	.00E+00	3.08E-10	4.40E-09	2.05E-08	6.00E-08	5.87E-08
pu244	.00E+00	4.39E-31	7.51E-28	5.75E-26	1.25E-24	1.25E-24
pu245	.00E+00	3.32E-37	5.63E-34	4.28E-32	9.22E-31	9.13E-31
pu246	.00E+00	2.78E-40	7.94E-37	7.83E-35	1.98E-33	1.98E-33
am239	.00E+00	2.33E-17	3.33E-16	1.55E-15	4.53E-15	4.49E-15
am240	.00E+00	8.14E-15	1.16E-13	5.41E-13	1.58E-12	1.58E-12

1
0
sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp
power= 7.25mw, burnup= 1160.mwd, flux= 1.76E+13n/cm**2-sec

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nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	40.0 d	80.0 d	120.0 d	160.0 d	160.0 d
am241	.00E+00	6.09E-07	8.77E-06	4.11E-05	1.21E-04	1.21E-04
am242m	.00E+00	1.08E-09	2.90E-08	1.93E-07	7.20E-07	7.20E-07
am242	.00E+00	6.90E-10	9.84E-09	4.58E-08	1.34E-07	1.33E-07
am243	.00E+00	8.49E-09	2.40E-07	1.69E-06	6.66E-06	6.66E-06
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	.00E+00	3.37E-12	9.45E-11	6.60E-10	2.58E-09	2.56E-09
am245	.00E+00	3.12E-35	5.23E-32	3.92E-30	8.34E-29	8.34E-29
am246	.00E+00	.00E+00	1.98E-39	1.96E-37	4.95E-36	4.95E-36
cm241	.00E+00	1.83E-17	9.05E-16	8.46E-15	3.96E-14	3.96E-14
cm242	.00E+00	4.67E-09	1.29E-07	8.87E-07	3.41E-06	3.41E-06
cm243	.00E+00	2.14E-12	1.17E-10	1.20E-09	6.13E-09	6.13E-09
cm244	.00E+00	3.76E-11	2.10E-09	2.22E-08	1.17E-07	1.17E-07
cm245	.00E+00	3.18E-14	3.49E-12	5.44E-11	3.77E-10	3.77E-10
cm246	.00E+00	5.78E-17	1.26E-14	2.92E-13	2.69E-12	2.69E-12
cm247	.00E+00	1.76E-20	7.60E-18	2.61E-16	3.18E-15	3.18E-15
cm248	.00E+00	2.30E-23	1.97E-20	1.00E-18	1.63E-17	1.63E-17
cm249	.00E+00	1.41E-28	1.19E-25	6.04E-24	9.75E-23	8.82E-23
cm250	.00E+00	1.10E-33	1.85E-30	1.39E-28	2.99E-27	2.99E-27
cm251	.00E+00	2.85E-41	4.62E-38	3.46E-36	7.37E-35	5.03E-35
totals	1.95E+03	1.95E+03	1.95E+03	1.95E+03	1.94E+03	1.94E+03
flux		1.78E+13	1.77E+13	1.75E+13	1.74E+13	1.74E-02

1
0
sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp
power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec

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nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	1160.2 d	1200.2 d	1240.2 d	1280.2 d
he 4	9.34E-03	1.07E-02	1.22E-02	1.39E-02	1.57E-02
pb206	4.08E-16	4.77E-16	5.54E-16	6.40E-16	7.37E-16
pb207	5.81E-13	6.61E-13	7.48E-13	8.43E-13	9.46E-13
pb208	5.09E-10	5.84E-10	6.67E-10	7.60E-10	8.62E-10
pb209	1.74E-17	1.94E-17	2.17E-17	2.42E-17	2.69E-17

pb210	3.09E-14	3.43E-14	3.80E-14	4.19E-14	4.61E-14
pb211	6.87E-17	7.53E-17	8.22E-17	8.94E-17	9.70E-17
pb212	1.15E-12	1.28E-12	1.42E-12	1.57E-12	1.73E-12
pb214	1.31E-18	1.44E-18	1.52E-18	1.61E-18	1.69E-18
ra222	2.20E-20	2.41E-20	2.63E-20	2.86E-20	3.11E-20
ra223	3.13E-14	3.43E-14	3.75E-14	4.08E-14	4.42E-14
ra224	9.48E-12	1.05E-11	1.17E-11	1.29E-11	1.43E-11
ra225	1.87E-15	2.10E-15	2.35E-15	2.61E-15	2.90E-15
ra226	4.26E-11	4.52E-11	4.78E-11	5.05E-11	5.32E-11
ra228	1.46E-17	1.61E-17	1.75E-17	1.91E-17	2.07E-17
th226	1.07E-18	1.17E-18	1.28E-18	1.40E-18	1.52E-18
th227	5.25E-14	5.74E-14	6.26E-14	6.80E-14	7.37E-14
th228	1.80E-09	2.00E-09	2.22E-09	2.46E-09	2.71E-09
th229	6.77E-11	7.58E-11	8.47E-11	9.45E-11	1.05E-10
th230	2.55E-06	2.59E-06	2.64E-06	2.67E-06	2.71E-06
th231	2.50E-09	2.62E-09	2.66E-09	2.71E-09	2.75E-09
th232	2.89E-07	3.07E-07	3.25E-07	3.43E-07	3.62E-07
th233	3.49E-14	2.77E-13	2.95E-13	3.13E-13	3.31E-13
th234	2.75E-08	2.75E-08	2.75E-08	2.75E-08	2.75E-08
pa231	9.60E-07	1.01E-06	1.06E-06	1.11E-06	1.16E-06
pa232	7.77E-10	8.41E-10	8.86E-10	9.32E-10	9.79E-10
pa233	1.34E-08	1.40E-08	1.47E-08	1.54E-08	1.61E-08
pa234m	9.28E-13	9.31E-13	9.30E-13	9.30E-13	9.30E-13
pa234	1.25E-12	1.40E-12	1.45E-12	1.51E-12	1.56E-12
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	1.04E-15	1.14E-15	1.24E-15	1.35E-15	1.47E-15
u231	1.98E-14	2.17E-14	2.37E-14	2.57E-14	2.78E-14
u232	2.51E-07	2.73E-07	2.97E-07	3.22E-07	3.48E-07
u233	3.03E-06	3.09E-06	3.15E-06	3.20E-06	3.25E-06
u234	3.54E-01	3.50E-01	3.46E-01	3.42E-01	3.39E-01
u235	2.99E+01	2.91E+01	2.84E+01	2.77E+01	2.70E+01
u236	5.51E+00	5.63E+00	5.75E+00	5.86E+00	5.97E+00
u237	6.42E-03	6.50E-03	6.64E-03	6.78E-03	6.91E-03
u238	1.86E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03
u239	7.64E-05	5.18E-04	5.20E-04	5.22E-04	5.24E-04
u240	2.20E-26	3.13E-26	4.42E-26	6.14E-26	8.46E-26
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	6.89E-09	7.42E-09	7.97E-09	8.54E-09	9.12E-09
np236m	2.44E-09	2.67E-09	2.81E-09	2.94E-09	3.08E-09
np236	2.91E-07	3.18E-07	3.47E-07	3.76E-07	4.08E-07
np237	3.98E-01	4.17E-01	4.36E-01	4.56E-01	4.75E-01
np238	5.32E-04	5.65E-04	5.94E-04	6.23E-04	6.52E-04
np239	7.40E-02	7.49E-02	7.51E-02	7.54E-02	7.56E-02
np240m	1.87E-28	2.68E-28	3.77E-28	5.24E-28	7.22E-28
np240	6.63E-07	1.38E-06	1.39E-06	1.40E-06	1.41E-06

1
0
sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp
power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	1160.2 d	1200.2 d	1240.2 d	1280.2 d
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	3.24E-07	3.52E-07	3.81E-07	4.11E-07	4.42E-07
pu237	1.01E-07	1.11E-07	1.21E-07	1.31E-07	1.41E-07
pu238	7.80E-02	8.50E-02	9.23E-02	1.00E-01	1.08E-01
pu239	9.81E+00	9.93E+00	1.01E+01	1.02E+01	1.03E+01
pu240	2.55E+00	2.65E+00	2.76E+00	2.86E+00	2.95E+00
pu241	1.32E+00	1.39E+00	1.45E+00	1.51E+00	1.58E+00
pu242	2.38E-01	2.60E-01	2.83E-01	3.07E-01	3.33E-01
pu243	2.82E-05	3.55E-05	3.68E-05	4.23E-05	4.59E-05

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pu244	1.09E-15	1.56E-15	2.20E-15	3.06E-15	4.21E-15
pu245	7.52E-22	1.16E-21	1.64E-21	2.30E-21	3.17E-21
pu246	3.29E-24	4.79E-24	6.84E-24	9.63E-24	1.34E-23
am239	2.30E-12	2.69E-12	2.91E-12	3.14E-12	3.37E-12
am240	8.37E-10	9.31E-10	1.01E-09	1.09E-09	1.17E-09
am241	5.19E-02	5.62E-02	6.06E-02	6.51E-02	6.97E-02
am242m	9.67E-04	1.06E-03	1.15E-03	1.24E-03	1.34E-03
am242	5.21E-05	5.89E-05	6.38E-05	6.88E-05	7.39E-05
am243	2.86E-02	3.24E-02	3.66E-02	4.11E-02	4.60E-02
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	1.03E-05	1.25E-05	1.41E-05	1.59E-05	1.79E-05
am245	6.20E-20	8.78E-20	1.23E-19	1.69E-19	2.31E-19
am246	8.24E-27	1.20E-26	1.71E-26	2.41E-26	3.35E-26
cm241	2.20E-10	2.47E-10	2.75E-10	3.05E-10	3.35E-10
cm242	6.74E-03	7.45E-03	8.20E-03	8.98E-03	9.80E-03
cm243	9.98E-05	1.15E-04	1.31E-04	1.48E-04	1.67E-04
cm244	4.01E-03	4.74E-03	5.55E-03	6.48E-03	7.51E-03
cm245	8.72E-05	1.06E-04	1.28E-04	1.54E-04	1.83E-04
cm246	4.97E-06	6.33E-06	7.97E-06	9.96E-06	1.23E-05
cm247	4.56E-08	6.01E-08	7.85E-08	1.01E-07	1.30E-07
cm248	1.93E-09	2.66E-09	3.61E-09	4.85E-09	6.46E-09
cm249	6.55E-15	1.82E-14	2.48E-14	3.34E-14	4.46E-14
cm250	2.93E-18	4.22E-18	5.99E-18	8.40E-18	1.16E-17
cm251	5.01E-27	1.05E-25	1.49E-25	2.10E-25	2.93E-25
bk249	1.60E-11	2.26E-11	3.16E-11	4.36E-11	5.96E-11
bk250	4.44E-15	7.98E-15	1.12E-14	1.55E-14	2.13E-14
bk251	3.73E-20	1.18E-19	1.66E-19	2.31E-19	3.17E-19
totals	1.91E+03	1.91E+03	1.91E+03	1.91E+03	1.91E+03
0 flux		1.73E+13	1.73E+13	1.74E+13	1.75E+13

1
sas2h: babcock wilcox 15x15, 3.00wtX, 20gwd/mtu burn high temp actinides
decay, following reactor irradiation identified by: power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec page 47
0
basis = single reactor assembly
nuclide concentrations, gram atoms

	initial	304.4 d	608.8 d	913.1 d	1217.5 d	1521.9 d	1826.3 d
he 4	1.57E-02	2.45E-02	2.82E-02	3.05E-02	3.25E-02	3.45E-02	3.65E-02
th230	2.71E-06	3.51E-06	4.31E-06	5.11E-06	5.91E-06	6.72E-06	7.52E-06
th232	3.62E-07	5.09E-07	6.57E-07	8.04E-07	9.51E-07	1.10E-06	1.25E-06
pa231	1.16E-06	1.19E-06	1.21E-06	1.23E-06	1.25E-06	1.28E-06	1.30E-06
u233	3.25E-06	3.40E-06	3.55E-06	3.69E-06	3.84E-06	3.99E-06	4.14E-06
u234	3.39E-01	3.39E-01	3.40E-01	3.41E-01	3.42E-01	3.43E-01	3.43E-01
u235	2.70E+01	2.70E+01	2.70E+01	2.70E+01	2.70E+01	2.70E+01	2.70E+01
u236	5.97E+00	5.97E+00	5.97E+00	5.98E+00	5.98E+00	5.98E+00	5.98E+00
u238	1.86E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03
np237	4.75E-01	4.83E-01	4.83E-01	4.83E-01	4.83E-01	4.84E-01	4.84E-01
pu238	1.08E-01	1.15E-01	1.16E-01	1.16E-01	1.16E-01	1.15E-01	1.14E-01
pu239	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.03E+01
pu240	2.95E+00	2.95E+00	2.95E+00	2.95E+00	2.95E+00	2.95E+00	2.95E+00
pu241	1.58E+00	1.52E+00	1.46E+00	1.40E+00	1.35E+00	1.29E+00	1.24E+00
pu242	3.33E-01	3.33E-01	3.33E-01	3.33E-01	3.33E-01	3.33E-01	3.33E-01
am241	6.97E-02	1.32E-01	1.92E-01	2.49E-01	3.04E-01	3.56E-01	4.07E-01
am242m	1.34E-03	1.34E-03	1.33E-03	1.33E-03	1.32E-03	1.32E-03	1.31E-03
am243	4.60E-02	4.60E-02	4.60E-02	4.60E-02	4.60E-02	4.60E-02	4.60E-02
cm242	9.80E-03	2.71E-03	7.44E-04	2.06E-04	5.90E-05	1.87E-05	7.59E-06
cm243	1.67E-04	1.64E-04	1.61E-04	1.57E-04	1.54E-04	1.51E-04	1.48E-04

[illegible]

```

=sas2h      parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 3.50wt%, 30gwd/mtu burn High Temp
44group     latticecell
/
/ mixtures of fuel-pin-unit-cell:
/   den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 3.50 92234 0.0300 92236 0.0161 92238 96.4539 end
kr-83      1 0 1-20 975 end
kr-85      1 0 1-20 975 end
sr-90      1 0 1-20 975 end
y-89       1 0 1-20 975 end
mo-95      1 0 1-20 975 end
zr-93      1 0 1-20 975 end
zr-94      1 0 1-20 975 end
zr-95      1 0 1-20 975 end
nb-94      1 0 1-20 975 end
tc-99      1 0 1-20 975 end
rh-103     1 0 1-20 975 end
rh-105     1 0 1-20 975 end
ru-101     1 0 1-20 975 end
ru-106     1 0 1-20 975 end
pd-105     1 0 1-20 975 end
pd-108     1 0 1-20 975 end
ag-109     1 0 1-20 975 end
sb-124     1 0 1-20 975 end
xe-131     1 0 1-20 975 end
xe-132     1 0 1-20 975 end
xe-135     1 0 1-20 975 end
xe-136     1 0 1-20 975 end
cs-134     1 0 1-20 975 end
cs-135     1 0 1-20 975 end
cs-137     1 0 1-20 975 end
ba-136     1 0 1-20 975 end
la-139     1 0 1-20 975 end
pr-141     1 0 1-20 975 end
pr-143     1 0 1-20 975 end
ce-144     1 0 1-20 975 end
nd-143     1 0 1-20 975 end
nd-145     1 0 1-20 975 end
pm-147     1 0 1-20 975 end
pm-148     1 0 1-20 975 end
nd-147     1 0 1-20 975 end
sm-147     1 0 1-20 975 end
sm-149     1 0 1-20 975 end
sm-150     1 0 1-20 975 end
sm-151     1 0 1-20 975 end
sm-152     1 0 1-20 975 end
gd-155     1 0 1-20 975 end
eu-153     1 0 1-20 975 end
eu-154     1 0 1-20 975 end
eu-155     1 0 1-20 975 end
h2o        3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4  6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
              40000 98.18 2 1.0 650.0 end
/
/ 1050 ppm boron
/ .....
end comp
/

```

```

/-----/
/ fuel-pin-cell geometry:
squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/-----/
/ assembly and cycle parameters:
npin/assm=208 fuelnlength=360.172 ncycles=1 nlib/cyc=8
printlevel=5 inplevel=2 numztotal=4 end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=1920 down=1826.25
end
end

```

```

1
sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp
power= 7.25mw, burnup= 1740.mwd, flux= 1.51E+13n/cm**2-sec
0
nuclide concentrations, gram atoms
basis = single reactor assembly

```

	charge	60.0 d	120.0 d	180.0 d	240.0 d	240.0 d
he 4	.00E+00	2.94E-06	1.17E-05	2.69E-05	5.03E-05	5.03E-05
th226	.00E+00	6.45E-21	1.77E-20	3.10E-20	4.66E-20	4.66E-20
th227	.00E+00	2.43E-17	1.64E-16	4.88E-16	1.05E-15	1.05E-15
th228	.00E+00	2.33E-12	9.41E-12	2.16E-11	3.96E-11	3.96E-11
th229	.00E+00	1.12E-13	4.53E-13	1.03E-12	1.85E-12	1.85E-12
th230	.00E+00	2.69E-07	5.26E-07	7.71E-07	1.00E-06	1.00E-06
th231	.00E+00	5.01E-10	7.01E-10	8.91E-10	1.07E-09	1.07E-09
th232	.00E+00	2.56E-09	7.12E-09	1.36E-08	2.18E-08	2.18E-08
th233	.00E+00	2.00E-15	5.50E-15	1.04E-14	1.67E-14	1.08E-14
th234	.00E+00	2.28E-08	2.69E-08	2.76E-08	2.77E-08	2.77E-08
pa231	.00E+00	1.49E-08	3.77E-08	6.75E-08	1.04E-07	1.04E-07
pa232	.00E+00	1.06E-11	2.67E-11	4.75E-11	7.28E-11	7.24E-11
pa233	.00E+00	1.14E-10	4.11E-10	8.07E-10	1.27E-09	1.27E-09
pa234m	.00E+00	7.69E-13	9.05E-13	9.29E-13	9.33E-13	9.33E-13
pa234	.00E+00	3.50E-13	4.29E-13	4.63E-13	4.92E-13	4.91E-13
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	.00E+00	6.25E-18	1.72E-17	3.01E-17	4.52E-17	4.52E-17
u231	.00E+00	2.61E-16	5.33E-16	8.32E-16	1.17E-15	1.17E-15
u232	.00E+00	2.95E-09	6.22E-09	1.00E-08	1.45E-08	1.45E-08
u233	.00E+00	3.01E-07	5.81E-07	8.44E-07	1.09E-06	1.09E-06
u234	5.95E-01	5.86E-01	5.78E-01	5.69E-01	5.61E-01	5.61E-01
u235	6.91E+01	6.69E+01	6.48E+01	6.27E+01	6.08E+01	6.08E+01
u236	3.16E-01	7.37E-01	1.14E+00	1.52E+00	1.89E+00	1.89E+00
u237	.00E+00	1.63E-03	2.01E-03	2.36E-03	2.70E-03	2.69E-03
u238	1.88E+03	1.88E+03	1.88E+03	1.88E+03	1.87E+03	1.87E+03
u239	.00E+00	4.47E-04	4.42E-04	4.39E-04	4.37E-04	2.90E-04
u240	.00E+00	3.08E-40	5.41E-37	4.15E-35	8.96E-34	8.96E-34
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	.00E+00	9.15E-12	4.45E-11	1.09E-10	2.05E-10	2.05E-10
np236m	.00E+00	3.82E-11	9.25E-11	1.56E-10	2.28E-10	2.26E-10
np236	.00E+00	2.49E-10	1.25E-09	3.17E-09	6.14E-09	6.14E-09
np237	.00E+00	7.53E-03	1.84E-02	3.12E-02	4.59E-02	4.59E-02
np238	.00E+00	9.17E-06	2.22E-05	3.75E-05	5.48E-05	5.47E-05

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np239	.00E+00	6.45E-02	6.39E-02	6.34E-02	6.31E-02	6.31E-02
np240m	.00E+00	2.63E-42	4.62E-39	3.54E-37	7.65E-36	7.65E-36
np240	.00E+00	1.03E-06	1.01E-06	9.93E-07	9.84E-07	8.42E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	3.30E-10	1.65E-09	4.15E-09	7.95E-09	7.95E-09
pu237	.00E+00	4.48E-10	1.47E-09	2.79E-09	4.32E-09	4.32E-09
pu238	.00E+00	7.16E-05	3.66E-04	9.28E-04	1.80E-03	1.80E-03
pu239	.00E+00	1.02E+00	1.98E+00	2.83E+00	3.60E+00	3.60E+00
pu240	.00E+00	2.08E-02	7.64E-02	1.57E-01	2.56E-01	2.56E-01
pu241	.00E+00	1.11E-03	7.97E-03	2.43E-02	5.23E-02	5.23E-02
pu242	.00E+00	7.72E-06	1.10E-04	5.05E-04	1.46E-03	1.46E-03
pu243	.00E+00	9.40E-10	1.32E-08	6.06E-08	1.75E-07	1.69E-07
pu244	.00E+00	1.56E-29	2.69E-26	2.07E-24	4.46E-23	4.46E-23
pu245	.00E+00	9.90E-36	1.69E-32	1.29E-30	2.77E-29	2.73E-29
pu246	.00E+00	1.00E-38	2.73E-35	2.60E-33	6.38E-32	6.38E-32
am239	.00E+00	8.47E-17	1.19E-15	5.41E-15	1.55E-14	1.53E-14
am240	.00E+00	2.95E-14	4.15E-13	1.89E-12	5.41E-12	5.40E-12

1
0
sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp
power= 7.25mw, burnup= 13920.mwd, flux= 1.51E+13n/cm**2-sec
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nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	1740.3 d	1800.3 d	1860.3 d	1920.3 d
he 4	3.70E-02	4.21E-02	4.76E-02	5.36E-02	6.00E-02
pb206	2.99E-15	3.48E-15	4.03E-15	4.64E-15	5.32E-15
pb207	3.09E-12	3.51E-12	3.96E-12	4.44E-12	4.97E-12
pb208	2.91E-09	3.35E-09	3.85E-09	4.40E-09	5.01E-09
pb209	6.48E-17	7.30E-17	8.21E-17	9.20E-17	1.03E-16
pb210	1.25E-13	1.39E-13	1.54E-13	1.70E-13	1.87E-13
pb211	2.38E-16	2.60E-16	2.82E-16	3.06E-16	3.30E-16
pb212	4.52E-12	5.04E-12	5.60E-12	6.19E-12	6.83E-12
pb214	3.22E-18	3.51E-18	3.70E-18	3.88E-18	4.07E-18
ra222	7.08E-20	7.74E-20	8.48E-20	9.27E-20	1.01E-19
ra223	1.09E-13	1.18E-13	1.29E-13	1.39E-13	1.50E-13
ra224	3.73E-11	4.16E-11	4.62E-11	5.11E-11	5.64E-11
ra225	7.05E-15	8.01E-15	9.01E-15	1.01E-14	1.12E-14
ra226	1.05E-10	1.10E-10	1.16E-10	1.22E-10	1.28E-10
ra228	4.50E-17	4.92E-17	5.36E-17	5.82E-17	6.30E-17
ac225	4.75E-15	5.38E-15	6.06E-15	6.79E-15	7.58E-15
ac227	8.04E-11	8.74E-11	9.47E-11	1.02E-10	1.10E-10
ac228	5.49E-21	6.00E-21	6.54E-21	7.10E-21	7.69E-21
th226	3.44E-18	3.78E-18	4.14E-18	4.52E-18	4.93E-18
th227	1.80E-13	1.96E-13	2.12E-13	2.30E-13	2.48E-13
th228	7.09E-09	7.91E-09	8.78E-09	9.71E-09	1.07E-08
th229	2.82E-10	3.21E-10	3.65E-10	4.13E-10	4.67E-10
th230	3.82E-06	3.85E-06	3.88E-06	3.90E-06	3.92E-06
th231	3.73E-09	3.93E-09	3.98E-09	4.02E-09	4.06E-09
th232	6.15E-07	6.51E-07	6.88E-07	7.25E-07	7.63E-07
th233	2.78E-14	5.99E-13	6.37E-13	6.77E-13	7.17E-13
th234	2.72E-08	2.72E-08	2.72E-08	2.71E-08	2.71E-08
pa231	2.10E-06	2.20E-06	2.29E-06	2.39E-06	2.48E-06
pa232	1.67E-09	1.82E-09	1.91E-09	2.00E-09	2.09E-09
pa233	2.40E-08	2.52E-08	2.63E-08	2.75E-08	2.87E-08
pa234m	9.17E-13	9.22E-13	9.22E-13	9.21E-13	9.21E-13
pa234	1.87E-12	2.22E-12	2.32E-12	2.41E-12	2.51E-12

pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	3.34E-15	3.66E-15	4.01E-15	4.38E-15	4.77E-15
u231	6.19E-14	6.83E-14	7.47E-14	8.14E-14	8.84E-14
u232	7.60E-07	8.28E-07	9.00E-07	9.75E-07	1.05E-06
u233	4.66E-06	4.72E-06	4.78E-06	4.84E-06	4.90E-06
u234	3.92E-01	3.86E-01	3.80E-01	3.74E-01	3.69E-01
u235	2.75E+01	2.65E+01	2.56E+01	2.47E+01	2.38E+01
u236	7.68E+00	7.83E+00	7.97E+00	8.10E+00	8.23E+00
u237	8.18E-03	8.27E-03	8.46E-03	8.64E-03	8.81E-03
u238	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03
u239	2.96E-05	5.19E-04	5.22E-04	5.25E-04	5.29E-04
u240	7.20E-25	1.02E-24	1.43E-24	1.99E-24	2.72E-24
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	1.58E-08	1.70E-08	1.82E-08	1.94E-08	2.06E-08
np236m	4.45E-09	4.94E-09	5.20E-09	5.45E-09	5.71E-09
np236	8.01E-07	8.76E-07	9.55E-07	1.04E-06	1.12E-06
np237	6.99E-01	7.31E-01	7.63E-01	7.95E-01	8.27E-01
np238	9.02E-04	9.64E-04	1.01E-03	1.06E-03	1.11E-03

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0
sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp
power= 7.25mw, burnup= 13920.mwd, flux= 1.51E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

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	charge	1740.3 d	1800.3 d	1860.3 d	1920.3 d
np239	7.36E-02	7.49E-02	7.54E-02	7.59E-02	7.63E-02
np240m	6.19E-27	8.73E-27	1.22E-26	1.70E-26	2.33E-26
np240	4.71E-07	1.40E-06	1.42E-06	1.44E-06	1.46E-06
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	8.21E-07	8.89E-07	9.60E-07	1.03E-06	1.11E-06
pu237	2.64E-07	2.91E-07	3.18E-07	3.47E-07	3.76E-07
pu238	2.00E-01	2.18E-01	2.37E-01	2.56E-01	2.77E-01
pu239	1.15E+01	1.16E+01	1.17E+01	1.18E+01	1.18E+01
pu240	3.60E+00	3.74E+00	3.87E+00	3.99E+00	4.11E+00
pu241	2.09E+00	2.16E+00	2.24E+00	2.32E+00	2.40E+00
pu242	5.21E-01	5.66E-01	6.12E-01	6.59E-01	7.08E-01
pu243	5.62E-05	7.47E-05	8.14E-05	8.83E-05	9.55E-05
pu244	3.59E-14	5.10E-14	7.15E-14	9.90E-14	1.36E-13
pu245	2.16E-20	3.47E-20	4.91E-20	6.85E-20	9.45E-20
pu246	9.71E-23	1.42E-22	2.03E-22	2.86E-22	3.98E-22
am239	5.26E-12	6.25E-12	6.70E-12	7.14E-12	7.60E-12
am240	1.96E-09	2.16E-09	2.32E-09	2.47E-09	2.63E-09
am241	1.16E-01	1.24E-01	1.32E-01	1.39E-01	1.47E-01
am242m	2.42E-03	2.59E-03	2.77E-03	2.95E-03	3.14E-03
am242	1.07E-04	1.23E-04	1.31E-04	1.40E-04	1.49E-04
am243	9.09E-02	1.02E-01	1.14E-01	1.27E-01	1.40E-01
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	3.09E-05	3.83E-05	4.31E-05	4.83E-05	5.39E-05
am245	1.83E-18	2.57E-18	3.56E-18	4.89E-18	6.64E-18
am246	2.43E-25	3.55E-25	5.07E-25	7.14E-25	9.95E-25
cm241	6.17E-10	6.82E-10	7.47E-10	8.15E-10	8.85E-10
cm242	1.70E-02	1.85E-02	2.00E-02	2.16E-02	2.32E-02
cm243	3.66E-04	4.13E-04	4.63E-04	5.16E-04	5.72E-04
cm244	1.91E-02	2.23E-02	2.59E-02	3.00E-02	3.45E-02
cm245	5.77E-04	6.94E-04	8.29E-04	9.83E-04	1.16E-03
cm246	4.73E-05	5.97E-05	7.47E-05	9.27E-05	1.14E-04
cm247	6.40E-07	8.38E-07	1.09E-06	1.39E-06	1.77E-06
cm248	4.18E-08	5.71E-08	7.72E-08	1.03E-07	1.37E-07
cm249	1.03E-13	4.02E-13	5.47E-13	7.37E-13	9.83E-13
cm250	8.90E-17	1.28E-16	1.82E-16	2.56E-16	3.55E-16
cm251	3.67E-26	2.91E-24	4.17E-24	5.90E-24	8.24E-24

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[illegible]

```
=sas2h      parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 4.00wt%, 40gwd/mtu burn High Temp
44group    latticecell

/ mixtures of fuel-pin-unit-cell:
/   den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 4.00 92234 0.0347 92236 0.0184 92238 95.9469 end
kr-83 1 0 1-20 975 end
kr-85 1 0 1-20 975 end
sr-90 1 0 1-20 975 end
y-89 1 0 1-20 975 end
mo-95 1 0 1-20 975 end
zr-93 1 0 1-20 975 end
zr-94 1 0 1-20 975 end
zr-95 1 0 1-20 975 end
nb-94 1 0 1-20 975 end
tc-99 1 0 1-20 975 end
rh-103 1 0 1-20 975 end
rh-105 1 0 1-20 975 end
ru-101 1 0 1-20 975 end
ru-106 1 0 1-20 975 end
pd-105 1 0 1-20 975 end
pd-108 1 0 1-20 975 end
ag-109 1 0 1-20 975 end
sb-124 1 0 1-20 975 end
xe-131 1 0 1-20 975 end
xe-132 1 0 1-20 975 end
xe-135 1 0 1-20 975 end
xe-136 1 0 1-20 975 end
cs-134 1 0 1-20 975 end
cs-135 1 0 1-20 975 end
cs-137 1 0 1-20 975 end
ba-136 1 0 1-20 975 end
la-139 1 0 1-20 975 end
pr-141 1 0 1-20 975 end
pr-143 1 0 1-20 975 end
ce-144 1 0 1-20 975 end
nd-143 1 0 1-20 975 end
nd-145 1 0 1-20 975 end
pm-147 1 0 1-20 975 end
pm-148 1 0 1-20 975 end
nd-147 1 0 1-20 975 end
sm-147 1 0 1-20 975 end
sm-149 1 0 1-20 975 end
sm-150 1 0 1-20 975 end
sm-151 1 0 1-20 975 end
sm-152 1 0 1-20 975 end
gd-155 1 0 1-20 975 end
eu-153 1 0 1-20 975 end
eu-154 1 0 1-20 975 end
eu-155 1 0 1-20 975 end
h2o 3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4 6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
          40000 98.18 2 1.0 650.0 end

/ 1050 ppm boron
/ -----
end comp
/
```

```

/ -----
/
/ fuel-pin-cell geometry:
/
squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/
/ -----
/
/ assembly and cycle parameters:
/
npin/assm=208 fuelngth=360.172 ncycles=1 nlib/cyc=8
printlevel=5 inplevel=2 numztotal=4 end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=2560 down=1826.25
end
end

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sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp
power= 7.25mw, burnup= 2320.mwd, flux= 1.32E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

```

	charge	80.0 d	160.0 d	240.0 d	320.0 d	320.0 d
he 4	.00E+00	4.98E-06	2.00E-05	4.74E-05	9.25E-05	9.25E-05
th226	.00E+00	1.11E-20	2.93E-20	5.17E-20	7.97E-20	7.96E-20
th227	.00E+00	6.16E-17	4.05E-16	1.20E-15	2.59E-15	2.59E-15
th228	.00E+00	4.70E-12	1.92E-11	4.47E-11	8.33E-11	8.33E-11
th229	.00E+00	2.25E-13	9.10E-13	2.08E-12	3.75E-12	3.75E-12
th230	.00E+00	4.12E-07	8.01E-07	1.17E-06	1.51E-06	1.51E-06
th231	.00E+00	6.47E-10	9.43E-10	1.22E-09	1.48E-09	1.47E-09
th232	.00E+00	4.21E-09	1.20E-08	2.32E-08	3.77E-08	3.77E-08
th233	.00E+00	3.14E-15	8.89E-15	1.71E-14	2.77E-14	1.56E-14
th234	.00E+00	2.48E-08	2.73E-08	2.75E-08	2.75E-08	2.75E-08
pa231	.00E+00	2.47E-08	6.47E-08	1.18E-07	1.84E-07	1.84E-07
pa232	.00E+00	1.65E-11	4.29E-11	7.81E-11	1.21E-10	1.21E-10
pa233	.00E+00	2.14E-10	6.96E-10	1.32E-09	2.05E-09	2.05E-09
pa234m	.00E+00	8.37E-13	9.21E-13	9.28E-13	9.28E-13	9.28E-13
pa234	.00E+00	3.86E-13	4.51E-13	4.90E-13	5.32E-13	5.29E-13
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	.00E+00	1.07E-17	2.84E-17	5.01E-17	7.72E-17	7.72E-17
u231	.00E+00	3.88E-16	8.10E-16	1.30E-15	1.89E-15	1.89E-15
u232	.00E+00	4.53E-09	9.78E-09	1.63E-08	2.44E-08	2.44E-08
u233	.00E+00	4.50E-07	8.65E-07	1.25E-06	1.60E-06	1.60E-06
u234	6.88E-01	6.76E-01	6.64E-01	6.52E-01	6.40E-01	6.40E-01
u235	7.90E+01	7.60E+01	7.32E+01	7.05E+01	6.79E+01	6.79E+01
u236	3.62E-01	9.34E-01	1.48E+00	1.99E+00	2.48E+00	2.48E+00
u237	.00E+00	1.82E-03	2.29E-03	2.74E-03	3.18E-03	3.17E-03
u238	1.87E+03	1.87E+03	1.87E+03	1.87E+03	1.86E+03	1.86E+03
u239	.00E+00	4.22E-04	4.18E-04	4.16E-04	4.15E-04	2.40E-04
u240	.00E+00	3.49E-39	6.05E-36	4.65E-34	1.00E-32	1.00E-32
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	.00E+00	1.96E-11	8.89E-11	2.13E-10	3.97E-10	3.97E-10
np236m	.00E+00	5.50E-11	1.33E-10	2.27E-10	3.36E-10	3.33E-10
np236	.00E+00	5.42E-10	2.56E-09	6.39E-09	1.24E-08	1.24E-08
np237	.00E+00	1.11E-02	2.71E-02	4.64E-02	6.87E-02	6.87E-02
np238	.00E+00	1.25E-05	3.03E-05	5.16E-05	7.63E-05	7.60E-05
np239	.00E+00	6.09E-02	6.04E-02	6.00E-02	5.99E-02	5.98E-02

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np240m	.00E+00	2.98E-41	5.16E-38	3.96E-36	8.56E-35	8.56E-35
np240	.00E+00	9.24E-07	9.09E-07	9.00E-07	8.96E-07	7.28E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	7.17E-10	3.36E-09	8.27E-09	1.58E-08	1.58E-08
pu237	.00E+00	7.02E-10	2.21E-09	4.14E-09	6.47E-09	6.47E-09
pu238	.00E+00	1.49E-04	7.08E-04	1.77E-03	3.41E-03	3.41E-03
pu239	.00E+00	1.29E+00	2.46E+00	3.49E+00	4.39E+00	4.39E+00
pu240	.00E+00	3.06E-02	1.10E-01	2.22E-01	3.55E-01	3.55E-01
pu241	.00E+00	2.03E-03	1.42E-02	4.27E-02	9.03E-02	9.03E-02
pu242	.00E+00	1.64E-05	2.31E-04	1.05E-03	3.00E-03	3.00E-03
pu243	.00E+00	1.91E-09	2.67E-08	1.21E-07	3.45E-07	3.30E-07
pu244	.00E+00	1.74E-28	3.01E-25	2.31E-23	5.00E-22	5.00E-22
pu245	.00E+00	9.41E-35	1.62E-31	1.24E-29	2.67E-28	2.61E-28
pu246	.00E+00	1.05E-37	2.76E-34	2.57E-32	6.19E-31	6.19E-31
am239	.00E+00	2.00E-16	2.78E-15	1.25E-14	3.52E-14	3.46E-14
am240	.00E+00	6.99E-14	9.69E-13	4.35E-12	1.23E-11	1.22E-11

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sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp
 power= 7.25mw, burnup= 18560.mwd, flux= 1.38E+13n/cm**2-sec
 nuclide concentrations, gram atoms
 basis = single reactor assembly

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	charge	2320.4 d	2400.4 d	2480.4 d	2560.4 d
he 4	9.08E-02	1.03E-01	1.15E-01	1.29E-01	1.43E-01
pb206	1.16E-14	1.35E-14	1.56E-14	1.79E-14	2.05E-14
pb207	9.81E-12	1.11E-11	1.25E-11	1.39E-11	1.55E-11
pb208	1.01E-08	1.16E-08	1.33E-08	1.52E-08	1.73E-08
pb209	1.66E-16	1.87E-16	2.11E-16	2.37E-16	2.65E-16
pb210	3.33E-13	3.70E-13	4.10E-13	4.52E-13	4.98E-13
pb211	5.50E-16	5.97E-16	6.45E-16	6.95E-16	7.46E-16
pb212	1.18E-11	1.31E-11	1.45E-11	1.60E-11	1.75E-11
pb214	5.84E-18	6.33E-18	6.63E-18	6.93E-18	7.23E-18
ra222	1.60E-19	1.74E-19	1.91E-19	2.08E-19	2.27E-19
ra223	2.51E-13	2.72E-13	2.94E-13	3.17E-13	3.40E-13
ra224	9.70E-11	1.08E-10	1.19E-10	1.32E-10	1.45E-10
ra225	1.81E-14	2.07E-14	2.33E-14	2.61E-14	2.92E-14
ra226	1.89E-10	1.99E-10	2.08E-10	2.18E-10	2.27E-10
ra228	9.92E-17	1.08E-16	1.18E-16	1.27E-16	1.38E-16
ac225	1.21E-14	1.38E-14	1.56E-14	1.75E-14	1.95E-14
ac227	1.82E-10	1.97E-10	2.13E-10	2.29E-10	2.46E-10
ac228	1.21E-20	1.32E-20	1.43E-20	1.55E-20	1.68E-20
th226	7.79E-18	8.50E-18	9.31E-18	1.02E-17	1.11E-17
th227	4.12E-13	4.47E-13	4.82E-13	5.19E-13	5.57E-13
th228	1.84E-08	2.05E-08	2.27E-08	2.50E-08	2.75E-08
th229	8.19E-10	9.42E-10	1.08E-09	1.23E-09	1.40E-09
th230	4.75E-06	4.75E-06	4.74E-06	4.72E-06	4.70E-06
th231	4.68E-09	4.92E-09	4.96E-09	4.99E-09	5.01E-09
th232	1.05E-06	1.11E-06	1.18E-06	1.24E-06	1.30E-06
th233	2.74E-14	1.04E-12	1.11E-12	1.18E-12	1.25E-12
th234	2.69E-08	2.69E-08	2.68E-08	2.68E-08	2.68E-08
pa231	3.47E-06	3.60E-06	3.73E-06	3.85E-06	3.97E-06
pa232	2.74E-09	2.98E-09	3.12E-09	3.25E-09	3.38E-09
pa233	3.62E-08	3.78E-08	3.94E-08	4.10E-08	4.26E-08
pa234m	9.07E-13	9.14E-13	9.13E-13	9.13E-13	9.12E-13
pa234	2.58E-12	3.18E-12	3.33E-12	3.47E-12	3.62E-12

pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	7.54E-15	8.24E-15	9.03E-15	9.86E-15	1.07E-14
u231	1.37E-13	1.51E-13	1.65E-13	1.80E-13	1.95E-13
u232	1.64E-06	1.78E-06	1.93E-06	2.08E-06	2.24E-06
u233	6.16E-06	6.22E-06	6.28E-06	6.33E-06	6.38E-06
u234	4.07E-01	3.99E-01	3.92E-01	3.84E-01	3.77E-01
u235	2.56E+01	2.44E+01	2.33E+01	2.23E+01	2.12E+01
u236	9.74E+00	9.89E+00	1.00E+01	1.02E+01	1.03E+01
u237	9.77E-03	9.84E-03	1.01E-02	1.03E-02	1.05E-02
u238	1.82E+03	1.82E+03	1.82E+03	1.81E+03	1.81E+03
u239	1.73E-05	5.20E-04	5.25E-04	5.30E-04	5.34E-04
u240	7.57E-24	1.07E-23	1.50E-23	2.07E-23	2.82E-23
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	2.78E-08	2.98E-08	3.17E-08	3.37E-08	3.58E-08
np236m	6.80E-09	7.60E-09	7.99E-09	8.38E-09	8.78E-09
np236	1.66E-06	1.81E-06	1.97E-06	2.14E-06	2.32E-06
np237	1.03E+00	1.08E+00	1.12E+00	1.16E+00	1.21E+00
np238	1.30E-03	1.40E-03	1.47E-03	1.54E-03	1.61E-03

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sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp
power= 7.25mw, burnup= 18560.mwd, flux= 1.38E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

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	charge	2320.4 d	2400.4 d	2480.4 d	2560.4 d
np239	7.36E-02	7.51E-02	7.58E-02	7.65E-02	7.71E-02
np240m	6.51E-26	9.15E-26	1.28E-25	1.77E-25	2.41E-25
np240	3.91E-07	1.43E-06	1.46E-06	1.48E-06	1.51E-06
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	1.57E-06	1.70E-06	1.83E-06	1.96E-06	2.10E-06
pu237	5.33E-07	5.86E-07	6.41E-07	6.99E-07	7.59E-07
pu238	3.88E-01	4.21E-01	4.56E-01	4.92E-01	5.29E-01
pu239	1.27E+01	1.28E+01	1.28E+01	1.29E+01	1.29E+01
pu240	4.45E+00	4.61E+00	4.75E+00	4.89E+00	5.01E+00
pu241	2.73E+00	2.80E+00	2.88E+00	2.97E+00	3.06E+00
pu242	8.46E-01	9.14E-01	9.84E-01	1.05E+00	1.13E+00
pu243	8.53E-05	1.16E-04	1.27E-04	1.37E-04	1.48E-04
pu244	3.77E-13	5.34E-13	7.46E-13	1.03E-12	1.41E-12
pu245	2.09E-19	3.42E-19	4.83E-19	6.74E-19	9.29E-19
pu246	9.42E-22	1.39E-21	1.98E-21	2.79E-21	3.90E-21
am239	8.79E-12	1.05E-11	1.12E-11	1.18E-11	1.25E-11
am240	3.31E-09	3.63E-09	3.86E-09	4.08E-09	4.30E-09
am241	1.88E-01	1.99E-01	2.09E-01	2.19E-01	2.29E-01
am242m	4.20E-03	4.43E-03	4.68E-03	4.92E-03	5.16E-03
am242	1.65E-04	1.90E-04	2.02E-04	2.14E-04	2.25E-04
am243	1.87E-01	2.08E-01	2.30E-01	2.54E-01	2.79E-01
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	6.15E-05	7.69E-05	8.61E-05	9.59E-05	1.07E-04
am245	1.75E-17	2.44E-17	3.36E-17	4.59E-17	6.20E-17
am246	2.36E-24	3.46E-24	4.95E-24	6.98E-24	9.73E-24
cm241	1.14E-09	1.24E-09	1.34E-09	1.45E-09	1.56E-09
cm242	2.92E-02	3.14E-02	3.36E-02	3.58E-02	3.81E-02
cm243	8.04E-04	8.94E-04	9.89E-04	1.09E-03	1.19E-03
cm244	5.19E-02	6.03E-02	6.96E-02	7.99E-02	9.13E-02
cm245	1.95E-03	2.32E-03	2.75E-03	3.23E-03	3.77E-03
cm246	2.08E-04	2.61E-04	3.24E-04	4.00E-04	4.89E-04
cm247	3.66E-06	4.76E-06	6.14E-06	7.83E-06	9.90E-06
cm248	3.27E-07	4.44E-07	5.98E-07	7.97E-07	1.05E-06
cm249	6.78E-13	3.20E-12	4.36E-12	5.87E-12	7.82E-12
cm250	8.89E-16	1.28E-15	1.82E-15	2.57E-15	3.57E-15
cm251	1.61E-25	2.74E-23	3.94E-23	5.60E-23	7.86E-23

bk249	4.50E-09	6.27E-09	8.66E-09	1.18E-08	1.60E-08
bk250	9.80E-13	2.09E-12	2.91E-12	4.02E-12	5.48E-12
bk251	4.54E-18	2.65E-17	3.74E-17	5.21E-17	7.17E-17
cf249	1.25E-09	1.79E-09	2.51E-09	3.48E-09	4.78E-09
cf250	6.01E-10	8.59E-10	1.21E-09	1.67E-09	2.29E-09
cf251	3.91E-10	5.66E-10	8.08E-10	1.14E-09	1.58E-09
cf252	1.80E-10	2.72E-10	4.06E-10	5.96E-10	8.63E-10
cf253	1.62E-13	2.49E-13	3.77E-13	5.61E-13	8.23E-13
cf254	7.00E-17	1.11E-16	1.71E-16	2.60E-16	3.89E-16
cf255	2.86E-21	1.10E-20	1.71E-20	2.63E-20	3.97E-20
totals	1.88E+03	1.88E+03	1.87E+03	1.87E+03	1.87E+03
flux		1.52E+13	1.53E+13	1.55E+13	1.56E+13

0
0

1
sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp actinides
decay, following reactor irradiation identified by: power= 7.25mw, burnup= 18560.mwd, flux= 1.38E+13n/cm**2-sec
0 nuclide concentrations, grams
basis =single reactor assembly
initial 304.4 d 608.8 d 913.1 d 1217.5 d 1521.9 d 1826.3 d
he 4 5.73E-01 7.15E-01 7.77E-01 8.17E-01 8.51E-01 8.83E-01 9.16E-01
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[illegible]


```

.=sas2h      parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 4.00wt%, 45gwd/mtu burn High Temp
44group      latticecell
/
/ mixtures of fuel-pin-unit-cell:
/ den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 4.00 92234 0.0347 92236 0.0184 92238 95.9469 end
kr-83      1 0 1-20 975 end
kr-85      1 0 1-20 975 end
sr-90      1 0 1-20 975 end
y-89      1 0 1-20 975 end
mo-95      1 0 1-20 975 end
zr-93      1 0 1-20 975 end
zr-94      1 0 1-20 975 end
zr-95      1 0 1-20 975 end
nb-94      1 0 1-20 975 end
tc-99      1 0 1-20 975 end
rh-103     1 0 1-20 975 end
rh-105     1 0 1-20 975 end
ru-101     1 0 1-20 975 end
ru-106     1 0 1-20 975 end
pd-105     1 0 1-20 975 end
pd-108     1 0 1-20 975 end
ag-109     1 0 1-20 975 end
sb-124     1 0 1-20 975 end
xe-131     1 0 1-20 975 end
xe-132     1 0 1-20 975 end
xe-135     1 0 1-20 975 end
xe-136     1 0 1-20 975 end
cs-134     1 0 1-20 975 end
cs-135     1 0 1-20 975 end
cs-137     1 0 1-20 975 end
ba-136     1 0 1-20 975 end
la-139     1 0 1-20 975 end
pr-141     1 0 1-20 975 end
pr-143     1 0 1-20 975 end
ce-144     1 0 1-20 975 end
nd-143     1 0 1-20 975 end
nd-145     1 0 1-20 975 end
pm-147     1 0 1-20 975 end
pm-148     1 0 1-20 975 end
nd-147     1 0 1-20 975 end
sm-147     1 0 1-20 975 end
sm-149     1 0 1-20 975 end
sm-150     1 0 1-20 975 end
sm-151     1 0 1-20 975 end
sm-152     1 0 1-20 975 end
gd-155     1 0 1-20 975 end
eu-153     1 0 1-20 975 end
eu-154     1 0 1-20 975 end
eu-155     1 0 1-20 975 end
h2o        3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4  6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
              40000 98.18 2 1.0 650.0 end
/
/ 1050 ppm boron
/ .....
end comp
/

```

```

/
/ fuel-pin-cell geometry:
/
squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/
/
/ assembly and cycle parameters:
/
npin/assm=208 fuelngth=360.172 ncycles=1 nlib/cyc=8
printlevel=5 inplevel=2 numztotal=4 end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=2880 down=1826.25
end
end

```

1
0

sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp
power= 7.25mw, burnup= 2610.mwd, flux= 1.32E+13n/cm**2-sec

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nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	90.0 d	180.0 d	270.0 d	360.0 d	360.0 d
he 4	.00E+00	6.30E-06	2.56E-05	6.19E-05	1.25E-04	1.25E-04
th226	.00E+00	1.33E-20	3.48E-20	6.20E-20	9.72E-20	9.72E-20
th227	.00E+00	8.52E-17	5.56E-16	1.65E-15	3.55E-15	3.55E-15
th228	.00E+00	5.99E-12	2.46E-11	5.78E-11	1.09E-10	1.09E-10
th229	.00E+00	2.87E-13	1.16E-12	2.66E-12	4.82E-12	4.82E-12
th230	.00E+00	4.62E-07	8.94E-07	1.30E-06	1.67E-06	1.67E-06
th231	.00E+00	6.86E-10	1.02E-09	1.32E-09	1.61E-09	1.60E-09
th232	.00E+00	4.99E-09	1.45E-08	2.83E-08	4.61E-08	4.61E-08
th233	.00E+00	3.74E-15	1.08E-14	2.09E-14	3.40E-14	1.78E-14
th234	.00E+00	2.55E-08	2.74E-08	2.75E-08	2.75E-08	2.75E-08
pa231	.00E+00	2.89E-08	7.71E-08	1.42E-07	2.22E-07	2.22E-07
pa232	.00E+00	1.93E-11	5.11E-11	9.38E-11	1.46E-10	1.45E-10
pa233	.00E+00	2.64E-10	8.40E-10	1.58E-09	2.46E-09	2.46E-09
pa234m	.00E+00	8.61E-13	9.24E-13	9.29E-13	9.28E-13	9.28E-13
pa234	.00E+00	4.00E-13	4.62E-13	5.06E-13	5.56E-13	5.51E-13
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	.00E+00	1.29E-17	3.37E-17	6.01E-17	9.42E-17	9.42E-17
u231	.00E+00	4.43E-16	9.35E-16	1.52E-15	2.26E-15	2.25E-15
u232	.00E+00	5.16E-09	1.13E-08	1.92E-08	2.94E-08	2.94E-08
u233	.00E+00	5.07E-07	9.69E-07	1.39E-06	1.78E-06	1.78E-06
u234	6.88E-01	6.74E-01	6.61E-01	6.48E-01	6.35E-01	6.35E-01
u235	7.90E+01	7.57E+01	7.25E+01	6.95E+01	6.66E+01	6.66E+01
u236	3.62E-01	1.00E+00	1.61E+00	2.18E+00	2.72E+00	2.72E+00
u237	.00E+00	1.88E-03	2.41E-03	2.91E-03	3.39E-03	3.38E-03
u238	1.87E+03	1.87E+03	1.87E+03	1.86E+03	1.86E+03	1.86E+03
u239	.00E+00	4.23E-04	4.19E-04	4.17E-04	4.16E-04	2.25E-04
u240	.00E+00	1.25E-38	2.16E-35	1.65E-33	3.54E-32	3.54E-32
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	.00E+00	2.56E-11	1.16E-10	2.77E-10	5.16E-10	5.16E-10
np236m	.00E+00	6.45E-11	1.57E-10	2.69E-10	3.99E-10	3.95E-10
np236	.00E+00	7.12E-10	3.36E-09	8.43E-09	1.64E-08	1.64E-08
np237	.00E+00	1.29E-02	3.17E-02	5.45E-02	8.11E-02	8.11E-02
np238	.00E+00	1.46E-05	3.54E-05	6.07E-05	9.01E-05	8.97E-05

np239	.00E+00	6.11E-02	6.05E-02	6.02E-02	6.00E-02	5.99E-02
np240m	.00E+00	1.07E-40	1.84E-37	1.41E-35	3.02E-34	3.02E-34
np240	.00E+00	9.29E-07	9.12E-07	9.04E-07	9.00E-07	7.14E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	9.42E-10	4.40E-09	1.08E-08	2.07E-08	2.07E-08
pu237	.00E+00	8.69E-10	2.68E-09	5.01E-09	7.87E-09	7.87E-09
pu238	.00E+00	1.95E-04	9.26E-04	2.32E-03	4.48E-03	4.48E-03
pu239	.00E+00	1.45E+00	2.74E+00	3.86E+00	4.82E+00	4.82E+00
pu240	.00E+00	3.82E-02	1.35E-01	2.70E-01	4.28E-01	4.28E-01
pu241	.00E+00	2.82E-03	1.95E-02	5.78E-02	1.21E-01	1.21E-01
pu242	.00E+00	2.56E-05	3.56E-04	1.60E-03	4.54E-03	4.54E-03
pu243	.00E+00	3.00E-09	4.13E-08	1.85E-07	5.23E-07	4.98E-07
pu244	.00E+00	6.23E-28	1.07E-24	8.22E-23	1.76E-21	1.76E-21
pu245	.00E+00	3.37E-34	5.76E-31	4.38E-29	9.39E-28	9.18E-28
pu246	.00E+00	4.08E-37	1.05E-33	9.55E-32	2.27E-30	2.27E-30
am239	.00E+00	3.15E-16	4.31E-15	1.91E-14	5.33E-14	5.23E-14
am240	.00E+00	1.10E-13	1.50E-12	6.67E-12	1.86E-11	1.85E-11

1

sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp
 power= 7.25mw, burnup= 20880.mwd, flux= 1.40E+13n/cm**2-sec
 nuclide concentrations, gram atoms
 basis = single reactor assembly

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0

	charge	2610.4 d	2700.4 d	2790.4 d	2880.4 d
he 4	1.36E-01	1.53E-01	1.72E-01	1.91E-01	2.11E-01
pb206	1.92E-14	2.23E-14	2.57E-14	2.96E-14	3.38E-14
pb207	1.47E-11	1.66E-11	1.86E-11	2.08E-11	2.31E-11
pb208	1.63E-08	1.88E-08	2.15E-08	2.45E-08	2.78E-08
pb209	2.51E-16	2.84E-16	3.20E-16	3.59E-16	4.00E-16
pb210	4.76E-13	5.29E-13	5.86E-13	6.47E-13	7.11E-13
pb211	7.21E-16	7.80E-16	8.40E-16	9.02E-16	9.65E-16
pb212	1.68E-11	1.86E-11	2.05E-11	2.26E-11	2.47E-11
pb214	6.86E-18	7.41E-18	7.75E-18	8.08E-18	8.41E-18
ra222	2.20E-19	2.39E-19	2.61E-19	2.85E-19	3.09E-19
ra223	3.29E-13	3.56E-13	3.83E-13	4.11E-13	4.40E-13
ra224	1.38E-10	1.54E-10	1.70E-10	1.86E-10	2.04E-10
ra225	2.75E-14	3.14E-14	3.53E-14	3.96E-14	4.42E-14
ra226	2.22E-10	2.33E-10	2.43E-10	2.54E-10	2.64E-10
ra228	1.32E-16	1.44E-16	1.56E-16	1.69E-16	1.82E-16
ac225	1.84E-14	2.10E-14	2.36E-14	2.65E-14	2.95E-14
ac227	2.38E-10	2.56E-10	2.76E-10	2.95E-10	3.16E-10
ac228	1.62E-20	1.76E-20	1.91E-20	2.06E-20	2.23E-20
th226	1.07E-17	1.17E-17	1.28E-17	1.39E-17	1.51E-17
th227	5.39E-13	5.82E-13	6.26E-13	6.72E-13	7.19E-13
th228	2.63E-08	2.92E-08	3.22E-08	3.54E-08	3.88E-08
th229	1.31E-09	1.51E-09	1.73E-09	1.98E-09	2.26E-09
th230	4.70E-06	4.67E-06	4.64E-06	4.60E-06	4.55E-06
th231	4.76E-09	4.98E-09	5.00E-09	5.00E-09	5.00E-09
th232	1.27E-06	1.34E-06	1.41E-06	1.48E-06	1.55E-06
th233	3.40E-14	1.29E-12	1.38E-12	1.46E-12	1.55E-12
th234	2.68E-08	2.67E-08	2.67E-08	2.67E-08	2.66E-08
pa231	3.92E-06	4.04E-06	4.17E-06	4.28E-06	4.39E-06
pa232	3.19E-09	3.46E-09	3.60E-09	3.74E-09	3.88E-09
pa233	4.19E-08	4.37E-08	4.54E-08	4.72E-08	4.89E-08

pa234m	9.03E-13	9.12E-13	9.11E-13	9.11E-13	9.10E-13
pa234	3.00E-12	3.71E-12	3.88E-12	4.05E-12	4.22E-12
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	1.04E-14	1.13E-14	1.24E-14	1.35E-14	1.46E-14
u231	1.87E-13	2.05E-13	2.24E-13	2.44E-13	2.65E-13
u232	2.17E-06	2.35E-06	2.54E-06	2.74E-06	2.94E-06
u233	6.38E-06	6.43E-06	6.47E-06	6.51E-06	6.55E-06
u234	3.80E-01	3.72E-01	3.64E-01	3.56E-01	3.49E-01
u235	2.18E+01	2.06E+01	1.96E+01	1.85E+01	1.75E+01
u236	1.02E+01	1.04E+01	1.05E+01	1.06E+01	1.07E+01
u237	1.04E-02	1.05E-02	1.07E-02	1.09E-02	1.11E-02
u238	1.81E+03	1.81E+03	1.81E+03	1.81E+03	1.80E+03
u239	1.78E-05	5.35E-04	5.41E-04	5.46E-04	5.51E-04
u240	2.46E-23	3.47E-23	4.82E-23	6.64E-23	9.02E-23
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	3.50E-08	3.74E-08	3.97E-08	4.21E-08	4.46E-08
np236m	8.16E-09	9.09E-09	9.55E-09	1.00E-08	1.05E-08
np236	2.25E-06	2.45E-06	2.67E-06	2.90E-06	3.14E-06
np237	1.19E+00	1.24E+00	1.28E+00	1.33E+00	1.38E+00
np238	1.54E-03	1.65E-03	1.73E-03	1.81E-03	1.89E-03

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0
sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp
power= 7.25mw, burnup= 20880.mwd, flux= 1.40E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

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	charge	2610.4 d	2700.4 d	2790.4 d	2880.4 d
np239	7.58E-02	7.73E-02	7.81E-02	7.89E-02	7.96E-02
np240m	2.11E-25	2.96E-25	4.12E-25	5.66E-25	7.70E-25
np240	4.15E-07	1.52E-06	1.55E-06	1.58E-06	1.61E-06
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	2.05E-06	2.21E-06	2.37E-06	2.54E-06	2.72E-06
pu237	7.35E-07	8.06E-07	8.81E-07	9.59E-07	1.04E-06
pu238	5.13E-01	5.56E-01	6.00E-01	6.46E-01	6.93E-01
pu239	1.30E+01	1.30E+01	1.30E+01	1.31E+01	1.31E+01
pu240	4.93E+00	5.10E+00	5.24E+00	5.38E+00	5.50E+00
pu241	3.04E+00	3.11E+00	3.19E+00	3.27E+00	3.35E+00
pu242	1.09E+00	1.17E+00	1.26E+00	1.34E+00	1.43E+00
pu243	1.10E-04	1.49E-04	1.61E-04	1.74E-04	1.87E-04
pu244	1.22E-12	1.73E-12	2.40E-12	3.30E-12	4.49E-12
pu245	7.01E-19	1.15E-18	1.62E-18	2.25E-18	3.09E-18
pu246	3.29E-21	4.84E-21	6.91E-21	9.72E-21	1.35E-20
am239	1.10E-11	1.30E-11	1.37E-11	1.44E-11	1.51E-11
am240	4.12E-09	4.48E-09	4.74E-09	4.98E-09	5.22E-09
am241	2.25E-01	2.36E-01	2.46E-01	2.56E-01	2.66E-01
am242m	5.10E-03	5.33E-03	5.58E-03	5.82E-03	6.06E-03
am242	2.03E-04	2.31E-04	2.44E-04	2.57E-04	2.69E-04
am243	2.68E-01	2.96E-01	3.26E-01	3.58E-01	3.92E-01
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	8.98E-05	1.11E-04	1.24E-04	1.38E-04	1.52E-04
am245	5.46E-17	7.57E-17	1.04E-16	1.41E-16	1.90E-16
am246	8.24E-24	1.21E-23	1.73E-23	2.43E-23	3.38E-23
cm241	1.52E-09	1.64E-09	1.77E-09	1.90E-09	2.03E-09
cm242	3.71E-02	3.96E-02	4.20E-02	4.45E-02	4.70E-02
cm243	1.15E-03	1.26E-03	1.38E-03	1.51E-03	1.64E-03
cm244	8.62E-02	9.95E-02	1.14E-01	1.31E-01	1.48E-01
cm245	3.54E-03	4.18E-03	4.91E-03	5.72E-03	6.64E-03
cm246	4.46E-04	5.58E-04	6.90E-04	8.46E-04	1.03E-03
cm247	8.93E-06	1.15E-05	1.48E-05	1.87E-05	2.36E-05
cm248	9.32E-07	1.26E-06	1.69E-06	2.24E-06	2.95E-06
cm249	2.00E-12	9.39E-12	1.27E-11	1.71E-11	2.27E-11

[illegible]

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=sas2h      parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 4.20wt%, 45gwd/mtu burn High Temp
44group    latticecell
/
/ mixtures of fuel-pin-unit-cell:
/   den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 4.20 92234 0.0366 92236 0.0193 92238 95.7441 end
kr-83      1 0 1-20 975 end
kr-85      1 0 1-20 975 end
sr-90      1 0 1-20 975 end
y-89       1 0 1-20 975 end
mo-95      1 0 1-20 975 end
zr-93      1 0 1-20 975 end
zr-94      1 0 1-20 975 end
zr-95      1 0 1-20 975 end
nb-94      1 0 1-20 975 end
tc-99      1 0 1-20 975 end
rh-103     1 0 1-20 975 end
rh-105     1 0 1-20 975 end
ru-101     1 0 1-20 975 end
ru-106     1 0 1-20 975 end
pd-105     1 0 1-20 975 end
pd-108     1 0 1-20 975 end
ag-109     1 0 1-20 975 end
sb-124     1 0 1-20 975 end
xe-131     1 0 1-20 975 end
xe-132     1 0 1-20 975 end
xe-135     1 0 1-20 975 end
xe-136     1 0 1-20 975 end
cs-134     1 0 1-20 975 end
cs-135     1 0 1-20 975 end
cs-137     1 0 1-20 975 end
ba-136     1 0 1-20 975 end
la-139     1 0 1-20 975 end
pr-141     1 0 1-20 975 end
pr-143     1 0 1-20 975 end
ce-144     1 0 1-20 975 end
nd-143     1 0 1-20 975 end
nd-145     1 0 1-20 975 end
pm-147     1 0 1-20 975 end
pm-148     1 0 1-20 975 end
nd-147     1 0 1-20 975 end
sm-147     1 0 1-20 975 end
sm-149     1 0 1-20 975 end
sm-150     1 0 1-20 975 end
sm-151     1 0 1-20 975 end
sm-152     1 0 1-20 975 end
gd-155     1 0 1-20 975 end
eu-153     1 0 1-20 975 end
eu-154     1 0 1-20 975 end
eu-155     1 0 1-20 975 end
h2o        3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4  6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
              40000 98.18 2 1.0 650.0 end
/
/ 1050 ppm boron
/ -----
end comp
/

```

```

/-----/
/ fuel-pin-cell geometry:
/ squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/-----/
/
/ assembly and cycle parameters:
/ npin/assm=208 fuelngth=360.172 ncycles=1 nlib/cyc=8
/ printlevel=5 inplevel=2 numztotal=4 end
/ 3 0.63246 2 0.67310 3 0.814 500 2.961
/ power=7.25 burn=2880 down=1826.25
/ end
end

```

```

1
sas2h: babcock wilcox 15x15, 4.20wt%, 45gwd/mtu burn high temp
0 power= 7.25mw, burnup= 2610.mwd, flux= 1.26E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

```

	charge	90.0 d	180.0 d	270.0 d	360.0 d	360.0 d
he 4	.00E+00	6.20E-06	2.51E-05	6.03E-05	1.21E-04	1.21E-04
th226	.00E+00	1.37E-20	3.58E-20	6.38E-20	9.98E-20	9.98E-20
th227	.00E+00	8.93E-17	5.83E-16	1.72E-15	3.72E-15	3.72E-15
th228	.00E+00	6.24E-12	2.56E-11	6.01E-11	1.13E-10	1.13E-10
th229	.00E+00	2.98E-13	1.21E-12	2.76E-12	5.00E-12	5.00E-12
th230	.00E+00	4.88E-07	9.44E-07	1.37E-06	1.77E-06	1.77E-06
th231	.00E+00	7.18E-10	1.06E-09	1.38E-09	1.68E-09	1.67E-09
th232	.00E+00	5.14E-09	1.49E-08	2.89E-08	4.70E-08	4.70E-08
th233	.00E+00	3.78E-15	1.08E-14	2.10E-14	3.41E-14	1.79E-14
th234	.00E+00	2.55E-08	2.74E-08	2.75E-08	2.75E-08	2.75E-08
pa231	.00E+00	3.03E-08	8.07E-08	1.49E-07	2.33E-07	2.33E-07
pa232	.00E+00	1.97E-11	5.22E-11	9.59E-11	1.50E-10	1.49E-10
pa233	.00E+00	2.63E-10	8.37E-10	1.58E-09	2.45E-09	2.45E-09
pa234m	.00E+00	8.59E-13	9.23E-13	9.27E-13	9.26E-13	9.26E-13
pa234	.00E+00	3.99E-13	4.60E-13	5.04E-13	5.53E-13	5.48E-13
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	.00E+00	1.32E-17	3.47E-17	6.18E-17	9.68E-17	9.67E-17
u231	.00E+00	4.56E-16	9.63E-16	1.57E-15	2.32E-15	2.31E-15
u232	.00E+00	5.38E-09	1.18E-08	1.99E-08	3.04E-08	3.04E-08
u233	.00E+00	5.28E-07	1.01E-06	1.46E-06	1.87E-06	1.87E-06
u234	7.26E-01	7.11E-01	6.98E-01	6.84E-01	6.71E-01	6.71E-01
u235	8.29E+01	7.96E+01	7.64E+01	7.34E+01	7.05E+01	7.05E+01
u236	3.79E-01	1.03E+00	1.64E+00	2.22E+00	2.77E+00	2.77E+00
u237	.00E+00	1.87E-03	2.40E-03	2.90E-03	3.38E-03	3.38E-03
u238	1.87E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03	1.86E+03
u239	.00E+00	4.13E-04	4.10E-04	4.08E-04	4.07E-04	2.21E-04
u240	.00E+00	9.65E-39	1.67E-35	1.29E-33	2.78E-32	2.78E-32
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	.00E+00	2.52E-11	1.14E-10	2.74E-10	5.09E-10	5.09E-10
np236m	.00E+00	6.35E-11	1.55E-10	2.65E-10	3.94E-10	3.90E-10
np236	.00E+00	7.01E-10	3.31E-09	8.31E-09	1.61E-08	1.61E-08
np237	.00E+00	1.29E-02	3.16E-02	5.44E-02	8.09E-02	8.09E-02

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np238	.00E+00	1.41E-05	3.43E-05	5.89E-05	8.76E-05	8.72E-05
np239	.00E+00	5.97E-02	5.92E-02	5.89E-02	5.88E-02	5.87E-02
np240m	.00E+00	8.23E-41	1.43E-37	1.10E-35	2.37E-34	2.37E-34
np240	.00E+00	8.92E-07	8.77E-07	8.70E-07	8.68E-07	8.88E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	9.27E-10	4.33E-09	1.07E-08	2.05E-08	2.05E-08
pu237	.00E+00	8.40E-10	2.60E-09	4.87E-09	7.65E-09	7.65E-09
pu238	.00E+00	1.89E-04	8.98E-04	2.25E-03	4.36E-03	4.36E-03
pu239	.00E+00	1.42E+00	2.70E+00	3.80E+00	4.77E+00	4.77E+00
pu240	.00E+00	3.60E-02	1.28E-01	2.56E-01	4.07E-01	4.07E-01
pu241	.00E+00	2.60E-03	1.81E-02	5.39E-02	1.13E-01	1.13E-01
pu242	.00E+00	2.26E-05	3.16E-04	1.43E-03	4.06E-03	4.06E-03
pu243	.00E+00	2.60E-09	3.60E-08	1.62E-07	4.61E-07	4.39E-07
pu244	.00E+00	4.81E-28	8.33E-25	6.41E-23	1.38E-21	1.38E-21
pu245	.00E+00	2.45E-34	4.22E-31	3.23E-29	6.97E-28	6.82E-28
pu246	.00E+00	2.86E-37	7.38E-34	6.78E-32	1.62E-30	1.62E-30
am239	.00E+00	2.88E-16	3.96E-15	1.76E-14	4.95E-14	4.85E-14
am240	.00E+00	1.00E-13	1.38E-12	6.16E-12	1.73E-11	1.72E-11

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sas2h: babcock wilcox 15x15, 4.20wt%, 45gwd/mtu burn high temp
 power= 7.25mw, burnup= 20880.mwd, flux= 1.34E+13n/cm**2-sec
 nuclide concentrations, gram atoms
 basis = single reactor assembly

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0

	charge	2610.4 d	2700.4 d	2790.4 d	2880.4 d
he 4	1.30E-01	1.47E-01	1.64E-01	1.83E-01	2.03E-01
pb206	1.99E-14	2.32E-14	2.67E-14	3.07E-14	3.51E-14
pb207	1.55E-11	1.75E-11	1.96E-11	2.19E-11	2.44E-11
pb208	1.67E-08	1.92E-08	2.20E-08	2.51E-08	2.85E-08
pb209	2.45E-16	2.77E-16	3.13E-16	3.51E-16	3.91E-16
pb210	4.94E-13	5.49E-13	6.07E-13	6.70E-13	7.36E-13
pb211	7.61E-16	8.24E-16	8.88E-16	9.54E-16	1.02E-15
pb212	1.72E-11	1.90E-11	2.10E-11	2.31E-11	2.53E-11
pb214	7.32E-18	7.91E-18	8.27E-18	8.63E-18	8.98E-18
ra222	2.22E-19	2.41E-19	2.64E-19	2.88E-19	3.13E-19
ra223	3.47E-13	3.76E-13	4.05E-13	4.35E-13	4.66E-13
ra224	1.42E-10	1.57E-10	1.74E-10	1.91E-10	2.09E-10
ra225	2.68E-14	3.07E-14	3.45E-14	3.87E-14	4.32E-14
ra226	2.37E-10	2.48E-10	2.60E-10	2.71E-10	2.82E-10
ra228	1.36E-16	1.48E-16	1.61E-16	1.74E-16	1.88E-16
ac225	1.79E-14	2.05E-14	2.31E-14	2.59E-14	2.89E-14
ac227	2.51E-10	2.71E-10	2.91E-10	3.13E-10	3.34E-10
ac228	1.66E-20	1.81E-20	1.96E-20	2.12E-20	2.29E-20
th226	1.08E-17	1.18E-17	1.29E-17	1.40E-17	1.53E-17
th227	5.69E-13	6.15E-13	6.62E-13	7.11E-13	7.61E-13
th228	2.69E-08	2.99E-08	3.30E-08	3.63E-08	3.97E-08
th229	1.28E-09	1.48E-09	1.70E-09	1.95E-09	2.22E-09
th230	5.05E-06	5.02E-06	4.99E-06	4.95E-06	4.91E-06
th231	5.05E-09	5.28E-09	5.30E-09	5.31E-09	5.32E-09
th232	1.31E-06	1.38E-06	1.45E-06	1.53E-06	1.60E-06
th233	3.44E-14	1.31E-12	1.39E-12	1.48E-12	1.57E-12
th234	2.67E-08	2.67E-08	2.67E-08	2.66E-08	2.66E-08
pa231	4.16E-06	4.30E-06	4.43E-06	4.56E-06	4.68E-06
pa232	3.31E-09	3.59E-09	3.74E-09	3.89E-09	4.04E-09
pa233	4.24E-08	4.42E-08	4.60E-08	4.78E-08	4.96E-08
pa234m	9.02E-13	9.10E-13	9.10E-13	9.09E-13	9.09E-13

pa234	2.99E-12	3.69E-12	3.87E-12	4.04E-12	4.22E-12
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	1.05E-14	1.14E-14	1.25E-14	1.36E-14	1.48E-14
u231	1.89E-13	2.07E-13	2.27E-13	2.47E-13	2.68E-13
u232	2.22E-06	2.41E-06	2.60E-06	2.81E-06	3.01E-06
u233	6.81E-06	6.86E-06	6.91E-06	6.96E-06	7.00E-06
u234	4.07E-01	3.99E-01	3.90E-01	3.82E-01	3.74E-01
u235	2.41E+01	2.29E+01	2.17E+01	2.06E+01	1.96E+01
u236	1.06E+01	1.08E+01	1.09E+01	1.11E+01	1.12E+01
u237	1.05E-02	1.05E-02	1.08E-02	1.10E-02	1.12E-02
u238	1.81E+03	1.81E+03	1.81E+03	1.80E+03	1.80E+03
u239	1.74E-05	5.24E-04	5.30E-04	5.35E-04	5.40E-04
u240	2.02E-23	2.85E-23	3.98E-23	5.48E-23	7.47E-23
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	3.47E-08	3.71E-08	3.94E-08	4.19E-08	4.43E-08
np236m	8.11E-09	9.04E-09	9.51E-09	9.97E-09	1.04E-08
np236	2.22E-06	2.43E-06	2.65E-06	2.87E-06	3.11E-06
np237	1.20E+00	1.25E+00	1.30E+00	1.35E+00	1.40E+00
np238	1.52E-03	1.62E-03	1.71E-03	1.79E-03	1.87E-03

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sas2h: babcock wilcox 15x15, 4.20wt%, 45gwd/mtu burn high temp
power= 7.25mw, burnup= 20880.mwd, flux= 1.34E+13n/cm**2-sec
nuclide concentrations, gram atoms
basis = single reactor assembly

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	charge	2610.4 d	2700.4 d	2790.4 d	2880.4 d
np239	7.42E-02	7.56E-02	7.64E-02	7.72E-02	7.79E-02
np240m	1.74E-25	2.43E-25	3.39E-25	4.68E-25	6.37E-25
np240	3.99E-07	1.46E-06	1.49E-06	1.52E-06	1.55E-06
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	2.03E-06	2.19E-06	2.36E-06	2.53E-06	2.70E-06
pu237	7.11E-07	7.81E-07	8.54E-07	9.31E-07	1.01E-06
pu238	5.05E-01	5.47E-01	5.92E-01	6.37E-01	6.85E-01
pu239	1.31E+01	1.32E+01	1.32E+01	1.32E+01	1.33E+01
pu240	4.84E+00	5.01E+00	5.16E+00	5.29E+00	5.42E+00
pu241	3.01E+00	3.08E+00	3.16E+00	3.25E+00	3.34E+00
pu242	1.03E+00	1.11E+00	1.19E+00	1.27E+00	1.36E+00
pu243	1.03E-04	1.39E-04	1.51E-04	1.63E-04	1.76E-04
pu244	1.01E-12	1.42E-12	1.98E-12	2.73E-12	3.72E-12
pu245	5.48E-19	9.00E-19	1.27E-18	1.77E-18	2.44E-18
pu246	2.48E-21	3.66E-21	5.23E-21	7.38E-21	1.03E-20
am239	1.08E-11	1.28E-11	1.36E-11	1.43E-11	1.50E-11
am240	4.06E-09	4.42E-09	4.68E-09	4.93E-09	5.17E-09
am241	2.25E-01	2.37E-01	2.47E-01	2.58E-01	2.68E-01
am242m	5.14E-03	5.38E-03	5.64E-03	5.90E-03	6.16E-03
am242	1.97E-04	2.25E-04	2.38E-04	2.50E-04	2.63E-04
am243	2.49E-01	2.76E-01	3.04E-01	3.35E-01	3.67E-01
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	8.20E-05	1.02E-04	1.14E-04	1.27E-04	1.40E-04
am245	4.46E-17	6.20E-17	8.53E-17	1.16E-16	1.56E-16
am246	6.21E-24	9.14E-24	1.31E-23	1.84E-23	2.57E-23
cm241	1.44E-09	1.56E-09	1.69E-09	1.81E-09	1.94E-09
cm242	3.59E-02	3.83E-02	4.08E-02	4.33E-02	4.58E-02
cm243	1.09E-03	1.20E-03	1.32E-03	1.44E-03	1.57E-03
cm244	7.81E-02	9.03E-02	1.04E-01	1.19E-01	1.35E-01
cm245	3.20E-03	3.79E-03	4.45E-03	5.20E-03	6.05E-03
cm246	3.84E-04	4.80E-04	5.96E-04	7.32E-04	8.92E-04
cm247	7.55E-06	9.78E-06	1.26E-05	1.60E-05	2.01E-05
cm248	7.70E-07	1.04E-06	1.40E-06	1.87E-06	2.46E-06
cm249	1.63E-12	7.65E-12	1.04E-11	1.40E-11	1.86E-11
cm250	2.36E-15	3.41E-15	4.85E-15	6.82E-15	9.48E-15

cm251	4.20E-25	7.19E-23	1.04E-22	1.47E-22	2.07E-22
bk249	1.15E-08	1.60E-08	2.20E-08	2.99E-08	4.03E-08
bk250	2.51E-12	5.32E-12	7.41E-12	1.02E-11	1.39E-11
bk251	1.14E-17	6.68E-17	9.41E-17	1.31E-16	1.80E-16
cf249	3.44E-09	4.88E-09	6.83E-09	9.42E-09	1.29E-08
cf250	1.59E-09	2.27E-09	3.17E-09	4.38E-09	5.98E-09
cf251	1.10E-09	1.57E-09	2.24E-09	3.14E-09	4.34E-09
cf252	5.59E-10	8.44E-10	1.25E-09	1.83E-09	2.64E-09
cf253	5.16E-13	7.89E-13	1.19E-12	1.76E-12	2.58E-12
cf254	2.28E-16	3.59E-16	5.54E-16	8.39E-16	1.25E-15
cf255	9.46E-21	3.61E-20	5.64E-20	8.64E-20	1.30E-19
0 totals	1.87E+03	1.87E+03	1.86E+03	1.86E+03	1.86E+03
flux	1.50E+13	1.52E+13	1.54E+13	1.54E+13	1.55E+13

1 sas2h: babcock wilcox 15x15, 4.20wtX, 45gwd/mtu burn high temp actinides page 49
 decay, following reactor irradiation identified by: power= 7.25mw, burnup= 20880.mwd, flux= 1.34E+13n/cm**2-sec
 0 nuclide concentrations, grams
 basis =single reactor assembly

	initial	304.4 d	608.8 d	913.1 d	1217.5 d	1521.9 d	1826.3 d
he 4	8.11E-01	9.85E-01	1.06E+00	1.12E+00	1.16E+00	1.20E+00	1.24E+00
pb208	5.92E-06	8.83E-06	1.25E-05	1.70E-05	2.22E-05	2.80E-05	3.43E-05
th228	9.06E-06	1.20E-05	1.49E-05	1.75E-05	1.99E-05	2.20E-05	2.38E-05
th230	1.13E-03	1.33E-03	1.54E-03	1.75E-03	1.96E-03	2.17E-03	2.39E-03
th232	3.72E-04	4.36E-04	5.00E-04	5.64E-04	6.28E-04	6.92E-04	7.56E-04
th234	6.23E-06	6.22E-06	6.22E-06	6.22E-06	6.22E-06	6.22E-06	6.22E-06
pa231	1.08E-03	1.09E-03	1.09E-03	1.09E-03	1.10E-03	1.10E-03	1.10E-03
pa233	1.16E-05	1.13E-05	1.13E-05	1.13E-05	1.14E-05	1.14E-05	1.14E-05
u232	6.99E-04	8.07E-04	8.93E-04	9.62E-04	1.02E-03	1.06E-03	1.09E-03
u233	1.63E-03	1.73E-03	1.83E-03	1.93E-03	2.03E-03	2.13E-03	2.23E-03
u234	8.75E+01	8.86E+01	8.97E+01	9.08E+01	9.19E+01	9.30E+01	9.41E+01
u235	4.60E+03	4.60E+03	4.60E+03	4.60E+03	4.60E+03	4.60E+03	4.60E+03
u236	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03
u237	2.66E+00	2.34E-05	2.25E-05	2.16E-05	2.08E-05	1.99E-05	1.91E-05
u238	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05
np235	1.04E-05	6.11E-06	3.59E-06	2.11E-06	1.24E-06	7.26E-07	4.26E-07
np236	7.34E-04	7.34E-04	7.34E-04	7.34E-04	7.34E-04	7.34E-04	7.34E-04
np237	3.31E+02	3.34E+02	3.34E+02	3.34E+02	3.34E+02	3.34E+02	3.35E+02
np239	1.86E+01	7.68E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05
pu236	6.38E-04	5.24E-04	4.29E-04	3.52E-04	2.88E-04	2.36E-04	1.94E-04
pu238	1.63E+02	1.70E+02	1.71E+02	1.71E+02	1.70E+02	1.69E+02	1.68E+02
pu239	3.17E+03	3.19E+03	3.19E+03	3.19E+03	3.19E+03	3.19E+03	3.19E+03
pu240	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.31E+03
pu241	8.04E+02	7.73E+02	7.42E+02	7.13E+02	6.85E+02	6.58E+02	6.32E+02
pu242	3.29E+02	3.29E+02	3.29E+02	3.29E+02	3.29E+02	3.29E+02	3.29E+02
am241	6.45E+01	9.62E+01	1.27E+02	1.56E+02	1.84E+02	2.10E+02	2.36E+02
am242m	1.49E+00	1.48E+00	1.48E+00	1.47E+00	1.47E+00	1.46E+00	1.45E+00
am242	6.36E-02	1.92E-05	1.91E-05	1.90E-05	1.89E-05	1.88E-05	1.88E-05
am243	8.92E+01	8.92E+01	8.92E+01	8.92E+01	8.92E+01	8.92E+01	8.92E+01
cm242	1.11E+01	3.05E+00	8.39E-01	2.33E-01	6.65E-02	2.10E-02	8.50E-03
cm243	3.81E-01	3.74E-01	3.66E-01	3.59E-01	3.51E-01	3.44E-01	3.38E-01
cm244	3.30E+01	3.20E+01	3.10E+01	3.01E+01	2.91E+01	2.82E+01	2.73E+01
cm245	1.48E+00	1.48E+00	1.48E+00	1.48E+00	1.48E+00	1.48E+00	1.48E+00
cm246	2.20E-01	2.20E-01	2.19E-01	2.19E-01	2.19E-01	2.19E-01	2.19E-01
cm247	4.97E-03	4.97E-03	4.97E-03	4.97E-03	4.97E-03	4.97E-03	4.97E-03
cm248	6.09E-04	6.09E-04	6.09E-04	6.09E-04	6.09E-04	6.09E-04	6.09E-04
cf249	3.20E-06	8.04E-06	1.05E-05	1.18E-05	1.25E-05	1.28E-05	1.29E-05

[illegible]

```

=sas2h      parm='halt8,skipcellwt,skipshipdata'
$AS2H: Babcock Wilcox 15x15, 4.50wt%, 53gwd/mtu.burn High Temp
44group    latticecell
/
/ mixtures of fuel-pin-unit-cell:
/ den=mass UO2/ Volume assembly = 526377.3 g/5.157524E4
uo2 1 den=10.2060 1 975 92235 4.50 92234 0.0395 92236 0.0207 92238 95.4398 end
kr-83      1 0 1-20 975 end
kr-85      1 0 1-20 975 end
sr-90      1 0 1-20 975 end
y-89       1 0 1-20 975 end
mo-95      1 0 1-20 975 end
zr-93      1 0 1-20 975 end
zr-94      1 0 1-20 975 end
zr-95      1 0 1-20 975 end
nb-94      1 0 1-20 975 end
tc-99      1 0 1-20 975 end
rh-103     1 0 1-20 975 end
rh-105     1 0 1-20 975 end
ru-101     1 0 1-20 975 end
ru-106     1 0 1-20 975 end
pd-105     1 0 1-20 975 end
pd-108     1 0 1-20 975 end
ag-109     1 0 1-20 975 end
sb-124     1 0 1-20 975 end
xe-131     1 0 1-20 975 end
xe-132     1 0 1-20 975 end
xe-135     1 0 1-20 975 end
xe-136     1 0 1-20 975 end
cs-134     1 0 1-20 975 end
cs-135     1 0 1-20 975 end
cs-137     1 0 1-20 975 end
ba-136     1 0 1-20 975 end
la-139     1 0 1-20 975 end
pr-141     1 0 1-20 975 end
pr-143     1 0 1-20 975 end
ce-144     1 0 1-20 975 end
nd-143     1 0 1-20 975 end
nd-145     1 0 1-20 975 end
pm-147     1 0 1-20 975 end
pm-148     1 0 1-20 975 end
nd-147     1 0 1-20 975 end
sm-147     1 0 1-20 975 end
sm-149     1 0 1-20 975 end
sm-150     1 0 1-20 975 end
sm-151     1 0 1-20 975 end
sm-152     1 0 1-20 975 end
gd-155     1 0 1-20 975 end
eu-153     1 0 1-20 975 end
eu-154     1 0 1-20 975 end
eu-155     1 0 1-20 975 end
h2o        3 den=0.6272 1 607.6 end
arbm-bormod 0.6272 1 1 0 0 5000 100 3 552.6e-6 607.6 end
arbm-zirc4  6.56 5 0 0 0 8016 0.12 24000 0.10 26000 0.20 50000 1.40
              40000 98.18 2 1.0 650.0 end
/
/ 1050 ppm boron
/ -----
end comp
/

```

```

/-----
/ fuel-pin-cell geometry:
/
squarepitch 1.44272 0.936244 1 3 1.0922 2 0.95758 0 end
/
/-----
/
/ assembly and cycle parameters:
/
npin/assm=208 fuelngth=360.172 ncycles=1 nlib/cyc=8
printlevel=5 inplevel=2 numztotal=4 end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=3392 down=1826.25
end
end

```

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sas2h: babcock wilcox 15x15, 4.50wt%, 53gwd/mtu burn high temp
 power= 7.25mw, burnup= 3074.mwd, flux= 1.18E+13n/cm**2-sec

actinides page 6

nuclide concentrations, gram atoms
 basis = single reactor assembly

	charge	106.0 d	212.0 d	318.0 d	424.0 d	424.0 d
he 4	.00E+00	8.39E-06	3.44E-05	8.52E-05	1.79E-04	1.79E-04
th226	.00E+00	1.83E-20	4.76E-20	8.63E-20	1.39E-19	1.38E-19
th227	.00E+00	1.49E-16	9.66E-16	2.86E-15	6.16E-15	6.16E-15
th228	.00E+00	9.28E-12	3.84E-11	9.14E-11	1.75E-10	1.75E-10
th229	.00E+00	4.42E-13	1.79E-12	4.10E-12	7.46E-12	7.46E-12
th230	.00E+00	6.17E-07	1.19E-06	1.72E-06	2.20E-06	2.20E-06
th231	.00E+00	8.36E-10	1.26E-09	1.66E-09	2.02E-09	2.00E-09
th232	.00E+00	6.83E-09	2.01E-08	3.93E-08	6.42E-08	6.42E-08
th233	.00E+00	4.92E-15	1.43E-14	2.80E-14	4.58E-14	2.14E-14
th234	.00E+00	2.61E-08	2.74E-08	2.74E-08	2.74E-08	2.74E-08
pa231	.00E+00	4.05E-08	1.10E-07	2.05E-07	3.23E-07	3.23E-07
pa232	.00E+00	2.55E-11	6.90E-11	1.28E-10	2.02E-10	2.00E-10
pa233	.00E+00	3.48E-10	1.08E-09	2.02E-09	3.15E-09	3.15E-09
pa234m	.00E+00	8.82E-13	9.23E-13	9.24E-13	9.23E-13	9.22E-13
pa234	.00E+00	4.13E-13	4.73E-13	5.26E-13	5.89E-13	5.82E-13
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	.00E+00	1.77E-17	4.61E-17	8.37E-17	1.34E-16	1.34E-16
u231	.00E+00	5.74E-16	1.23E-15	2.06E-15	3.12E-15	3.12E-15
u232	.00E+00	6.86E-09	1.54E-08	2.67E-08	4.19E-08	4.19E-08
u233	.00E+00	6.61E-07	1.26E-06	1.81E-06	2.31E-06	2.31E-06
u234	7.83E-01	7.66E-01	7.49E-01	7.32E-01	7.16E-01	7.16E-01
u235	8.88E+01	8.49E+01	8.12E+01	7.76E+01	7.42E+01	7.42E+01
u236	4.07E-01	1.18E+00	1.90E+00	2.59E+00	3.24E+00	3.24E+00
u237	.00E+00	1.96E-03	2.57E-03	3.15E-03	3.70E-03	3.70E-03
u238	1.86E+03	1.86E+03	1.86E+03	1.85E+03	1.85E+03	1.85E+03
u239	.00E+00	4.02E-04	3.99E-04	3.97E-04	3.97E-04	1.93E-04
u240	.00E+00	3.93E-38	6.83E-35	5.25E-33	1.13E-31	1.13E-31
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	.00E+00	3.57E-11	1.61E-10	3.87E-10	7.21E-10	7.21E-10
np236m	.00E+00	7.76E-11	1.90E-10	3.30E-10	4.94E-10	4.88E-10
np236	.00E+00	1.00E-09	4.75E-09	1.20E-08	2.35E-08	2.35E-08
np237	.00E+00	1.59E-02	3.92E-02	6.80E-02	1.02E-01	1.02E-01
np238	.00E+00	1.67E-05	4.09E-05	7.09E-05	1.06E-04	1.06E-04

np239	.00E+00	5.80E-02	5.76E-02	5.74E-02	5.74E-02	5.73E-02
np240m	.00E+00	3.35E-40	5.83E-37	4.48E-35	9.66E-34	9.66E-34
np240	.00E+00	8.48E-07	8.36E-07	8.32E-07	8.32E-07	6.33E-07
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	.00E+00	1.32E-09	6.18E-09	1.53E-08	2.95E-08	2.95E-08
pu237	.00E+00	1.07E-09	3.25E-09	6.11E-09	9.75E-09	9.74E-09
pu238	.00E+00	2.62E-04	1.25E-03	3.15E-03	6.15E-03	6.15E-03
pu239	.00E+00	1.62E+00	3.06E+00	4.28E+00	5.33E+00	5.33E+00
pu240	.00E+00	4.49E-02	1.58E-01	3.12E-01	4.90E-01	4.90E-01
pu241	.00E+00	3.67E-03	2.52E-02	7.42E-02	1.54E-01	1.54E-01
pu242	.00E+00	3.51E-05	4.86E-04	2.18E-03	6.14E-03	6.14E-03
pu243	.00E+00	3.94E-09	5.42E-08	2.42E-07	6.83E-07	6.46E-07
pu244	.00E+00	1.96E-27	3.40E-24	2.61E-22	5.64E-21	5.64E-21
pu245	.00E+00	9.20E-34	1.59E-30	1.22E-28	2.63E-27	2.56E-27
pu246	.00E+00	1.13E-36	2.84E-33	2.57E-31	6.11E-30	6.11E-30
am239	.00E+00	4.73E-16	6.44E-15	2.84E-14	7.89E-14	7.70E-14
am240	.00E+00	1.65E-13	2.25E-12	9.92E-12	2.76E-11	2.74E-11

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sas2h: babcock wilcox 15x15, 4.50wt%, 53gwd/mtu burn high temp
 power= 7.25mw, burnup= 24592.mwd, flux= 1.29E+13n/cm**2-sec
 nuclide concentrations, gram atoms
 basis = single reactor assembly

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	charge	3074.4 d	3180.4 d	3286.4 d	3392.4 d
he 4	2.11E-01	2.37E-01	2.64E-01	2.92E-01	3.23E-01
pb206	4.22E-14	4.90E-14	5.65E-14	6.48E-14	7.40E-14
pb207	2.91E-11	3.27E-11	3.66E-11	4.07E-11	4.51E-11
pb208	3.33E-08	3.83E-08	4.38E-08	4.98E-08	5.64E-08
pb209	4.33E-16	4.91E-16	5.53E-16	6.19E-16	6.90E-16
pb210	8.51E-13	9.45E-13	1.04E-12	1.15E-12	1.26E-12
pb211	1.18E-15	1.27E-15	1.36E-15	1.46E-15	1.55E-15
pb212	2.87E-11	3.17E-11	3.48E-11	3.81E-11	4.16E-11
pb214	9.92E-18	1.07E-17	1.11E-17	1.16E-17	1.20E-17
ra222	3.47E-19	3.75E-19	4.09E-19	4.45E-19	4.83E-19
ra223	5.39E-13	5.80E-13	6.22E-13	6.65E-13	7.09E-13
ra224	2.37E-10	2.62E-10	2.88E-10	3.15E-10	3.43E-10
ra225	4.61E-14	5.28E-14	5.94E-14	6.65E-14	7.41E-14
ra226	3.21E-10	3.35E-10	3.49E-10	3.63E-10	3.77E-10
ra228	2.09E-16	2.28E-16	2.47E-16	2.66E-16	2.86E-16
ac225	3.18E-14	3.63E-14	4.08E-14	4.57E-14	5.09E-14
ac227	3.86E-10	4.15E-10	4.45E-10	4.75E-10	5.05E-10
ac228	2.56E-20	2.78E-20	3.01E-20	3.25E-20	3.50E-20
th226	1.69E-17	1.83E-17	2.00E-17	2.17E-17	2.35E-17
th227	8.80E-13	9.47E-13	1.02E-12	1.08E-12	1.16E-12
th228	4.50E-08	4.97E-08	5.46E-08	5.98E-08	6.52E-08
th229	2.42E-09	2.80E-09	3.22E-09	3.69E-09	4.20E-09
th230	5.38E-06	5.32E-06	5.25E-06	5.17E-06	5.09E-06
th231	5.51E-09	5.71E-09	5.71E-09	5.69E-09	5.66E-09
th232	1.75E-06	1.85E-06	1.95E-06	2.04E-06	2.14E-06
th233	4.69E-14	1.79E-12	1.91E-12	2.03E-12	2.15E-12
th234	2.65E-08	2.65E-08	2.64E-08	2.64E-08	2.63E-08
pa231	5.26E-06	5.40E-06	5.52E-06	5.64E-06	5.75E-06
pa232	4.24E-09	4.57E-09	4.75E-09	4.91E-09	5.07E-09
pa233	5.25E-08	5.46E-08	5.67E-08	5.87E-08	6.08E-08
pa234m	8.94E-13	9.05E-13	9.04E-13	9.04E-13	9.03E-13

pa234	3.68E-12	4.56E-12	4.77E-12	4.99E-12	5.21E-12
pa235	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
u230	1.64E-14	1.77E-14	1.94E-14	2.11E-14	2.28E-14
u231	2.93E-13	3.20E-13	3.49E-13	3.80E-13	4.11E-13
u232	3.35E-06	3.62E-06	3.90E-06	4.18E-06	4.47E-06
u233	7.78E-06	7.82E-06	7.86E-06	7.90E-06	7.93E-06
u234	4.05E-01	3.95E-01	3.86E-01	3.77E-01	3.68E-01
u235	2.17E+01	2.05E+01	1.93E+01	1.81E+01	1.70E+01
u236	1.20E+01	1.21E+01	1.22E+01	1.23E+01	1.24E+01
u237	1.15E-02	1.16E-02	1.18E-02	1.21E-02	1.23E-02
u238	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.78E+03
u239	1.75E-05	5.31E-04	5.37E-04	5.43E-04	5.49E-04
u240	7.77E-23	1.09E-22	1.52E-22	2.09E-22	2.84E-22
u241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
np235	4.68E-08	4.98E-08	5.29E-08	5.60E-08	5.91E-08
np236m	1.03E-08	1.15E-08	1.21E-08	1.26E-08	1.32E-08
np236	3.34E-06	3.65E-06	3.97E-06	4.31E-06	4.67E-06
np237	1.48E+00	1.53E+00	1.59E+00	1.64E+00	1.69E+00
np238	1.87E-03	2.00E-03	2.10E-03	2.20E-03	2.29E-03

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sas2h: babcock wilcox 15x15, 4.50wt%, 53gwd/mtu burn high temp
power= 7.25mw, burnup= 24592.mwd, flux= 1.29E+13n/cm**2-sec

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nuclide concentrations, gram atoms
basis = single reactor assembly

	charge	3074.4 d	3180.4 d	3286.4 d	3392.4 d
np239	7.52E-02	7.66E-02	7.76E-02	7.85E-02	7.93E-02
np240m	6.68E-25	9.34E-25	1.30E-24	1.78E-24	2.42E-24
np240	4.12E-07	1.51E-06	1.55E-06	1.58E-06	1.62E-06
np241	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu236	2.89E-06	3.11E-06	3.33E-06	3.57E-06	3.80E-06
pu237	1.06E-06	1.16E-06	1.27E-06	1.38E-06	1.49E-06
pu238	7.23E-01	7.82E-01	8.42E-01	9.04E-01	9.67E-01
pu239	1.37E+01	1.37E+01	1.37E+01	1.37E+01	1.37E+01
pu240	5.41E+00	5.58E+00	5.73E+00	5.86E+00	5.99E+00
pu241	3.41E+00	3.48E+00	3.55E+00	3.64E+00	3.72E+00
pu242	1.34E+00	1.44E+00	1.54E+00	1.64E+00	1.74E+00
pu243	1.31E-04	1.76E-04	1.91E-04	2.06E-04	2.21E-04
pu244	3.87E-12	5.45E-12	7.58E-12	1.04E-11	1.41E-11
pu245	2.08E-18	3.42E-18	4.82E-18	6.70E-18	9.21E-18
pu246	9.51E-21	1.40E-20	2.01E-20	2.83E-20	3.94E-20
am239	1.40E-11	1.65E-11	1.74E-11	1.82E-11	1.90E-11
am240	5.27E-09	5.69E-09	5.99E-09	6.27E-09	6.54E-09
am241	2.82E-01	2.94E-01	3.05E-01	3.15E-01	3.25E-01
am242m	6.62E-03	6.86E-03	7.12E-03	7.38E-03	7.63E-03
am242	2.45E-04	2.78E-04	2.92E-04	3.06E-04	3.19E-04
am243	3.65E-01	4.02E-01	4.40E-01	4.82E-01	5.25E-01
am244m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am244	1.20E-04	1.48E-04	1.65E-04	1.83E-04	2.02E-04
am245	1.61E-16	2.22E-16	3.05E-16	4.13E-16	5.54E-16
am246	2.38E-23	3.51E-23	5.02E-23	7.07E-23	9.85E-23
cm241	1.96E-09	2.10E-09	2.25E-09	2.41E-09	2.56E-09
cm242	4.65E-02	4.92E-02	5.20E-02	5.48E-02	5.75E-02
cm243	1.61E-03	1.76E-03	1.91E-03	2.07E-03	2.23E-03
cm244	1.35E-01	1.55E-01	1.78E-01	2.02E-01	2.29E-01
cm245	6.19E-03	7.26E-03	8.47E-03	9.82E-03	1.13E-02
cm246	8.84E-04	1.10E-03	1.36E-03	1.66E-03	2.02E-03
cm247	2.02E-05	2.60E-05	3.32E-05	4.20E-05	5.26E-05
cm248	2.49E-06	3.37E-06	4.51E-06	5.97E-06	7.82E-06
cm249	5.39E-12	2.53E-11	3.43E-11	4.60E-11	6.11E-11
cm250	9.14E-15	1.32E-14	1.87E-14	2.64E-14	3.66E-14

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[illegible]

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Far-Field External Criticality Analysis

Avogadro's 0.602252

Calico Hills Tuff - Nominal Porosity .306 / density=1.746 g/cc
Vol Den tuff 6.9400E-01

Number Density Calculations

		3.0% / 20 GWD/mt	3.0% / 20 GWD/mt	3.0% / 20 GWD/mt	3.0% / 20 GWD/mt	3.0% / 20 GWD/mt	3.0% / 20 GWD/mt
		Full Density	water vol frac	UO2 vol frac	water vol frac	UO2 vol frac	water vol frac
UO2	O	4.8888950E-02	3.000000E-01	1.500000E-01	3.000000E-01	1.000000E-01	3.000000E-01
	U-234	5.8680620E-06	8.802093E-07	7.333343E-03	2.444448E-03	4.888895E-03	1.173612E-06
	U-235	4.7816080E-04	7.172412E-05	2.934031E-07	2.390804E-05	4.781608E-05	9.563216E-05
	U-236	1.1441480E-04	1.716222E-05	5.720740E-06	1.190938E-03	1.144148E-05	2.288296E-05
	U-238	2.3818750E-02	3.572813E-03	1.190938E-03	1.190938E-03	2.381875E-03	4.763750E-03
H2O	Np-237	2.7286570E-05	4.092986E-06	1.364329E-06	1.364329E-06	2.728657E-06	5.457314E-06
	H	6.6861260E-02	1.704962E-02	1.905546E-02	1.905546E-02	1.805254E-02	1.604670E-02
	O	3.3430630E-02	8.524811E-03	9.527730E-03	9.527730E-03	9.026270E-03	8.023351E-03
	H	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	O	3.2628830E-02	2.773451E-02	3.099739E-02	3.099739E-02	2.936595E-02	2.610306E-02
Tuff	Na	4.5533820E-04	3.870375E-04	4.325713E-04	4.325713E-04	4.098044E-04	3.642706E-04
	Mg	2.6751210E-04	2.273853E-04	2.541365E-04	2.541365E-04	2.407609E-04	2.140097E-04
	Al	3.0153870E-03	2.563079E-03	2.864618E-03	2.864618E-03	2.713848E-03	2.412310E-03
	Si	1.3193410E-02	1.121440E-02	1.253374E-02	1.253374E-02	1.187407E-02	1.055473E-02
	P	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	K	6.4299900E-04	5.465492E-04	6.108491E-04	6.108491E-04	5.786991E-04	5.143992E-04
	Ca	6.5871220E-04	5.599054E-04	6.257766E-04	6.257766E-04	5.928410E-04	5.269698E-04
	Ti	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	Mn	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	Fe	1.6235590E-04	1.380025E-04	1.542381E-04	1.542381E-04	1.461203E-04	1.298847E-04
	Total		7.994531E-02	8.072318E-02	8.072318E-02	8.033424E-02	7.955638E-02
	Total O		4.359266E-02	4.296957E-02	4.296957E-02	4.328111E-02	4.390421E-02
	Total H		1.704962E-02	1.905546E-02	1.905546E-02	1.805254E-02	1.604670E-02

		3.5% / 30 GWD/mt	3.5% / 30 GWD/mt	3.5% / 30 GWD/mt	3.5% / 30 GWD/mt	3.5% / 30 GWD/mt	3.5% / 30 GWD/mt
		Full Density	water vol frac	UO2 vol frac	water vol frac	UO2 vol frac	water vol frac
UO2	O	4.8888950E-02	3.000000E-01	1.500000E-01	3.000000E-01	1.400000E-01	3.000000E-01
	U-234	8.6916090E-06	1.303741E-06	7.822232E-03	1.390657E-06	6.844453E-03	4.888895E-03
	U-235	4.6281670E-04	6.942251E-05	2.395760E-05	7.405067E-05	1.216825E-06	8.691609E-07
	U-236	1.5971730E-04	2.395760E-05	2.555477E-05	2.555477E-05	6.479434E-05	4.628167E-05
	U-238	2.3769490E-02	3.565424E-03	3.803118E-03	3.803118E-03	2.238042E-05	1.597173E-05
H2O	Np-237	4.3765000E-05	6.564750E-06	7.002400E-06	7.002400E-06	3.327729E-03	4.376500E-06
	H	6.6861260E-02	1.704962E-02	1.684904E-02	1.684904E-02	6.127100E-06	1.805254E-02
	O	3.3430630E-02	8.524811E-03	8.424519E-03	8.424519E-03	1.725021E-02	9.026270E-03
	H	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	8.625103E-03	0.000000E+00
	O	3.2628830E-02	2.773451E-02	2.740822E-02	2.740822E-02	0.000000E+00	0.000000E+00
Tuff	Na	4.5533820E-04	3.870375E-04	3.824841E-04	3.824841E-04	2.806079E-02	4.098044E-04
	Mg	2.6751210E-04	2.273853E-04	2.247102E-04	2.247102E-04	3.915909E-04	2.407609E-04
	Al	3.0153870E-03	2.563079E-03	2.532925E-03	2.532925E-03	2.300604E-04	2.713848E-03
	Si	1.3193410E-02	1.121440E-02	1.108246E-02	1.108246E-02	2.593233E-03	1.187407E-02
	P	0.000000E+00	0.000000E+00	1.108246E-02	1.108246E-02	1.134633E-02	0.000000E+00
	K	6.4299900E-04	5.465492E-04	5.401192E-04	5.401192E-04	0.000000E+00	0.000000E+00
	Ca	6.5871220E-04	5.599054E-04	5.533182E-04	5.533182E-04	5.529791E-04	5.786991E-04
	Ti	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	5.664925E-04	5.928410E-04
	Mn	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	Fe	1.6235590E-04	1.380025E-04	1.363790E-04	1.363790E-04	0.000000E+00	1.461203E-04
	Total		7.994531E-02	7.986752E-02	7.986752E-02	1.396261E-04	8.033424E-02
	Total O		4.359266E-02	4.365497E-02	4.365497E-02	8.002310E-02	4.328111E-02
	Total H		1.704962E-02	1.684904E-02	1.684904E-02	4.353035E-02	1.805254E-02

3.0% / 20 GWD/mt

water vol frac	4.700000E-01
UO2 vol frac	2.500000E-01
O	1.222224E-02
U-234	1.467016E-06
U-235	1.195402E-04
U-236	2.860370E-05
U-238	5.954688E-03
Np-237	6.821643E-06
H	2.356859E-02
O	1.178430E-02
H	0.000000E+00
O	1.868870E-02
Na	2.608025E-04
Mg	1.532220E-04
Al	1.727113E-03
Si	7.556744E-03
P	0.000000E+00
K	3.682883E-04
Ca	3.772883E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	9.299203E-05
Total	8.291140E-02
Total O	4.269524E-02
Total H	2.356859E-02

3.0% / 20 GWD/mt

water vol frac	4.700000E-01
UO2 vol frac	5.000000E-02
O	2.444448E-03
U-234	2.934031E-07
U-235	2.390804E-05
U-236	5.720740E-06
U-238	1.190938E-03
Np-237	1.364329E-06
H	2.985355E-02
O	1.492678E-02
H	0.000000E+00
O	2.367236E-02
Na	3.303498E-04
Mg	1.940812E-04
Al	2.187676E-03
Si	9.571876E-03
P	0.000000E+00
K	4.664986E-04
Ca	4.778985E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.177899E-04
Total	8.546553E-02
Total O	4.104358E-02
Total H	2.985355E-02

3.0% / 20 GWD/mt

water vol frac	4.700000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	5.868062E-07
U-235	4.781608E-05
U-236	1.144148E-05
U-238	2.381875E-03
Np-237	2.728657E-06
H	2.828231E-02
O	1.414116E-02
H	0.000000E+00
O	2.242644E-02
Na	3.129630E-04
Mg	1.838684E-04
Al	2.072535E-03
Si	9.068093E-03
P	0.000000E+00
K	4.419460E-04
Ca	4.527460E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.115904E-04
Total	8.482700E-02
Total O	4.145650E-02
Total H	2.828231E-02

3.0% / 20 GWD/mt

water vol frac	4.700000E-01
UO2 vol frac	1.850000E-01
O	9.044456E-03
U-234	1.085591E-06
U-235	8.845975E-05
U-236	2.116674E-05
U-238	4.406469E-03
Np-237	5.048015E-06
H	2.561121E-02
O	1.280560E-02
H	0.000000E+00
O	2.030839E-02
Na	2.834054E-04
Mg	1.665012E-04
Al	1.876796E-03
Si	8.211662E-03
P	0.000000E+00
K	4.002067E-04
Ca	4.099866E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.010513E-04
Total	8.374149E-02
Total O	4.215845E-02
Total H	2.561121E-02

3.0% / 20 GWD/mt

water vol frac	4.700000E-01
UO2 vol frac	8.000000E-02
O	3.911116E-03
U-234	4.694450E-07
U-235	3.825286E-05
U-236	9.153184E-06
U-238	1.905500E-03
Np-237	2.182926E-06
H	2.891081E-02
O	1.445540E-02
H	0.000000E+00
O	2.292481E-02
Na	3.199177E-04
Mg	1.879523E-04
Al	2.118592E-03
Si	9.269606E-03
P	0.000000E+00
K	4.517670E-04
Ca	4.628070E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.140702E-04
Total	8.508241E-02
Total O	4.129133E-02
Total H	2.891081E-02

3.5% / 30 GWD/mt

water vol frac	2.000000E-01
UO2 vol frac	5.000000E-02
O	2.444448E-03
U-234	4.345805E-07
U-235	2.314084E-05
U-236	7.985865E-06
U-238	1.188475E-03
Np-237	2.188250E-06
H	1.270364E-02
O	6.351820E-03
H	0.000000E+00
O	3.099739E-02
Na	4.325713E-04
Mg	2.541365E-04
Al	2.864618E-03
Si	1.253374E-02
P	0.000000E+00
K	6.108491E-04
Ca	6.257766E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.542381E-04
Total	7.119545E-02
Total O	3.979366E-02
Total H	1.270364E-02

3.5% / 30 GWD/mt

water vol frac	3.000000E-01
UO2 vol frac	5.000000E-02
O	2.444448E-03
U-234	4.345805E-07
U-235	2.314084E-05
U-236	7.985865E-06
U-238	1.188475E-03
Np-237	2.188250E-06
H	1.905546E-02
O	9.527730E-03
H	0.000000E+00
O	3.099739E-02
Na	4.325713E-04
Mg	2.541365E-04
Al	2.864618E-03
Si	1.253374E-02
P	0.000000E+00
K	6.108491E-04
Ca	6.257766E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.542381E-04
Total	8.072318E-02
Total O	4.296957E-02
Total H	1.905546E-02

log model			log model			log model			log model		
3.0% / 20 GWD/mt			3.0% / 20 GWD/mt			3.0% / 20 GWD/mt			3.0% / 20 GWD/mt		
water vol frac	4.700000E-01		water vol frac	3.000000E-01		water vol frac	3.000000E-01		water vol frac	1.000000E-01	
UO2 vol frac	5.000000E-02		UO2 vol frac	3.600000E-02		UO2 vol frac	5.000000E-02		UO2 vol frac	8.000000E-02	
O	2.444448E-03		O	1.760002E-03		O	3.911116E-03		O	3.911116E-03	
U-234	2.934031E-07		U-234	2.112502E-07		U-234	4.694450E-07		U-234	4.694450E-07	
U-235	2.390804E-05		U-235	1.721379E-05		U-235	3.825286E-05		U-235	3.825286E-05	
U-236	5.720740E-06		U-236	4.118933E-06		U-236	9.153184E-06		U-236	9.153184E-06	
U-238	1.190938E-03		U-238	8.574750E-04		U-238	1.905500E-03		U-238	1.905500E-03	
Np-237	1.364329E-06		Np-237	9.823165E-07		Np-237	2.182926E-06		Np-237	2.182926E-06	
H	2.985355E-02		H	1.933628E-02		H	1.845371E-02		H	6.151236E-03	
O	1.492678E-02		O	9.668138E-03		O	9.226854E-03		O	3.075618E-03	
H	0.000000E+00		H	0.000000E+00		H	0.000000E+00		H	0.000000E+00	
O	2.367236E-02		O	1.572710E-02		O	1.500926E-02		O	1.500926E-02	
Na	3.303498E-04		Na	2.194730E-04		Na	2.094556E-04		Na	2.094556E-04	
Mg	1.940812E-04		Mg	1.289408E-04		Mg	1.230556E-04		Mg	1.230556E-04	
Al	2.187676E-03		Al	1.453417E-03		Al	1.387078E-03		Al	1.387078E-03	
Si	9.571876E-03		Si	6.359224E-03		Si	6.068969E-03		Si	6.068969E-03	
P	0.000000E+00		P	0.000000E+00		P	0.000000E+00		P	0.000000E+00	
K	4.664986E-04		K	3.099255E-04		K	2.957795E-04		K	2.957795E-04	
Ca	4.778985E-04		Ca	3.174993E-04		Ca	3.030076E-04		Ca	3.030076E-04	
Ti	0.000000E+00		Ti	0.000000E+00		Ti	0.000000E+00		Ti	0.000000E+00	
Mn	0.000000E+00		Mn	0.000000E+00		Mn	0.000000E+00		Mn	0.000000E+00	
Fe	1.177899E-04		Fe	7.825554E-05		Fe	7.468371E-05		Fe	7.468371E-05	
Total	8.546553E-02		Total	2.706816E-02		Total	2.583268E-02		Total	2.583268E-02	
Total O	4.104358E-02		Total O	8.330641E-02		Total O	8.285121E-02		Total O	6.439750E-02	
Total H	2.985355E-02		Total H	2.715524E-02		Total H	2.814723E-02		Total H	2.199600E-02	
			Total H	1.933628E-02		Total H	1.845371E-02		Total H	6.151236E-03	

3.0% / 20 GWD/mt

water vol frac	2.000000E-01
UO2 vol frac	8.000000E-02
O	3.911116E-03
U-234	4.694450E-07
U-235	3.825286E-05
U-236	9.153184E-06
U-238	1.905500E-03
Np-237	2.182926E-06
H	1.230247E-02
O	6.151236E-03
H	0.000000E+00
O	1.500926E-02
Na	2.094556E-04
Mg	1.230556E-04
Al	1.387078E-03
Si	6.068969E-03
P	0.000000E+00
K	2.957795E-04
Ca	3.030076E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	7.468371E-05
C	2.583268E-02
Total	7.362436E-02
Total O	2.507161E-02
Total H	1.230247E-02

3.0% / 20 GWD/mt

water vol frac	2.500000E-01
UO2 vol frac	8.000000E-02
O	3.911116E-03
U-234	4.694450E-07
U-235	3.825286E-05
U-236	9.153184E-06
U-238	1.905500E-03
Np-237	2.182926E-06
H	1.537809E-02
O	7.689045E-03
H	0.000000E+00
O	1.500926E-02
Na	2.094556E-04
Mg	1.230556E-04
Al	1.387078E-03
Si	6.068969E-03
P	0.000000E+00
K	2.957795E-04
Ca	3.030076E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	7.468371E-05
C	2.583268E-02
Total	7.823778E-02
Total O	2.660942E-02
Total H	1.537809E-02

3.0% / 20 GWD/mt

water vol frac	2.700000E-01
UO2 vol frac	8.000000E-02
O	3.911116E-03
U-234	4.694450E-07
U-235	3.825286E-05
U-236	9.153184E-06
U-238	1.905500E-03
Np-237	2.182926E-06
H	1.660834E-02
O	8.304168E-03
H	0.000000E+00
O	1.500926E-02
Na	2.094556E-04
Mg	1.230556E-04
Al	1.387078E-03
Si	6.068969E-03
P	0.000000E+00
K	2.957795E-04
Ca	3.030076E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	7.468371E-05
C	2.583268E-02
Total	8.008315E-02
Total O	2.722455E-02
Total H	1.660834E-02

Additional Case Soddyite/water in Tuff

3.0% / 20 GWD/mt

water vol frac	1.210000E-01
UO2 vol frac	9.100000E-02
O	4.448894E-03
U-234	5.339936E-07
U-235	4.351263E-05
U-236	1.041175E-05
U-238	2.167506E-03
Np-237	2.483078E-06
H	8.090212E-03
O	4.045106E-03
H	0.000000E+00
O	3.262883E-02
Na	4.553382E-04
Mg	2.675121E-04
Al	3.015387E-03
Si	1.319341E-02
P	0.000000E+00
K	6.429990E-04
Ca	6.587122E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.623559E-04
C	0.000000E+00
Total	6.983321E-02
Total O	4.112283E-02
Total H	8.090212E-03

Additional Case Soddyite/water in Tuff

3.0% / 20 GWD/mt

water vol frac	1.570000E-01
UO2 vol frac	7.400000E-02
O	3.617782E-03
U-234	4.342366E-07
U-235	3.538390E-05
U-236	8.466695E-06
U-238	1.762588E-03
Np-237	2.019206E-06
H	1.049722E-02
O	5.248609E-03
H	0.000000E+00
O	3.262883E-02
Na	4.553382E-04
Mg	2.675121E-04
Al	3.015387E-03
Si	1.319341E-02
P	0.000000E+00
K	6.429990E-04
Ca	6.587122E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.623559E-04
C	0.000000E+00
Total	7.219704E-02
Total O	4.149522E-02
Total H	1.049722E-02

Additional C Soddyite/water in Tuff		Additional Cas Soddyite/water in Tuff		Additional Cas Soddyite/water in Tuff		Additional Case Soddyite/water in Tuff		.40 Porosity		.40 Porosity	
3.0% / 20 GWD/mt		3.0% / 20 GWD/mt		3.0% / 20 GWD/mt		3.0% / 20 GWD/mt		3.0% / 20 GWD/mt		3.0% / 20 GW	
water vol fra	1.920000E-01	water vol frac	1.470000E-01	water vol frac	2.190000E-01	water vol frac	2.900000E-01	water vol frac	4.000000E-01	water vol frac	water vol frac
UO2 vol frac	5.500000E-02	UO2 vol frac	1.650000E-01	UO2 vol frac	1.290000E-01	UO2 vol frac	9.200000E-02	UO2 vol frac	5.000000E-02	UO2 vol frac	UO2 vol frac
O	2.688892E-03	O	8.066677E-03	O	6.306675E-03	O	4.497783E-03	O	2.444448E-03	O	O
U-234	3.227434E-07	U-234	9.682302E-07	U-234	7.569800E-07	U-234	5.398617E-07	U-234	2.934031E-07	U-234	U-234
U-235	2.629884E-05	U-235	7.889653E-05	U-235	6.168274E-05	U-235	4.399079E-05	U-235	2.390804E-05	U-235	U-235
U-236	6.292814E-06	U-236	1.887844E-05	U-236	1.475951E-05	U-236	1.052616E-05	U-236	5.720740E-06	U-236	U-236
U-238	1.310031E-03	U-238	3.930094E-03	U-238	3.072619E-03	U-238	2.191325E-03	U-238	1.190938E-03	U-238	U-238
Np-237	1.500761E-06	Np-237	4.502284E-06	Np-237	3.519968E-06	Np-237	2.510364E-06	Np-237	1.364329E-06	Np-237	Np-237
H	1.283736E-02	H	9.828605E-03	H	1.464262E-02	H	1.938977E-02	H	2.540728E-02	H	H
O	6.418681E-03	O	4.914303E-03	O	7.321308E-03	O	9.694883E-03	O	1.270364E-02	O	O
H	0.000000E+00	H	0.000000E+00	H	0.000000E+00	H	0.000000E+00	H	0.000000E+00	H	H
O	3.262883E-02	O	2.470469E-02	O	2.470469E-02	O	2.470469E-02	O	2.679889E-02	O	O
Na	4.553382E-04	Na	3.447561E-04	Na	3.447561E-04	Na	3.447561E-04	Na	3.739809E-04	Na	Na
Mg	2.675121E-04	Mg	2.025449E-04	Mg	2.025449E-04	Mg	2.025449E-04	Mg	2.197145E-04	Mg	Mg
Al	3.015387E-03	Al	2.283079E-03	Al	2.283079E-03	Al	2.283079E-03	Al	2.476615E-03	Al	Al
Si	1.319341E-02	Si	9.989296E-03	Si	9.989296E-03	Si	9.989296E-03	Si	1.083609E-02	Si	Si
P	0.000000E+00	P	0.000000E+00	P	0.000000E+00	P	0.000000E+00	P	0.000000E+00	P	P
K	6.429990E-04	K	4.868421E-04	K	4.868421E-04	K	4.868421E-04	K	5.281116E-04	K	K
Ca	6.587122E-04	Ca	4.987392E-04	Ca	4.987392E-04	Ca	4.987392E-04	Ca	5.410172E-04	Ca	Ca
Ti	0.000000E+00	Ti	0.000000E+00	Ti	0.000000E+00	Ti	0.000000E+00	Ti	0.000000E+00	Ti	Ti
Mn	0.000000E+00	Mn	0.000000E+00	Mn	0.000000E+00	Mn	0.000000E+00	Mn	0.000000E+00	Mn	Mn
Fe	1.623559E-04	Fe	1.229266E-04	Fe	1.229266E-04	Fe	1.229266E-04	Fe	1.333471E-04	Fe	Fe
C	0.000000E+00	C	0.000000E+00	C	0.000000E+00	C	0.000000E+00	Total	8.368536E-02	Total	Total
Total	7.431393E-02	Total	6.547579E-02	Total	7.005681E-02	Total	7.446419E-02	Total O	4.194698E-02	Total O	Total O
Total O	4.173640E-02	Total O	3.768566E-02	Total O	3.833267E-02	Total O	3.889735E-02	Total H	2.540728E-02	Total H	Total H
Total H	1.283736E-02	Total H	9.828605E-03	Total H	1.464262E-02	Total H	1.938977E-02				

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-01
UO2 vol frac	0.000000E+00
O	0.000000E+00
U-234	0.000000E+00
U-235	0.000000E+00
U-236	0.000000E+00
U-238	0.000000E+00
Np-237	0.000000E+00
H	2.674450E-02
O	1.337225E-02
H	0.000000E+00
O	2.820936E-02
Na	3.936641E-04
Mg	2.312785E-04
Al	2.606963E-03
Si	1.140641E-02
P	0.000000E+00
K	5.559069E-04
Ca	5.694918E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.403653E-04
Total	8.423019E-02
Total O	4.158162E-02
Total H	2.674450E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	2.500000E-01
O	1.222224E-02
U-234	1.467016E-06
U-235	1.195402E-04
U-236	2.860370E-05
U-238	5.954688E-03
Np-237	6.821643E-06
H	1.504378E-02
O	7.521892E-03
H	0.000000E+00
O	2.447162E-02
Na	3.415037E-04
Mg	2.006341E-04
Al	2.261540E-03
Si	9.895058E-03
P	0.000000E+00
K	4.822493E-04
Ca	4.940342E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.217669E-04
Total	7.916744E-02
Total O	4.421575E-02
Total H	1.504378E-02

.47 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.700000E-01
UO2 vol frac	7.870000E-02
O	3.847560E-03
U-234	4.618165E-07
U-235	3.763125E-05
U-236	9.004445E-06
U-238	1.874536E-03
Np-237	2.147453E-06
H	2.895166E-02
O	1.447583E-02
H	0.000000E+00
O	2.295720E-02
Na	3.203698E-04
Mg	1.882179E-04
Al	2.121585E-03
Si	9.282705E-03
P	0.000000E+00
K	4.524054E-04
Ca	4.634610E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.142314E-04
Total	8.509901E-02
Total O	4.128059E-02
Total H	2.895166E-02

3.0% / 20 GWD/mt	
water vol frac	4.700000E-01
UO2 vol frac	2.614300E-02
O	1.278104E-03
U-234	1.534087E-07
U-235	1.250056E-05
U-236	2.991146E-06
U-238	6.226936E-04
Np-237	7.133528E-07
H	3.060325E-02
O	1.530163E-02
H	0.000000E+00
O	2.426683E-02
Na	3.386458E-04
Mg	1.989551E-04
Al	2.242615E-03
Si	9.812251E-03
P	0.000000E+00
K	4.782136E-04
Ca	4.898998E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.207479E-04
Total	8.577020E-02
Total O	4.084656E-02
Total H	3.060325E-02

3.0% / 20 GWD/mt	
water vol frac	4.700000E-01
UO2 vol frac	4.700000E-02
O	2.297781E-03
U-234	2.757989E-07
U-235	2.247356E-05
U-236	5.377496E-06
U-238	1.119481E-03
Np-237	1.282469E-06
H	2.994783E-02
O	1.497391E-02
H	0.000000E+00
O	2.374711E-02
Na	3.313930E-04
Mg	1.946941E-04
Al	2.194585E-03
Si	9.602103E-03
P	0.000000E+00
K	4.679717E-04
Ca	4.794077E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.181619E-04
Total	8.550384E-02
Total O	4.101881E-02
Total H	2.994783E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	1.800000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	5.868062E-07
U-235	4.781608E-05
U-236	1.144148E-05
U-238	2.381875E-03
Np-237	2.728657E-06
H	1.083152E-02
O	5.415762E-03
H	0.000000E+00
O	2.936595E-02
Na	4.098044E-04
Mg	2.407609E-04
Al	2.713848E-03
Si	1.187407E-02
P	0.000000E+00
K	5.786991E-04
Ca	5.928410E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.461203E-04
Total	6.950272E-02
Total O	3.967060E-02
Total H	1.083152E-02

3.0% / 20 GWD/mt	
water vol frac	1.800000E-01
UO2 vol frac	1.200000E-01
O	5.866674E-03
U-234	7.041674E-07
U-235	5.737930E-05
U-236	1.372978E-05
U-238	2.858250E-03
Np-237	3.274388E-06
H	1.059082E-02
O	5.295412E-03
H	0.000000E+00
O	2.871337E-02
Na	4.006976E-04
Mg	2.354106E-04
Al	2.653541E-03
Si	1.161020E-02
P	0.000000E+00
K	5.658391E-04
Ca	5.796667E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.428732E-04
Total	6.958785E-02
Total O	3.987546E-02
Total H	1.059082E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	1.600000E-01
UO2 vol frac	8.000000E-02
O	3.911116E-03
U-234	4.694450E-07
U-235	3.825286E-05
U-236	9.153184E-06
U-238	1.905500E-03
Np-237	2.182926E-06
H	9.841977E-03
O	4.920989E-03
H	0.000000E+00
O	3.001852E-02
Na	4.189111E-04
Mg	2.461111E-04
Al	2.774156E-03
Si	1.213794E-02
P	0.000000E+00
K	5.915591E-04
Ca	6.060152E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.493674E-04
Total	6.757222E-02
Total O	3.885063E-02
Total H	9.841977E-03

3.0% / 20 GWD/mt	
water vol frac	1.600000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	5.868062E-07
U-235	4.781608E-05
U-236	1.144148E-05
U-238	2.381875E-03
Np-237	2.728657E-06
H	9.628021E-03
O	4.814011E-03
H	0.000000E+00
O	2.936595E-02
Na	4.098044E-04
Mg	2.407609E-04
Al	2.713848E-03
Si	1.187407E-02
P	0.000000E+00
K	5.786991E-04
Ca	5.928410E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.461203E-04
Total	6.769747E-02
Total O	3.906885E-02
Total H	9.628021E-03

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	1.600000E-01
UO2 vol frac	1.200000E-01
O	5.866674E-03
U-234	7.041674E-07
U-235	5.737930E-05
U-236	1.372978E-05
U-238	2.858250E-03
Np-237	3.274388E-06
H	9.414065E-03
O	4.707033E-03
H	0.000000E+00
O	2.871337E-02
Na	4.006976E-04
Mg	2.354106E-04
Al	2.653541E-03
Si	1.161020E-02
P	0.000000E+00
K	5.658391E-04
Ca	5.796667E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.428732E-04
Total	6.782271E-02
Total O	3.928708E-02
Total H	9.414065E-03

.40 Porosity

3.0% / 20 GWD/mt

water vol frac	4.000000E-01
UO2 vol frac	4.300000E-02
O	2.102225E-03
U-234	2.523267E-07
U-235	2.056091E-05
U-236	4.919836E-06
U-238	1.024206E-03
Np-237	1.173323E-06
H	2.559449E-02
O	1.279725E-02
H	0.000000E+00
O	2.699636E-02
Na	3.767366E-04
Mg	2.213335E-04
Al	2.494863E-03
Si	1.091593E-02
P	0.000000E+00
K	5.320029E-04
Ca	5.450037E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.343296E-04
Total	8.376163E-02
Total O	4.189583E-02
Total H	2.559449E-02

3.0% / 20 GWD/mt

water vol frac	4.000000E-01
UO2 vol frac	4.600000E-02
O	2.248892E-03
U-234	2.699309E-07
U-235	2.199540E-05
U-236	5.263081E-06
U-238	1.095663E-03
Np-237	1.255182E-06
H	2.551426E-02
O	1.275713E-02
H	0.000000E+00
O	2.691173E-02
Na	3.755556E-04
Mg	2.206397E-04
Al	2.487043E-03
Si	1.088171E-02
P	0.000000E+00
K	5.303352E-04
Ca	5.432952E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.339085E-04
Total	8.372894E-02
Total O	4.191775E-02
Total H	2.551426E-02

3.0% / 20 GWD/mt

water vol frac	3.200000E-01
UO2 vol frac	0.000000E+00
O	0.000000E+00
U-234	0.000000E+00
U-235	0.000000E+00
U-236	0.000000E+00
U-238	0.000000E+00
Np-237	0.000000E+00
H	2.139560E-02
O	1.069780E-02
H	0.000000E+00
O	3.197061E-02
Na	4.461527E-04
Mg	2.621156E-04
Al	2.954558E-03
Si	1.292726E-02
P	0.000000E+00
K	6.300278E-04
Ca	6.454241E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.590807E-04
Total	8.208864E-02
Total O	4.266841E-02
Total H	2.139560E-02

		4.0% /40 GWD/mt	4.0% /40 GWD/mt	4.0% /40 GWD/mt	4.0% /40 GWD/mt
		water vol frac	water vol frac	water vol frac	water vol frac
		UO2 vol frac	UO2 vol frac	UO2 vol frac	UO2 vol frac
UO2	O	4.8888950E-02	4.8888950E-02	O	4.8888950E-02
	U-234	1.2468890E-05	1.2468890E-05	U-234	1.2468890E-05
	U-235	4.5157230E-04	4.5157230E-04	U-235	4.5157230E-04
	U-236	2.0176000E-04	2.0176000E-04	U-236	2.0176000E-04
	U-238	2.3719690E-02	2.3719690E-02	U-238	2.3719690E-02
	Np-237	5.8984170E-05	5.8984170E-05	Np-237	5.8984170E-05
	H	6.8861260E-02	6.8861260E-02	H	6.8861260E-02
	O	3.3430630E-02	3.3430630E-02	O	3.3430630E-02
	H	0.0000000E+00	0.0000000E+00	H	0.0000000E+00
	O	3.2628830E-02	3.2628830E-02	O	3.2628830E-02
H2O	Na	4.5533820E-04	4.5533820E-04	Na	4.5533820E-04
	Mg	2.6751210E-04	2.6751210E-04	Mg	2.6751210E-04
	Al	3.0153870E-03	3.0153870E-03	Al	3.0153870E-03
	Si	1.3193410E-02	1.3193410E-02	Si	1.3193410E-02
	P	0.0000000E+00	0.0000000E+00	P	0.0000000E+00
	K	6.4299900E-04	6.4299900E-04	K	6.4299900E-04
	Ca	6.5871220E-04	6.5871220E-04	Ca	6.5871220E-04
	Ti	0.0000000E+00	0.0000000E+00	Ti	0.0000000E+00
	Mn	0.0000000E+00	0.0000000E+00	Mn	0.0000000E+00
	Fe	1.6235590E-04	1.6235590E-04	Fe	1.6235590E-04
Tuff	Total	8.002310E-02	8.002310E-02	Total	8.002310E-02
	Total O	4.353035E-02	4.353035E-02	Total O	4.353035E-02
	Total H	1.725021E-02	1.725021E-02	Total H	1.725021E-02
		4.0% /40 GWD/mt	4.0% /40 GWD/mt	4.0% /40 GWD/mt	4.0% /40 GWD/mt
		water vol frac	water vol frac	water vol frac	water vol frac
		UO2 vol frac	UO2 vol frac	UO2 vol frac	UO2 vol frac
UO2	O	4.8888950E-02	4.8888950E-02	O	4.8888950E-02
	U-234	1.2468890E-05	1.2468890E-05	U-234	1.2468890E-05
	U-235	4.5157230E-04	4.5157230E-04	U-235	4.5157230E-04
	U-236	2.0176000E-04	2.0176000E-04	U-236	2.0176000E-04
	U-238	2.3719690E-02	2.3719690E-02	U-238	2.3719690E-02
	Np-237	5.8984170E-05	5.8984170E-05	Np-237	5.8984170E-05
	H	6.8861260E-02	6.8861260E-02	H	6.8861260E-02
	O	3.3430630E-02	3.3430630E-02	O	3.3430630E-02
	H	0.0000000E+00	0.0000000E+00	H	0.0000000E+00
	O	3.2628830E-02	3.2628830E-02	O	3.2628830E-02
H2O	Na	4.5533820E-04	4.5533820E-04	Na	4.5533820E-04
	Mg	2.6751210E-04	2.6751210E-04	Mg	2.6751210E-04
	Al	3.0153870E-03	3.0153870E-03	Al	3.0153870E-03
	Si	1.3193410E-02	1.3193410E-02	Si	1.3193410E-02
	P	0.0000000E+00	0.0000000E+00	P	0.0000000E+00
	K	6.4299900E-04	6.4299900E-04	K	6.4299900E-04
	Ca	6.5871220E-04	6.5871220E-04	Ca	6.5871220E-04
	Ti	0.0000000E+00	0.0000000E+00	Ti	0.0000000E+00
	Mn	0.0000000E+00	0.0000000E+00	Mn	0.0000000E+00
	Fe	1.6235590E-04	1.6235590E-04	Fe	1.6235590E-04
Tuff	Total	8.002310E-02	8.002310E-02	Total	8.002310E-02
	Total O	4.353035E-02	4.353035E-02	Total O	4.353035E-02
	Total H	1.725021E-02	1.725021E-02	Total H	1.725021E-02
		4.2% /45 GWD/mt	4.2% /45 GWD/mt	4.2% /45 GWD/mt	4.2% /45 GWD/mt
		water vol frac	water vol frac	water vol frac	water vol frac
		UO2 vol frac	UO2 vol frac	UO2 vol frac	UO2 vol frac
UO2	O	4.8888950E-02	4.8888950E-02	O	4.8888950E-02
	U-234	1.4634310E-05	1.4634310E-05	U-234	1.4634310E-05
	U-235	4.3780630E-04	4.3780630E-04	U-235	4.3780630E-04
	U-236	2.2045330E-04	2.2045330E-04	U-236	2.2045330E-04
	U-238	2.3705580E-02	2.3705580E-02	U-238	2.3705580E-02
	Np-237	6.5997150E-05	6.5997150E-05	Np-237	6.5997150E-05
	H	6.8861260E-02	6.8861260E-02	H	6.8861260E-02
	O	3.3430630E-02	3.3430630E-02	O	3.3430630E-02
	H	0.0000000E+00	0.0000000E+00	H	0.0000000E+00
	O	3.2628830E-02	3.2628830E-02	O	3.2628830E-02
H2O	Na	4.5533820E-04	4.5533820E-04	Na	4.5533820E-04
	Mg	2.6751210E-04	2.6751210E-04	Mg	2.6751210E-04
	Al	3.0153870E-03	3.0153870E-03	Al	3.0153870E-03
	Si	1.3193410E-02	1.3193410E-02	Si	1.3193410E-02
	P	0.0000000E+00	0.0000000E+00	P	0.0000000E+00
	K	6.4299900E-04	6.4299900E-04	K	6.4299900E-04
	Ca	6.5871220E-04	6.5871220E-04	Ca	6.5871220E-04
	Ti	0.0000000E+00	0.0000000E+00	Ti	0.0000000E+00
	Mn	0.0000000E+00	0.0000000E+00	Mn	0.0000000E+00
	Fe	1.6235590E-04	1.6235590E-04	Fe	1.6235590E-04
Tuff	Total	8.033424E-02	8.033424E-02	Total	8.033424E-02
	Total O	4.328111E-02	4.328111E-02	Total O	4.328111E-02
	Total H	1.805254E-02	1.805254E-02	Total H	1.805254E-02
		4.2% /45 GWD/mt	4.2% /45 GWD/mt	4.2% /45 GWD/mt	4.2% /45 GWD/mt
		water vol frac	water vol frac	water vol frac	water vol frac
		UO2 vol frac	UO2 vol frac	UO2 vol frac	UO2 vol frac
UO2	O	4.8888950E-02	4.8888950E-02	O	4.8888950E-02
	U-234	1.4634310E-05	1.4634310E-05	U-234	1.4634310E-05
	U-235	4.3780630E-04	4.3780630E-04	U-235	4.3780630E-04
	U-236	2.2045330E-04	2.2045330E-04	U-236	2.2045330E-04
	U-238	2.3705580E-02	2.3705580E-02	U-238	2.3705580E-02
	Np-237	6.5997150E-05	6.5997150E-05	Np-237	6.5997150E-05
	H	6.8861260E-02	6.8861260E-02	H	6.8861260E-02
	O	3.3430630E-02	3.3430630E-02	O	3.3430630E-02
	H	0.0000000E+00	0.0000000E+00	H	0.0000000E+00
	O	3.2628830E-02	3.2628830E-02	O	3.2628830E-02
H2O	Na	4.5533820E-04	4.5533820E-04	Na	4.5533820E-04
	Mg	2.6751210E-04	2.6751210E-04	Mg	2.6751210E-04
	Al	3.0153870E-03	3.0153870E-03	Al	3.0153870E-03
	Si	1.3193410E-02	1.3193410E-02	Si	1.3193410E-02
	P	0.0000000E+00	0.0000000E+00	P	0.0000000E+00
	K	6.4299900E-04	6.4299900E-04	K	6.4299900E-04
	Ca	6.5871220E-04	6.5871220E-04	Ca	6.5871220E-04
	Ti	0.0000000E+00	0.0000000E+00	Ti	0.0000000E+00
	Mn	0.0000000E+00	0.0000000E+00	Mn	0.0000000E+00
	Fe	1.6235590E-04	1.6235590E-04	Fe	1.6235590E-04
Tuff	Total	8.033424E-02	8.033424E-02	Total	8.033424E-02
	Total O	4.328111E-02	4.328111E-02	Total O	4.328111E-02
	Total H	1.805254E-02	1.805254E-02	Total H	1.805254E-02

4.0% /40 GWD/mt

water vol frac	3.000000E-01
UO2 vol frac	1.800000E-01
O	8.800011E-03
U-234	2.244400E-06
U-235	8.128301E-05
U-236	3.631680E-05
U-238	4.269544E-03
Np-237	1.061715E-05
H	1.644787E-02
O	8.223935E-03
H	0.000000E+00
O	2.675564E-02
Na	3.733773E-04
Mg	2.193599E-04
Al	2.472617E-03
Si	1.081860E-02
P	0.000000E+00
K	5.272592E-04
Ca	5.401440E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.331318E-04
Total	7.971195E-02
Total O	4.377959E-02
Total H	1.644787E-02

4.0% /40 GWD/mt

water vol frac	3.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	1.870334E-06
U-235	6.773585E-05
U-236	3.026400E-05
U-238	3.557954E-03
Np-237	8.847626E-06
H	1.704962E-02
O	8.524811E-03
H	0.000000E+00
O	2.773451E-02
Na	3.870375E-04
Mg	2.273853E-04
Al	2.563079E-03
Si	1.121440E-02
P	0.000000E+00
K	5.465492E-04
Ca	5.599054E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.380025E-04
Total	7.994531E-02
Total O	4.359266E-02
Total H	1.704962E-02

4.0% /40 GWD/mt

water vol frac	3.000000E-01
UO2 vol frac	5.000000E-02
O	2.444448E-03
U-234	6.234445E-07
U-235	2.257862E-05
U-236	1.008800E-05
U-238	1.185985E-03
Np-237	2.949209E-06
H	1.905546E-02
O	9.527730E-03
H	0.000000E+00
O	3.099739E-02
Na	4.325713E-04
Mg	2.541365E-04
Al	2.864618E-03
Si	1.253374E-02
P	0.000000E+00
K	6.108491E-04
Ca	6.257766E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.542381E-04
Total	8.072318E-02
Total O	4.296957E-02
Total H	1.905546E-02

1mcnp version 4a ld=10/01/93 04/26/96 14:14:39

 INP=i3020md OUTP=i3020md0

probid = 04/26/96 14:14:39

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 5% UO2 (i3020md)
 2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
 3- C CELL SPECIFICATIONS
 4- C INNER WATER REGION
 5- 1 1 8.546553-2 -1 IMP:N=1
 6- C OUTSIDE WORLD
 7- 2 0 1 IMP:N=0
 8-
 9- C SURFACE SPECIFICATIONS
 10- 1* SO 30 \$ INNER FUEL ZONE
 11-
 12- MODE N
 13- KCODE 4000 1. 7 37
 14- KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
 15- 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
 16- C MATERIAL SPECIFICATIONS
 17- c (47 vol% water in calico Hills tuff) x .95 5 vol% UO2
 18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
 19- m1 1001.50c 2.985355-2 8016.50c 4.104358-2 11023.50c 3.303498-4
 20- 12000.50c 1.940812-4 13027.50c 2.187676-3 14000.50c 9.571876-3
 21- 19000.50c 4.664986-4 20000.50c 4.778985-4 26000.55c 1.177899-4
 22- 92234.50c 2.934031-7 92235.50c 2.390804-5 92236.50c 5.720740-6
 23- 92238.50c 1.190938-3 93237.50c 1.364329-6
 24- mt1 lwtr.01t
 25- PRINT

1 initial source from ksrc card.

print table 90

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 5% UO2 (i3020md)

probid = 04/26/96 14:14:39

the initial fission neutron source distribution used the 14 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27591 neutron histories and 30 active cycles with 120478 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148069 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .88050 with an estimated standard deviation of .00125
 the estimated 68, 95, & 99 percent keff confidence intervals are .87923 to .88177, .87794 to .88307, and .87704 to .88397
 the estimated collision/absorption neutron removal lifetime = 1.19E-04 seconds with an estimated standard deviation of 4.22E-07

1mcnp version 4a ld=10/01/93 04/26/96 15:23:19

probid = 04/26/96 15:23:19

inp=i3020mf outp=i3020mfo

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (i3020mf)
2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (47 vol% water in calico Hills tuff) x .90 10 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
20- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
21- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
22- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
23- 92238.50c 1.905500-3 93237.50c 2.182926-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (i3020mf)

probid = 04/26/96 15:23:19

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28076 neutron histories and 30 active cycles with 120009 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148085 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00957 with an estimated standard deviation of .00116
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00840 to 1.01075, 1.00719 to 1.01196, and 1.00635 to 1.01279
the estimated collision/absorption neutron removal lifetime = 8.45E-05 seconds with an estimated standard deviation of 1.95E-07

1mcnp version 4a ld=10/01/93 04/26/96 14:50:33

probid = 04/26/96 14:50:33

INP=i3020me OUTP=i3020me0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (i3020me)
2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.482700-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (47 vol% water in calico Hills tuff) x .90 10 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.828231-2 8016.50c 4.145650-2 11023.50c 3.129630-4
20- 12000.50c 1.838664-4 13027.50c 2.072535-3 14000.50c 9.068093-3
21- 19000.50c 4.419460-4 20000.50c 4.527460-4 26000.55c 1.115904-4
22- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
23- 92238.50c 2.381875-3 93237.50c 2.728657-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from ksrg card.

print table 90

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (i3020me)

probid = 04/26/96 14:50:33

the initial fission neutron source distribution used the 14 source points that were input on the ksrg card.
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28111 neutron histories and 30 active cycles with 119763 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147874 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.05593 with an estimated standard deviation of .00144
the estimated 68, 95, & 99 percent keff confidence intervals are 1.05447 to 1.05739, 1.05297 to 1.05888, and 1.05193 to 1.05992
the estimated collision/absorption neutron removal lifetime = 7.07E-05 seconds with an estimated standard deviation of 1.60E-07

1mcnp version 4a ld=10/01/93 04/26/96 13:13:47

probid = 04/26/96 13:13:47

INP=i3020ma OUP=i3020ma0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 15% UO2 (i3020ma)
2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.418847-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (47 vol% water in calico Hills tuff) x .85 .15 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.671107-2 8016.50c 4.186941-2 11023.50c 2.955762-4
20- 12000.50c 1.736516-4 13027.50c 1.957395-3 14000.50c 8.564310-3
21- 19000.50c 4.173934-4 20000.50c 4.275934-4 26000.55c 1.053910-4
22- 92234.50c 8.802093-7 92235.50c 7.172412-5 92236.50c 1.716222-5
23- 92238.50c 3.572813-3 93237.50c 4.092986-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 15% UO2 (i3020ma)

probid = 04/26/96 13:13:47

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28394 neutron histories and 30 active cycles with 119889 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148283 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.10696 with an estimated standard deviation of .00181
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.10512 to 1.10879, 1.10324 to 1.11067, and 1.10194 to 1.11197
 the estimated collision/absorption neutron removal lifetime = 4.86E-05 seconds with an estimated standard deviation of 1.26E-07

1mcnp version 4a ld=10/01/93 04/26/96 13:38:19

probid = 04/26/96 13:38:19

INP=i3020mb OUTP=i3020mbo

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 20% UO2 (i3020mb)
2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.354993-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (47 vol% water in calico Hills tuff) x .80 20 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.513983-2 8016.50c 4.228232-2 11023.50c 2.781893-4
20- 12000.50c 1.634368-4 13027.50c 1.842254-3 14000.50c 8.060527-3
21- 19000.50c 3.928409-4 20000.50c 4.024409-4 26000.55c 9.199150-5
22- 92234.50c 1.173612-6 92235.50c 9.563216-5 92236.50c 2.288296-5
23- 92238.50c 4.763750-3 93237.50c 5.457314-6
24- mt1 lwtr.01t
25- PRINT
1 initial source from file srctp
1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 20% UO2 (i3020mb)

```

probid = 04/26/96 13:38:19

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28339 neutron histories and 30 active cycles with 120266 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148605 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.11122 with an estimated standard deviation of .00147
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.10973 to 1.11271, 1.10821 to 1.11423, and 1.10715 to 1.11529
 the estimated collision/absorption neutron removal lifetime = 3.60E-05 seconds with an estimated standard deviation of 9.38E-08

1mcnp version 4a ld=10/01/93 04/26/96 13:56:54

 INP=i3020mc OUP=i3020mc0

probid = 04/26/96 13:56:54

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 25% UO2 (i3020mc)
 2- C Calico Hills Tuff 1.137 g/cc .470 porosity - reflected sphere
 3- C CELL SPECIFICATIONS
 4- C INNER WATER REGION
 5- 1 1 8.291140-2 -1 IMP:N=1
 6- C OUTSIDE WORLD
 7- 2 0 1 IMP:N=0
 8-
 9- C SURFACE SPECIFICATIONS
 10- 1* SO 30 \$ INNER FUEL ZONE
 11-
 12- MODE N
 13- KCODE 4000 1. 7 37
 14- KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
 15- 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
 16- C MATERIAL SPECIFICATIONS
 17- c (47 vol% water in calico Hills tuff) x .75 25 vol% UO2
 18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
 19- mt 1001.50c 2.356859-2 8016.50c 4.269524-2 11023.50c 2.608025-4
 20- 12000.50c 1.532220-4 13027.50c 1.727113-3 14000.50c 7.556744-3
 21- 19000.50c 3.682883-4 20000.50c 3.772883-4 26000.55c 9.299203-5
 22- 92234.50c 1.467016-6 92235.50c 1.195402-4 92236.50c 2.860370-5
 23- 92238.50c 5.954688-3 93237.50c 6.821643-6
 24- mt1 lwtr.01t
 25- PRINT

1 initial source from ksrc card.

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 25% UO2 (i3020mc)

print table 90

probid = 04/26/96 13:56:54

the initial fission neutron source distribution used the 14 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28583 neutron histories and 30 active cycles with 120656 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 149239 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.09884 with an estimated standard deviation of .00195
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.09686 to 1.10082, 1.09484 to 1.10285, and 1.09343 to 1.10425
 the estimated collision/absorption neutron removal lifetime = 2.81E-05 seconds with an estimated standard deviation of 8.14E-08

1mcnp version 4a ld=10/01/93 05/03/96 09:39:29

 inp=i3020oa outp=i3020oa0

probid = 05/03/96 09:39:29

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 5% UO2 (i3020oa)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.368536-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .95 5 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.540728-2 8016.50c 4.194698-2 11023.50c 3.739809-4
20- 12000.50c 2.197145-4 13027.50c 2.476615-3 14000.50c 1.083609-2
21- 19000.50c 5.281116-4 20000.50c 5.410172-4 26000.55c 1.333471-4
22- 92234.50c 2.934031-7 92235.50c 2.390804-5 92236.50c 5.720740-6
23- 92238.50c 1.190938-3 93237.50c 1.364329-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 5% UO2 (i3020oa)

probid = 05/03/96 09:39:29

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27616 neutron histories and 30 active cycles with 120059 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147675 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .89315 with an estimated standard deviation of .00131
 the estimated 68, 95, & 99 percent keff confidence intervals are .89182 to .89448, .89046 to .89584, and .88952 to .89678
 the estimated collision/absorption neutron removal lifetime = 1.20E-04 seconds with an estimated standard deviation of 3.92E-07

1mcnp version 4a ld=10/01/93 05/03/96 10:28:15

 inp=i3020ob outp=i3020obo

probid = 05/03/96 10:28:15

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (i3020ob)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- mt1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
20- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
21- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
22- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
23- 92238.50c 1.905500-3 93237.50c 2.182926-6
24- mt1 lwtr.01t
25- PRINT
1 initial source from file srctp
1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (i3020ob)
  
```

probid = 05/03/96 10:28:15

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28034 neutron histories and 30 active cycles with 120109 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148143 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01547 with an estimated standard deviation of .00137
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.01408 to 1.01686, 1.01265 to 1.01828, and 1.01167 to 1.01926
 the estimated collision/absorption neutron removal lifetime = 8.46E-05 seconds with an estimated standard deviation of 2.56E-07

1mcnp version 4a ld=10/01/93 05/03/96 11:44:23

probid = 05/03/96 11:44:23

inp=i3020oc outp=i3020oc0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 10% UO2 (i3020oc)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.314052-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .90 10 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.407005-2 8016.50c 4.231235-2 11023.50c 3.542977-4
20- 12000.50c 2.081506-4 13027.50c 2.346267-3 14000.50c 1.026577-2
21- 19000.50c 5.003162-4 20000.50c 5.125426-4 26000.55c 1.263288-4
22- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
23- 92238.50c 2.381875-3 93237.50c 2.728657-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 10% UO2 (i3020oc)

probid = 05/03/96 11:44:23

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28172 neutron histories and 30 active cycles with 120097 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148269 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

warning. there appears to be decreasing trend in the average col/abs/tl keff estimator over the last 10 active cycles.
the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
warning. the k(trk length) cycle values do not appear normally distributed at the 99 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.05803 with an estimated standard deviation of .00143
the estimated 68, 95, & 99 percent keff confidence intervals are 1.05657 to 1.05948, 1.05509 to 1.06097, and 1.05405 to 1.06200
the estimated collision/absorption neutron removal lifetime = 7.04E-05 seconds with an estimated standard deviation of 1.38E-07

1mcnp version 4a ld=10/01/93 05/03/96 13:48:52

 inp=i3020od outp=i3020od

probid = 05/03/96 13:48:52

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 15% UO2 (i3020od)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.259568-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .85 15 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.273283-2 8016.50c 4.267772-2 11023.50c 3.346145-4
20- 12000.50c 1.965867-4 13027.50c 2.215918-3 14000.50c 9.695445-3
21- 19000.50c 4.725209-4 20000.50c 4.840680-4 26000.55c 1.193105-4
22- 92234.50c 8.802093-7 92235.50c 7.172412-5 92236.50c 1.716222-5
23- 92238.50c 3.572813-3 93237.50c 4.092986-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 15% UO2 (i3020od)

probid = 05/03/96 13:48:52

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28106 neutron histories and 30 active cycles with 119849 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147955 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.09023 with an estimated standard deviation of .00165
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.08856 to 1.09190, 1.08685 to 1.09361, and 1.08567 to 1.09479
 the estimated collision/absorption neutron removal lifetime = 4.77E-05 seconds with an estimated standard deviation of 1.32E-07

inp= version 4a ld=10/01/93 05/03/96 14:59:14

probid = 05/03/96 14:59:14

inp=i3020oe out=i3020oe

```

1- Far-Field Criticality Study - 3.0% /20 Gd/mt - 40% H2O/ 20% UO2 (i3020oe)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.205084-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .80 20 vol% UO2
18- c 3.0% Original Enrichment/ 20 Gd/MT decayed to Uranium isotopes
19- ml 1001.50c 2.139560-2 8016.50c 4.304308-2 11023.50c 3.149313-4
20- 12000.50c 1.850228-4 13027.50c 2.085570-3 14000.50c 9.125125-3
21- 19000.50c 4.447255-4 20000.50c 4.555985-4 26000.50c 1.122923-4
22- 92234.50c 1.173612-6 92236.50c 9.563216-5 92236.50c 2.288296-5
23- 92238.50c 4.763750-3 92237.50c 5.457314-6
24- ml1 lwr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 Gd/mt - 40% H2O/ 20% UO2 (i3020oe)

probid = 05/03/96 14:59:14

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28065 neutron histories and 30 active cycles with 120161 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148226 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.0852 with an estimated standard deviation of .00169
the estimated 68, 95, & 99 percent keff confidence intervals are 1.08761 to 1.09104, 1.08586 to 1.09279, and 1.08464 to 1.09401
the estimated collision/absorption neutron removal lifetime = 3.51E-05 seconds with an estimated standard deviation of 8.88E-08

1mcnp version 4a ld=10/01/93 05/03/96 15:25:19

probid = 05/03/96 15:25:19

inp=i3020of outp=i3020of

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 25% UO2 (i3020of)
2- C Calico Hills Tuff 1.5095 g/cc .4 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.150600-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (40 vol% water in calico Hills tuff) x .75 25 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 2.005838-2 8016.50c 4.340845-2 11023.50c 2.952481-4
20- 12000.50c 1.734589-4 13027.50c 1.955222-3 14000.50c 8.554805-3
21- 19000.50c 4.169302-4 20000.50c 4.271189-4 26000.55c 1.052740-4
22- 92234.50c 1.467016-6 92235.50c 1.195402-4 92236.50c 2.860370-5
23- 92238.50c 5.954688-3 93237.50c 6.821643-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 25% UO2 (i3020of)

probid = 05/03/96 15:25:19

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28151 neutron histories and 30 active cycles with 120514 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148665 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.06938 with an estimated standard deviation of .00142
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.06794 to 1.07082, 1.06647 to 1.07230, and 1.06545 to 1.07332
 the estimated collision/absorption neutron removal lifetime = 2.71E-05 seconds with an estimated standard deviation of 8.73E-08

1mcnp version 4a ld=10/01/93 04/20/96 22:45:00

probid = 04/20/96 22:45:00

INP=3.0E05I OUTP=30E05.I0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 5% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 8.07231773416-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 2000 1 33 158
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 2.934031-7 92235.50C 2.390804-5 92236.50C 5.720740-6 $ Fi
25- 92238.50C 1.190938-3 93237.50C 1.364329-6 8016.50C 4.296957-2 $ At
26- 1001.50C 1.905546-2 $ an
27- 14000.50C 1.253374-2 13027.50C 2.864618-3 $ Ca
28- 26000.55C 1.542381-4 12000.50C 2.541365-4 20000.50C 6.257766-4 $ Wi
29- 11023.50C 4.325713-4 19000.50C 6.108491-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 4.265802-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 5% U-Np 02

probid = 04/20/96 22:45:00

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 33 cycles and run a total of 158 cycles with nominally 2000 neutrons per cycle.
this problem has run 33 inactive cycles with 65542 neutron histories and 125 active cycles with 250850 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 316392 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent

the final estimated combined collision/absorption/track-length keff = .90721 with an estimated standard deviation of .00087
the estimated 68, 95, & 99 percent keff confidence intervals are .90634 to .90808, .90548 to .90894, and .90491 to .90950
the estimated collision/absorption neutron removal lifetime = 1.22E-04 seconds with an estimated standard deviation of 2.27E-07

1mcnp version 4a ld=10/01/93 04/20/96 23:50:29

probid = 04/20/96 23:50:29

INP=3.OE10I OUTP=3OE10.IO

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 10% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 8.03342432832-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 2000 1 33 158
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 5.868062-7 92235.50C 4.781608-5 92236.50C 1.144148-5 $ Fi
25- 92238.50C 2.381875-3 93237.50C 2.728657-6 8016.50C 4.328111-2 $ At
26- 1001.50C 1.805254-2 $ an
27- 14000.50C 1.187407-2 13027.50C 2.713848-3 $ Ca
28- 26000.55C 1.461203-4 12000.50C 2.407609-4 20000.50C 5.928410-4 $ Wi
29- 11023.50C 4.098044-4 19000.50C 5.786991-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 4.265802-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 10% U-Np 02

probid = 04/20/96 23:50:29

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 33 cycles and run a total of 158 cycles with nominally 2000 neutrons per cycle.
this problem has run 33 inactive cycles with 66233 neutron histories and 125 active cycles with 250174 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 316407 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent

the final estimated combined collision/absorption/track-length keff = 1.03712 with an estimated standard deviation of .00104
the estimated 68, 95, & 99 percent keff confidence intervals are 1.03608 to 1.03816, 1.03506 to 1.03919, and 1.03438 to 1.03986
the estimated collision/absorption neutron removal lifetime = 6.86E-05 seconds with an estimated standard deviation of 1.27E-07

1mcnp version 4a ld=10/01/93 04/18/96 11:18:06

probid = 04/18/96 11:18:06

INP=3.0E1 OUTP=3.0E.10

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02
2- C k-inf
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10. $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 183.15 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 2000 1 13 138
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
25- 92238.50C 3.572813-3 92237.50C 4.092986-6 8016.50C 4.359266-2 $ At
26- 1001.50C 1.704962-2 $ an
27- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
28- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
29- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 4.265802-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02

probid = 04/18/96 11:18:06

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 13 cycles and run a total of 138 cycles with nominally 2000 neutrons per cycle.
 this problem has run 13 inactive cycles with 25735 neutron histories and 125 active cycles with 251201 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 276936 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.05465 with an estimated standard deviation of .00113
the estimated 68, 95, & 99 percent keff confidence intervals are 1.05351 to 1.05578, 1.05239 to 1.05691, and 1.05165 to 1.05764
the estimated collision/absorption neutron removal lifetime = 4.56E-05 seconds with an estimated standard deviation of 9.27E-08

1mcnp version 4a ld=10/01/93 04/20/96 22:09:09

 INP=3.OE20I OUTP=30E20.IO

probid = 04/20/96 22:09:09

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 20% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 7.95563751664-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 2000 1 33 158
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 1.173612-6 92235.50C 9.563216-5 92236.50C 2.288296-5 $ Fi
25- 92238.50C 4.763750-3 92237.50C 5.457314-6 8016.50C 4.390421-2 $ At
26- 1001.50C 1.604670-2 $ an
27- 14000.50C 1.055473-2 13027.50C 2.412310-3 $ Ca
28- 26000.55C 1.298847-4 12000.50C 2.140097-4 20000.50C 5.269698-4 $ Wi
29- 11023.50C 3.642706-4 19000.50C 5.143992-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 4.265802-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT
1 initial source from ksrc card.

```

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 20% U-Np 02

probid = 04/20/96 22:09:09

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 33 cycles and run a total of 158 cycles with nominally 2000 neutrons per cycle.
 this problem has run 33 inactive cycles with 66069 neutron histories and 125 active cycles with 250814 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 316883 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.03934 with an estimated standard deviation of .00122
the estimated 68, 95, & 99 percent keff confidence intervals are 1.03812 to 1.04056, 1.03691 to 1.04177, and 1.03612 to 1.04257
the estimated collision/absorption neutron removal lifetime = 3.31E-05 seconds with an estimated standard deviation of 6.79E-08

1mcnp version 4a ld=10/01/93 05/14/96 10:05:12

 INP=3E30W25I OUTP=3E3025.0

probid = 05/14/96 10:05:12

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 25% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 7.91674411080-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 1.467016-6 92235.50C 1.195402-4 92236.50C 2.860370-5 $ Fi
25- 92238.50C 5.954688-3 93237.50C 6.821643-6 8016.50C 4.421575-2 $ At
26- 1001.50C 1.504378-2 $ an
27- 14000.50C 9.895058-3 13027.50C 2.261540-3 $ Ca
28- 26000.55C 1.217669-4 12000.50C 2.006341-4 20000.50C 4.940342-4 $ Wi
29- 11023.50C 3.415037-4 19000.50C 4.822493-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 25% U-Np 02

probid = 05/14/96 10:05:12

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 711 neutron histories and 1000 active cycles with 251306 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 252017 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00732 with an estimated standard deviation of .00121
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00611 to 1.00853, 1.00492 to 1.00972, and 1.00414 to 1.01051
the estimated collision/absorption neutron removal lifetime = 2.49E-05 seconds with an estimated standard deviation of 5.37E-08

1mcnp version 4a ld=10/01/93 04/30/96 11:58:30

probid = 04/30/96 11:58:30

INP=3E20W05I OUTP=3E2005.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 5% U-Np 02
2- C k-inf
3- C
4- C SPHERE
5- 1 1 7.11954477916-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 2.934031-7 92235.50C 2.390804-5 92236.50C 5.720740-6 $ Fi
25- 92238.50C 1.190938-3 93237.50C 1.364329-6 8016.50C 3.979366-2 $ At
26- 1001.50C 1.270364-2 $ an
27- 14000.50C 1.253374-2 13027.50C 2.864618-3 $ Ca
28- 26000.55C 1.542381-4 12000.50C 2.541365-4 20000.50C 6.257766-4 $ Wi
29- 11023.50C 4.325713-4 19000.50C 6.108491-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 5% U-Np 02

probid = 04/30/96 11:58:30

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
this problem has run 3 inactive cycles with 1487 neutron histories and 500 active cycles with 250104 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251591 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .92846 with an estimated standard deviation of .00095
the estimated 68, 95, & 99 percent keff confidence intervals are .92751 to .92941, .92657 to .93035, and .92595 to .93096
the estimated collision/absorption neutron removal lifetime = 1.24E-04 seconds with an estimated standard deviation of 2.39E-07

1mcnp version 4a ld=10/01/93 04/23/96 09:19:08

probid = 04/23/96 09:19:08

INP=3.OE08I OUTP=3E08.I0

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 8% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 7.12629630266-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 4000 1 13 43
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 4.008088-2 $ At
26- 1001.50C 1.230247-2 $ an
27- 14000.50C 1.213793-2 13027.50C 2.774156-3 $ Ca
28- 26000.55C 1.493674-4 12000.50C 2.461111-4 20000.50C 6.060152-4 $ Wi
29- 11023.50C 4.189111-4 19000.50C 5.915591-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 10% U-Np 02

probid = 04/23/96 09:19:08

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 13 cycles and run a total of 43 cycles with nominally 4000 neutrons per cycle.
this problem has run 13 inactive cycles with 51859 neutron histories and 30 active cycles with 119742 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 171601 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99502 with an estimated standard deviation of .00156
the estimated 68, 95, & 99 percent keff confidence intervals are .99344 to .99660, .99183 to .99821, and .99071 to .99933
the estimated collision/absorption neutron removal lifetime = 8.22E-05 seconds with an estimated standard deviation of 2.19E-07

1mcnp version 4a ld=10/01/93 04/22/96 14:38:14

probid = 04/22/96 14:38:14

INP=3.0E10I OUTP=3E10.I0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 10% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 7.13079731832-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 4000 1 13 43
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 5.868062-7 92235.50C 4.781608-5 92236.50C 1.144148-5 $ Fi
25- 92238.50C 2.381875-3 92237.50C 2.728657-6 8016.50C 4.027236-2 $ At
26- 1001.50C 1.203503-2 $ an
27- 14000.50C 1.187407-2 13027.50C 2.713848-3 $ Ca
28- 26000.55C 1.461203-4 12000.50C 2.407609-4 20000.50C 5.928410-4 $ Wi
29- 11023.50C 4.098044-4 19000.50C 5.786991-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 10% U-Np 02

probid = 04/22/96 14:38:14

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 13 cycles and run a total of 43 cycles with nominally 4000 neutrons per cycle.
 this problem has run 13 inactive cycles with 52351 neutron histories and 30 active cycles with 119304 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 171655 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00572 with an estimated standard deviation of .00144
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00426 to 1.00717, 1.00276 to 1.00867, and 1.00173 to 1.00970
the estimated collision/absorption neutron removal lifetime = 6.57E-05 seconds with an estimated standard deviation of 1.80E-07

1mcnp version 4a ld=10/01/93 04/23/96 11:14:58

 INP=3.OE12I OUTP=3E12.10

probid = 04/23/96 11:14:58

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 11.6% U-Np 02
2- C k-inf Optimization
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 4000 1 13 43
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
25- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
26- 1001.50C 1.182107-2 $ an
27- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
28- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
29- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT
1 initial source from ksrc card.

```

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 11.6% U-Np 02

probid = 04/23/96 11:14:58

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 13 cycles and run a total of 43 cycles with nominally 4000 neutrons per cycle.
 this problem has run 13 inactive cycles with 52024 neutron histories and 30 active cycles with 119849 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 171873 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00904 with an estimated standard deviation of .00204
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00697 to 1.01111, 1.00485 to 1.01323, and 1.00338 to 1.01469
the estimated collision/absorption neutron removal lifetime = 5.67E-05 seconds with an estimated standard deviation of 1.99E-07

1mcnp version 4a ld=10/01/93 04/22/96 15:23:31

 INP=3.0E15I OUTP=3E15.IO

probid = 04/22/96 15:23:31

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 15% U-Np 02
2- C Critical Radius
3- C
4- C SPHERE
5- 1 1 7.14204985748-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 4000 1 13 43
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
25- 92238.50C 3.572813-3 92237.50C 4.092986-6 8016.50C 4.075106-2 $ At
26- 1001.50C 1.136641-2 $ an
27- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
28- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
29- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 15% U-Np 02

probid = 04/22/96 15:23:31

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 13 cycles and run a total of 43 cycles with nominally 4000 neutrons per cycle.
 this problem has run 13 inactive cycles with 52433 neutron histories and 30 active cycles with 120237 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 172670 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99654 with an estimated standard deviation of .00152
the estimated 68, 95, & 99 percent keff confidence intervals are .99499 to .99808, .99341 to .99966, and .99231 to 1.00076
the estimated collision/absorption neutron removal lifetime = $4.23\text{E-}05$ seconds with an estimated standard deviation of $9.98\text{E-}08$

1mcnp version 4a ld=10/01/93 04/23/96 16:48:09

probid = 04/23/96 16:48:09

INP=i30loga OUTP=i30loga0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 3.6% UO2 (i30loga)
2- C Calico Hills Tuff 0.5685 g/cc .35 vol% C - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.330641-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff & C) x .964 3.6 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- mt1 1001.50c 1.933628-2 8016.50c 2.715524-2 11023.50c 2.194730-4
20- 12000.50c 1.289408-4 13027.50c 1.453417-3 14000.50c 6.359224-3
21- 19000.50c 3.099255-4 20000.50c 3.174993-4 26000.55c 7.825554-5
22- 92234.50c 2.112502-7 92235.50c 1.721379-5 92236.50c 4.118933-6
23- 92238.50c 8.574750-4 93237.50c 9.823165-7 6000.50c 2.706816-2
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 3.6% UO2 (i30loga)

probid = 04/23/96 16:48:09

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27671 neutron histories and 30 active cycles with 120210 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147881 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .89704 with an estimated standard deviation of .00111
the estimated 68, 95, & 99 percent keff confidence intervals are .89592 to .89816, .89477 to .89931, and .89397 to .90011
the estimated collision/absorption neutron removal lifetime = 1.69E-04 seconds with an estimated standard deviation of 4.97E-07

1mcnp version 4a ld=10/01/93 04/24/96 07:17:23

 inp=i30logc outp=i30logco

probid = 04/24/96 07:17:23

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 5% UO2 (i30logc)
2- C Calico Hills Tuff 0.5685 g/cc .35 vol% C - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.316157-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff & C) x .95 5 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.905546-2 8016.50c 2.747087-2 11023.50c 2.162856-4
20- 12000.50c 1.270682-4 13027.50c 1.432309-3 14000.50c 6.266870-3
21- 19000.50c 3.054245-4 20000.50c 3.128883-4 26000.55c 7.711905-5
22- 92234.50c 2.934031-7 92235.50c 2.390804-5 92236.50c 5.720740-6
23- 92238.50c 1.190938-3 92327.50c 1.364329-6 6000.50c 2.667505-2
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 5% UO2 (i30logc)

probid = 04/24/96 07:17:23

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27985 neutron histories and 30 active cycles with 120395 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148380 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98475 with an estimated standard deviation of .00139
 the estimated 68, 95, & 99 percent keff confidence intervals are .98333 to .98616, .98189 to .98761, and .98089 to .98861
 the estimated collision/absorption neutron removal lifetime = 1.33E-04 seconds with an estimated standard deviation of 3.36E-07

1mcnp version 4a ld=10/01/93 04/23/96 18:14:39

probid = 04/23/96 18:14:39

INP=i30logb OUTP=i30logb0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (i30logb)
2- C Calico Hills Tuff 0.5685 g/cc .35 vol% C - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.285121-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff & C) x .92 8 vol% UO2
18- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.845371-2 8016.50c 2.814723-2 11023.50c 2.094556-4
20- 12000.50c 1.230556-4 13027.50c 1.387078-3 14000.50c 6.068969-3
21- 19000.50c 2.957795-4 20000.50c 3.030076-4 26000.55c 7.468371-5
22- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
23- 92238.50c 1.905500-3 93237.50c 2.182929-6 6000.50c 2.583268-2
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (i30logb)

probid = 04/23/96 18:14:39

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28102 neutron histories and 30 active cycles with 120123 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148225 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.07039 with an estimated standard deviation of .00174
the estimated 68, 95, & 99 percent keff confidence intervals are 1.06863 to 1.07216, 1.06682 to 1.07397, and 1.06557 to 1.07522
the estimated collision/absorption neutron removal lifetime = 8.91E-05 seconds with an estimated standard deviation of 2.66E-07

1mcnp version 4a ld=10/01/93 05/26/96 00:08:17

 INP=3E20W08I OUTP=320W08.O

probid = 05/26/96 00:08:17

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 7.12629630266-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 4.008088-2 $ At
26- 1001.50C 1.230247-2 $ an
27- 14000.50C 1.213794-2 13027.50C 2.774156-3 $ Ca
28- 26000.55C 1.493674-4 12000.50C 2.461111-4 20000.50C 6.060152-4 $ Wi
29- 11023.50C 4.189111-4 19000.50C 5.915591-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT
1 initial source from ksrc card.

```

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8% U-Np 02

probid = 05/26/96 00:08:17

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 716 neutron histories and 1000 active cycles with 249994 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 250710 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99598 with an estimated standard deviation of .00106
the estimated 68, 95, & 99 percent keff confidence intervals are .99492 to .99704, .99387 to .99810, and .99318 to .99879
the estimated collision/absorption neutron removal lifetime = 8.22E-05 seconds with an estimated standard deviation of 1.63E-07

1mcnp version 4a ld=10/01/93 05/26/96 00:47:15

 INP=3E20W10I OUTP=320W10.0

probid = 05/26/96 00:47:15

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 10% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 7.13079731832-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 5.868062-7 92235.50C 4.781608-5 92236.50C 1.144148-5 $ Fi
25- 92238.50C 2.381875-3 92237.50C 2.728657-6 8016.50C 4.027236-2 $ At
26- 1001.50C 1.203503-2 $ an
27- 14000.50C 1.187407-2 13027.50C 2.713848-3 $ Ca
28- 26000.55C 1.461203-4 12000.50C 2.407609-4 20000.50C 5.928410-4 $ Wi
29- 11023.50C 4.098044-4 19000.50C 5.786991-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 10% U-Np 02 probid = 05/26/96 00:47:15

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 730 neutron histories and 1000 active cycles with 251405 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 252135 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

warning. the k(collision) cycle values do not appear normally distributed at the 99 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent

the final estimated combined collision/absorption/track-length keff = 1.00783 with an estimated standard deviation of .00112
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00671 to 1.00895, 1.00559 to 1.01007, and 1.00486 to 1.01080
the estimated collision/absorption neutron removal lifetime = 6.57E-05 seconds with an estimated standard deviation of 1.25E-07

1mcnp version 4a ld=10/01/93 05/26/96 01:23:13

probid = 05/26/96 01:23:13

INP=3E20W12I OUTP=320W12.O

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 12% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 7.13529833398-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 7.041674-7 92235.50C 5.737930-5 92236.50C 1.372978-5 $ Fi
25- 92238.50C 2.858250-3 93237.50C 3.274388-6 8016.50C 4.046384-2 $ At
26- 1001.50C 1.176758-2 $ an
27- 14000.50C 1.161020-2 13027.50C 2.673541-3 $ Ca
28- 26000.55C 1.428732-4 12000.50C 2.354106-4 20000.50C 5.796667-4 $ Wi
29- 11023.50C 4.006976-4 19000.50C 5.658391-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 20% Water 12% U-Np 02

probid = 05/26/96 01:23:13

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
this problem has run 3 inactive cycles with 711 neutron histories and 1000 active cycles with 250794 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251505 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00885 with an estimated standard deviation of .00117
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00768 to 1.01002, 1.00652 to 1.01118, and 1.00576 to 1.01194
the estimated collision/absorption neutron removal lifetime = 5.44E-05 seconds with an estimated standard deviation of 1.12E-07

1mcnp version 4a ld=10/01/93 05/25/96 20:14:43

 INP=3E18W08I OUTP=318W08.O

probid = 05/25/96 20:14:43

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 8% U-Np O2
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 6.94175922506-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.946575-2 $ At
26- 1001.50C 1.107222-2 $ an
27- 14000.50C 1.213794-2 13027.50C 2.774156-3 $ Ca
28- 26000.55C 1.493674-4 12000.50C 2.461111-4 20000.50C 6.060152-4 $ Wi
29- 11023.50C 4.189111-4 19000.50C 5.915591-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT
  
```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 8% U-Np O2

probid = 05/25/96 20:14:43

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 722 neutron histories and 1000 active cycles with 251266 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251988 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99044 with an estimated standard deviation of .00110
the estimated 68, 95, & 99 percent keff confidence intervals are .98935 to .99154, .98826 to .99263, and .98755 to .99334
the estimated collision/absorption neutron removal lifetime = 8.15×10^{-5} seconds with an estimated standard deviation of 1.66×10^{-7}

1mcnp version 4a ld=10/01/93 05/25/96 22:03:42

probid = 05/25/96 22:03:42

INP=3E18W10I OUTP=318W10.O

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 10% U-Np O2
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 6.95027191632-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 -1 0 1 1 0 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 5.868062-7 92235.50C 4.781608-5 92236.50C 1.144148-5 $ Fi
25- 92238.50C 2.381875-3 93237.50C 2.728657-6 8016.50C 3.967060-2 $ At
26- 1001.50C 1.083152-2 $ an
27- 14000.50C 1.187407-2 13027.50C 2.713848-3 $ Ca
28- 26000.55C 1.461203-4 12000.50C 2.407609-4 20000.50C 5.928410-4 $ Wi
29- 11023.50C 4.098044-4 19000.50C 5.786991-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 10% U-Np O2

probid = 05/25/96 22:03:42

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
this problem has run 3 inactive cycles with 755 neutron histories and 1000 active cycles with 250120 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 250875 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level.

the final estimated combined collision/absorption/track-length keff = .99483 with an estimated standard deviation of .00108
the estimated 68, 95, & 99 percent keff confidence intervals are .99375 to .99592, .99268 to .99699, and .99197 to .99770
the estimated collision/absorption neutron removal lifetime = 6.48E-05 seconds with an estimated standard deviation of 1.31E-07

1mcnp version 4a ld=10/01/93 05/25/96 23:34:27

 INP=3E18W12I OUTP=318W12.0

probid = 05/25/96 23:34:27

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 12% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 6.95878460758-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 7.041674-7 92235.50C 5.737930-5 92236.50C 1.372978-5 $ Fi
25- 92238.50C 2.858250-3 93237.50C 3.274388-6 8016.50C 3.987546-2 $ At
26- 1001.50C 1.059082-2 $ an
27- 14000.50C 1.161020-2 13027.50C 2.673541-3 $ Ca
28- 26000.55C 1.428732-4 12000.50C 2.354106-4 20000.50C 5.796667-4 $ Wi
29- 11023.50C 4.006976-4 19000.50C 5.658391-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT
  
```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 18% Water 12% U-Np 02 probid = 05/25/96 23:34:27

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 711 neutron histories and 1000 active cycles with 250079 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 250790 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99307 with an estimated standard deviation of .00116
the estimated 68, 95, & 99 percent keff confidence intervals are .99190 to .99423, .99075 to .99538, and .99000 to .99613
the estimated collision/absorption neutron removal lifetime = 5.33E-05 seconds with an estimated standard deviation of 1.11E-07

1mcnp version 4a ld=10/01/93 05/25/96 15:08:23

probid = 05/25/96 15:08:23

INP=3E16W08I OUTP=316W08.O

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 8% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 6.75722214746-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.885063-2 $ At
26- 1001.50C 9.841977-3 $ an
27- 14000.50C 1.213794-2 13027.50C 2.774156-3 $ Ca
28- 26000.55C 1.493674-4 12000.50C 2.461111-4 20000.50C 6.060152-4 $ Wi
29- 11023.50C 4.189111-4 19000.50C 5.915591-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 8% U-Np 02

probid = 05/25/96 15:08:23

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 729 neutron histories and 1000 active cycles with 250378 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251107 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97770 with an estimated standard deviation of .00102
the estimated 68, 95, & 99 percent keff confidence intervals are .97668 to .97872, .97566 to .97974, and .97500 to .98040
the estimated collision/absorption neutron removal lifetime = 8.03E-05 seconds with an estimated standard deviation of 1.56E-07

1mcnp version 4a ld=10/01/93 05/25/96 17:06:59

 INP=3E16W10I OUTP=316W10.O

probid = 05/25/96 17:06:59

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 10% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 6.76974651432-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 5.868062-7 92235.50C 4.781608-5 92236.50C 1.144148-5 $ Fi
25- 92238.50C 2.381875-3 92237.50C 2.728657-6 8016.50C 3.906885-2 $ At
26- 1001.50C 9.628021-3 $ an
27- 14000.50C 1.187407-2 13027.50C 2.713848-3 $ Ca
28- 26000.55C 1.461203-4 12000.50C 2.407609-4 20000.50C 5.928410-4 $ Wi
29- 11023.50C 4.098044-4 19000.50C 5.786991-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 10% U-Np 02

probid = 05/25/96 17:06:59

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 713 neutron histories and 1000 active cycles with 250152 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 250865 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98034 with an estimated standard deviation of .00115
the estimated 68, 95, & 99 percent keff confidence intervals are .97919 to .98149, .97805 to .98263, and .97731 to .98338
the estimated collision/absorption neutron removal lifetime = 6.36E-05 seconds with an estimated standard deviation of 1.31E-07

1mcnp version 4a ld=10/01/93 05/25/96 18:40:56

probid = 05/25/96 18:40:56

INP=3E16W12I OUTP=316W12.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 12% U-Np 02
2- C k-inf Optimization Minimum Water
3- C
4- C SPHERE
5- 1 1 6.78227088118-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning. this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 250 1 3 1003
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 7.041674-7 92235.50C 5.737930-5 92236.50C 1.372978-5 $ Fi
25- 92238.50C 2.858250-3 93237.50C 3.274388-6 8016.50C 3.928708-2 $ At
26- 1001.50C 9.414065-3 $ an
27- 14000.50C 1.161020-2 13027.50C 2.673541-3 $ Ca
28- 26000.55C 1.428732-4 12000.50C 2.354106-4 20000.50C 5.796667-4 $ Wi
29- 11023.50C 4.006976-4 19000.50C 5.658391-4 $ 30
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3
32- C 8016.50C 3.931496-2
33- C 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4
34- C 11023.50C 4.553382-4 19000.50C 6.429990-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 16% Water 12% U-Np 02

probid = 05/25/96 18:40:56

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 250 neutrons per cycle.
 this problem has run 3 inactive cycles with 694 neutron histories and 1000 active cycles with 251086 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251780 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97294 with an estimated standard deviation of .00113
the estimated 68, 95, & 99 percent keff confidence intervals are .97181 to .97406, .97069 to .97518, and .96996 to .97591
the estimated collision/absorption neutron removal lifetime = 5.19E-05 seconds with an estimated standard deviation of 1.11E-07

1mcnp version 4a ld=10/01/93 04/30/96 12:14:11

probid = 04/30/96 12:14:11

inp=i3530f outp=i3530fo

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 5% UO2 (i3530f)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.072318-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .95 5 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.905546-2 8016.50c 4.296957-2 11023.50c 4.325713-4
20- 12000.50c 2.541365-4 13027.50c 2.864618-3 14000.50c 1.253374-2
21- 19000.50c 6.108491-4 20000.50c 6.257766-4 26000.55c 1.542381-4
22- 92234.50c 4.345805-7 92235.50c 2.314084-5 92236.50c 7.985865-6
23- 92238.50c 1.188475-3 93237.50c 2.188250-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 5% UO2 (i3530f)

probid = 04/30/96 12:14:11

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27361 neutron histories and 30 active cycles with 120254 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147615 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .88719 with an estimated standard deviation of .00164
 the estimated 68, 95, & 99 percent keff confidence intervals are .88552 to .88885, .88382 to .89056, and .88264 to .89174
 the estimated collision/absorption neutron removal lifetime = 1.23E-04 seconds with an estimated standard deviation of 4.03E-07

1mcnp version 4a ld=10/01/93 04/17/96 12:22:10

probid = 04/17/96 12:22:10

inp=i3530e outp=i3530e0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 8.8% UO2 (i3530e)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.042759-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .912 8.8 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.829324-2 8016.50c 4.320634-2 11023.50c 4.152684-4
20- 12000.50c 2.439710-4 13027.50c 2.750033-3 14000.50c 1.203239-2
21- 19000.50c 5.864151-4 20000.50c 6.007455-4 26000.55c 1.480686-4
22- 92234.50c 7.648616-7 92235.50c 4.072787-5 92236.50c 1.405512-5
23- 92238.50c 2.091715-3 93237.50c 3.851320-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 8.8% UO2 (i3530e)

probid = 04/17/96 12:22:10

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27658 neutron histories and 30 active cycles with 120679 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148337 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99900 with an estimated standard deviation of .00171
 the estimated 68, 95, & 99 percent keff confidence intervals are .99727 to 1.00073, .99550 to 1.00250, and .99428 to 1.00373
 the estimated collision/absorption neutron removal lifetime = 7.79E-05 seconds with an estimated standard deviation of 2.07E-07

1mcnp version 4a ld=10/01/93 04/16/96 16:30:08

 inp=i3530d outp=i3530d0

probid = 04/16/96 16:30:08

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 10% UO2 (i3530d)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.033424-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .90 .10 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
20- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
21- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
22- 92234.50c 8.691609-7 92235.50c 4.628167-5 92236.50c 1.597173-5
23- 92238.50c 2.376949-3 93237.50c 4.376500-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 10% UO2 (i3530d)

probid = 04/16/96 16:30:08

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27948 neutron histories and 30 active cycles with 120460 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148408 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01253 with an estimated standard deviation of .00199
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.01051 to 1.01454, 1.00844 to 1.01661, and 1.00701 to 1.01804
 the estimated collision/absorption neutron removal lifetime = 6.91E-05 seconds with an estimated standard deviation of 1.93E-07

1mcnp version 4a ld=10/01/93 04/16/96 15:57:11

probid = 04/16/96 15:57:11

inp=i3530c outp=i3530c0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (i3530c)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- mt 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
20- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
21- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
22- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
23- 92238.50c 3.327729-3 93237.50c 6.127100-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (i3530c)

probid = 04/16/96 15:57:11

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28135 neutron histories and 30 active cycles with 120342 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148477 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.03159 with an estimated standard deviation of .00184
the estimated 68, 95, & 99 percent keff confidence intervals are 1.02972 to 1.03345, 1.02781 to 1.03536, and 1.02649 to 1.03668
the estimated collision/absorption neutron removal lifetime = 4.97E-05 seconds with an estimated standard deviation of 1.25E-07

1mcnp version 4a ld=10/01/93 04/16/96 14:56:57

probid = 04/16/96 14:56:57

inp=i3530a outp=i3530a0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 15% UO2 (i3530a)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.994531-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .85 .15 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.704962-2 8016.50c 4.359266-2 11023.50c 3.870375-4
20- 12000.50c 2.273853-4 13027.50c 2.563079-3 14000.50c 1.121440-2
21- 19000.50c 5.465492-4 20000.50c 5.599054-4 26000.55c 1.380025-4
22- 92234.50c 1.303741-6 92235.50c 6.942251-5 92236.50c 2.395760-5
23- 92238.50c 3.565424-3 93237.50c 6.564750-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from ksrc card.

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 15% UO2 (i3530a)

print table 90

probid = 04/16/96 14:56:57

the initial fission neutron source distribution used the 14 source points that were input on the ksrc card.
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27946 neutron histories and 30 active cycles with 119996 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147942 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.03087 with an estimated standard deviation of .00154
the estimated 68, 95, & 99 percent keff confidence intervals are 1.02931 to 1.03243, 1.02772 to 1.03402, and 1.02661 to 1.03513
the estimated collision/absorption neutron removal lifetime = 4.62E-05 seconds with an estimated standard deviation of 1.24E-07

1mcnp version 4a ld=10/01/93 04/16/96 15:23:12

 inp=i3530b outp=i3530b0

probid = 04/16/96 15:23:12

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 16% UO2 (i3530b)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.986752-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 5 35
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .84 .16 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.684904-2 8016.50c 4.365497-2 11023.50c 3.824841-4
20- 12000.50c 2.247102-4 13027.50c 2.532925-3 14000.50c 1.108246-2
21- 19000.50c 5.401192-4 20000.50c 5.533182-4 26000.55c 1.363790-4
22- 92234.50c 1.390657-6 92235.50c 7.405067-5 92236.50c 2.555477-5
23- 92238.50c 3.803118-3 93237.50c 7.002400-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 16% UO2 (i3530b)

probid = 04/16/96 15:23:12

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 5 cycles and run a total of 35 cycles with nominally 4000 neutrons per cycle.
 this problem has run 5 inactive cycles with 19986 neutron histories and 30 active cycles with 120160 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 140146 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.02680 with an estimated standard deviation of .00183
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.02494 to 1.02865, 1.02305 to 1.03054, and 1.02173 to 1.03186
 the estimated collision/absorption neutron removal lifetime = 4.26E-05 seconds with an estimated standard deviation of 1.10E-07

1mcnp version 4a ld=10/01/93 04/30/96 12:52:39

inp=i3530j outp=i3530jo

probid = 04/30/96 12:52:39

```
1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 5% UO2 (i3530j)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 7.119545-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (20 vol% water in calico Hills tuff) x .95 5 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.270364-2 8016.50c 3.979366-2 11023.50c 4.325713-4
20- 12000.50c 2.541365-4 13027.50c 2.864618-3 14000.50c 1.253374-2
21- 19000.50c 6.108491-4 20000.50c 6.257766-4 26000.55c 1.542381-4
22- 92234.50c 4.345805-7 92235.50c 2.314084-5 92236.50c 7.985865-6
23- 92238.50c 1.188475-3 93237.50c 2.188250-6
24- mt1 lwtr.01t
25- PRINT
```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 5% UO2 (i3530j)

probid = 04/30/96 12:52:39

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27756 neutron histories and 30 active cycles with 119857 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147613 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .90652 with an estimated standard deviation of .00130
the estimated 68, 95, & 99 percent keff confidence intervals are .90521 to .90784, .90386 to .90919, and .90292 to .91013
the estimated collision/absorption neutron removal lifetime = 1.25E-04 seconds with an estimated standard deviation of 2.87E-07

1mcnp version 4a ld=10/01/93 04/17/96 15:56:27

 inp=i3530i outp=i3530io

probid = 04/17/96 15:56:27

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 10% UO2 (i3530i)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.130797-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (20 vol% water in calico Hills tuff) x .90 10 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.150014-2 8016.50c 4.065532-2 11023.50c 4.098044-4
20- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
21- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
22- 92234.50c 8.691609-7 92235.50c 4.628167-5 92236.50c 1.597173-5
23- 92238.50c 2.376949-3 93237.50c 4.376500-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 10% UO2 (i3530i)

probid = 04/17/96 15:56:27

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27922 neutron histories and 30 active cycles with 120249 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148171 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97944 with an estimated standard deviation of .00156
 the estimated 68, 95, & 99 percent keff confidence intervals are .97785 to .98102, .97623 to .98264, and .97511 to .98377
 the estimated collision/absorption neutron removal lifetime = 6.56E-05 seconds with an estimated standard deviation of 1.84E-07

1mcnp version 4a ld=10/01/93 04/17/96 15:03:47

 inp=i3530g outp=i3530g

probid = 04/17/96 15:03:47

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 12% UO2 (i3530g)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.135298-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (20 vol% water in calico Hills tuff) x .88 12 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.176758-2 8016.50c 4.046384-2 11023.50c 4.006976-4
20- 12000.50c 2.354106-4 13027.50c 2.653541-3 14000.50c 1.161020-2
21- 19000.50c 5.658391-4 20000.50c 5.796667-4 26000.55c 1.428732-4
22- 92234.50c 1.042993-6 92235.50c 5.553800-5 92236.50c 1.916608-5
23- 92238.50c 2.852339-3 93237.50c 5.251800-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 12% UO2 (i3530g)

probid = 04/17/96 15:03:47

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27658 neutron histories and 30 active cycles with 119751 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147409 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98612 with an estimated standard deviation of .00200
 the estimated 68, 95, & 99 percent keff confidence intervals are .98409 to .98814, .98202 to .99021, and .98059 to .99165
 the estimated collision/absorption neutron removal lifetime = 5.50E-05 seconds with an estimated standard deviation of 2.01E-07

1mcnp version 4a ld=10/01/93 04/17/96 15:26:39

 inp=i3530h outp=i3530h0

probid = 04/17/96 15:26:39

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 14% UO2 (i3530h)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.139799-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (20 vol% water in calico Hills tuff) x .86 .14 vol% UO2
18- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.150014-2 8016.50c 4.065532-2 11023.50c 3.915909-4
20- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
21- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
22- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
23- 92238.50c 3.327729-3 93237.50c 6.127100-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 20% H2O/ 14% UO2 (i3530h)

probid = 04/17/96 15:26:39

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27868 neutron histories and 30 active cycles with 120155 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148023 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98040 with an estimated standard deviation of .00160
 the estimated 68, 95, & 99 percent keff confidence intervals are .97877 to .98202, .97711 to .98368, and .97596 to .98483
 the estimated collision/absorption neutron removal lifetime = 4.62E-05 seconds with an estimated standard deviation of 1.24E-07

1mcnp version 4a ld=10/01/93 04/30/96 13:31:56

probid = 04/30/96 13:31:56

inp=i4040f outp=i4040fo

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 5% UO2 (i4040f)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.072318-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .95 5 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.905546-2 8016.50c 4.296957-2 11023.50c 4.325731-4
20- 12000.50c 2.541365-4 13027.50c 2.864618-3 14000.50c 1.253374-2
21- 19000.50c 6.108491-4 20000.50c 6.257766-4 26000.55c 1.542381-4
22- 92234.50c 6.234445-7 92235.50c 2.257862-5 92236.50c 1.008800-5
23- 92238.50c 1.185985-3 93237.50c 2.949209-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 5% UO2 (i4040f)

probid = 04/30/96 13:31:56

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27518 neutron histories and 30 active cycles with 120246 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147764 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .86893 with an estimated standard deviation of .00117
the estimated 68, 95, & 99 percent keff confidence intervals are .86774 to .87012, .86653 to .87134, and .86568 to .87219
the estimated collision/absorption neutron removal lifetime = 1.23E-04 seconds with an estimated standard deviation of 3.60E-07

1mcnp version 4a ld=10/01/93 04/18/96 07:15:02

probid = 04/18/96 07:15:02

inp=i4040d outp=i4040d0

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 10% UO2 (i4040d)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.033424-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .90 .10 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
20- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
21- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
22- 92234.50c 1.246889-6 92235.50c 4.515723-5 92236.50c 2.017600-5
23- 92238.50c 2.371969-3 93237.50c 5.898417-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 10% UO2 (i4040d)

probid = 04/18/96 07:15:02

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27997 neutron histories and 30 active cycles with 120176 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148173 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99662 with an estimated standard deviation of .00134
 the estimated 68, 95, & 99 percent keff confidence intervals are .99526 to .99799, .99387 to .99938, and .99290 to 1.00035
 the estimated collision/absorption neutron removal lifetime = 6.97E-05 seconds with an estimated standard deviation of 1.33E-07

1mcnp version 4a ld=10/01/93 04/17/96 17:11:03

 INP=i4040b OUTP=i4040bo

probid = 04/17/96 17:11:03

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 12% UO2 (i4040b)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.017867-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .88 12 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.765137-2 8016.50c 4.340573-2 11023.50c 4.006976-4
20- 12000.50c 2.354106-4 13027.50c 2.653541-3 14000.50c 1.161020-2
21- 19000.50c 5.658391-4 20000.50c 5.796667-4 26000.55c 1.428732-4
22- 92234.50c 1.496267-6 92235.50c 5.418868-5 92236.50c 2.421120-5
23- 92238.50c 2.846363-3 93237.50c 7.078100-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 12% UO2 (i4040b)

probid = 04/17/96 17:11:03

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27978 neutron histories and 30 active cycles with 120259 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148237 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

warning. there appears to be decreasing trend in the average col/abs/tl keff estimator over the last 10 active cycles.
 the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00578 with an estimated standard deviation of .00152
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.00424 to 1.00732, 1.00267 to 1.00889, and 1.00158 to 1.00998
 the estimated collision/absorption neutron removal lifetime = 5.83E-05 seconds with an estimated standard deviation of 1.92E-07

1mcnp version 4a ld=10/01/93 04/17/96 16:37:13

 INP=i4040a OUTP=i4040a0

probid = 04/17/96 16:37:13

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 14% UO2 (i4040a)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
20- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
21- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
22- 92234.50c 1.745645-6 92235.50c 6.322012-5 92236.50c 2.824640-5
23- 92238.50c 3.320757-3 93237.50c 8.257784-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 14% UO2 (i4040a)

probid = 04/17/96 16:37:13

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28071 neutron histories and 30 active cycles with 119929 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148000 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00910 with an estimated standard deviation of .00174
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.00733 to 1.01087, 1.00553 to 1.01267, and 1.00427 to 1.01392
 the estimated collision/absorption neutron removal lifetime = 4.97E-05 seconds with an estimated standard deviation of 1.08E-07

1mcnp version 4a ld=10/01/93 04/17/96 17:32:17

 INP=i4040c OUTP=i4040c0

probid = 04/17/96 17:32:17

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 16% UO2 (i4040c)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.986752-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 5 35
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .84 .16 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.684904-2 8016.50c 4.365497-2 11023.50c 3.824841-4
20- 12000.50c 2.247102-4 13027.50c 2.532925-3 14000.50c 1.108246-2
21- 19000.50c 5.401192-4 20000.50c 5.533182-4 26000.55c 1.363790-4
22- 92234.50c 1.995022-6 92235.50c 7.225157-5 92236.50c 3.228160-5
23- 92238.50c 3.795150-3 93237.50c 9.437467-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 16% UO2 (i4040c)

probid = 04/17/96 17:32:17

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 5 cycles and run a total of 35 cycles with nominally 4000 neutrons per cycle.
 this problem has run 5 inactive cycles with 20062 neutron histories and 30 active cycles with 120608 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 140670 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00923 with an estimated standard deviation of .00124
 the estimated 68, 95, & 99 percent keff confidence intervals are 1.00798 to 1.01048, 1.00669 to 1.01177, and 1.00580 to 1.01265
 the estimated collision/absorption neutron removal lifetime = 4.29E-05 seconds with an estimated standard deviation of 9.74E-08

1mcnp version 4a ld=10/01/93 04/18/96 07:50:56

probid = 04/18/96 07:50:56

inp=i4040e outp=i4040e0

```

1- Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 18% UO2 (i4040e)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 7.971195-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 37
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .82 18 vol% UO2
18- c 4.0% Original Enrichment/ 40 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.644787-2 8016.50c 4.377959-2 11023.50c 3.733773-4
20- 12000.50c 2.193599-4 13027.50c 2.472617-3 14000.50c 1.081860-2
21- 19000.50c 5.272592-4 20000.50c 5.401440-4 26000.55c 1.331318-4
22- 92234.50c 2.244400-6 92235.50c 8.128301-5 92236.50c 3.631680-5
23- 92238.50c 4.269544-3 93237.50c 1.061715-5
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 4.0% /40 GWD/mt - 30% H2O/ 18% UO2 (i4040e)

probid = 04/18/96 07:50:56

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27979 neutron histories and 30 active cycles with 119975 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147954 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00343 with an estimated standard deviation of .00145
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00196 to 1.00491, 1.00045 to 1.00641, and .99940 to 1.00746
the estimated collision/absorption neutron removal lifetime = 3.77E-05 seconds with an estimated standard deviation of 1.02E-07

1mcnp version 4a ld=10/01/93 08/21/96 15:06:06

probid = 08/21/96 15:06:06

INP=i4245a OUTP=i4245a0

```

1- Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 10% UO2 (i4245a)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.033424-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 67
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .90 .10 vol% UO2
18- c 4.2% Original Enrichment/ 45 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
20- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
21- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
22- 92234.50c 1.463431-6 92235.50c 4.378063-5 92236.50c 2.204533-5
23- 92238.50c 2.370558-3 93237.50c 6.599715-6
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 10% UO2 (i4245a)

probid = 08/21/96 15:06:06

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 67 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27813 neutron histories and 60 active cycles with 239404 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 267217 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98086 with an estimated standard deviation of .00117
 the estimated 68, 95, & 99 percent keff confidence intervals are .97969 to .98203, .97852 to .98320, and .97775 to .98397
 the estimated collision/absorption neutron removal lifetime = 7.07E-05 seconds with an estimated standard deviation of 1.48E-07

1mcnp version 4a ld=10/01/93 08/21/96 15:48:08

 INP=i4245b OUTP=i4245b0

probid = 08/21/96 15:48:08

```

1- Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 15% UO2 (i4245b)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.994531-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 67
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .85 .15 vol% UO2
18- c 4.2% Original Enrichment/ 45 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.704962-2 8016.50c 4.359266-2 11023.50c 3.870375-4
20- 12000.50c 2.273853-4 13027.50c 2.563079-3 14000.50c 1.121440-2
21- 19000.50c 5.465492-4 20000.50c 5.599054-4 26000.55c 1.380025-4
22- 92234.50c 2.195147-6 92235.50c 6.567095-5 92236.50c 3.306800-5
23- 92238.50c 3.555837-3 93237.50c 9.899573-6
24- mt1 lwtr.01t
25- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 15% UO2 (i4245b)

probid = 08/21/96 15:48:08

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 67 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27899 neutron histories and 60 active cycles with 239713 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 267612 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99348 with an estimated standard deviation of .00131
 the estimated 68, 95, & 99 percent keff confidence intervals are .99217 to .99479, .99087 to .99610, and .99000 to .99696
 the estimated collision/absorption neutron removal lifetime = 4.68E-05 seconds with an estimated standard deviation of 1.03E-07

1mcnp version 4a ld=10/01/93 08/21/96 16:23:15

 INP=i4245c OUP=i4245co

probid = 08/21/96 16:23:15

```

1- Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 20% UO2 (i4245c)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - reflected sphere
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 7.955637-2 -1 IMP:N=1
6- C OUTSIDE WORLD
7- 2 0 1 IMP:N=0
8-
9- C SURFACE SPECIFICATIONS
10- 1* SO 30 $ INNER FUEL ZONE
11-
12- MODE N
13- KCODE 4000 1. 7 67
14- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
15- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
16- C MATERIAL SPECIFICATIONS
17- c (30 vol% water in calico Hills tuff) x .80 .20 vol% UO2
18- c 4.2% Original Enrichment/ 45 GWD/MT decayed to Uranium isotopes
19- m1 1001.50c 1.604670-2 8016.50c 4.390421-2 11023.50c 3.642706-4
20- 12000.50c 2.140097-4 13027.50c 2.412310-3 14000.50c 1.055473-2
21- 19000.50c 5.143992-4 20000.50c 5.269698-4 26000.55c 1.298847-4
22- 92234.50c 2.926862-6 92235.50c 8.756126-5 92236.50c 4.409066-5
23- 92238.50c 4.741116-3 93237.50c 1.319943-5
24- mt1 lwtr.01t
25- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 4.2% /45 GWD/mt - 30% H2O/ 20% UO2 (i4245c)

probid = 08/21/96 16:23:15

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 67 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27872 neutron histories and 60 active cycles with 239942 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 267814 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97442 with an estimated standard deviation of .00110
 the estimated 68, 95, & 99 percent keff confidence intervals are .97332 to .97552, .97222 to .97661, and .97150 to .97734
 the estimated collision/absorption neutron removal lifetime = 3.35E-05 seconds with an estimated standard deviation of 6.49E-08

1mcnp version 4a ld=10/01/93 04/30/96 18:00:32

probid = 04/30/96 18:00:32

INP=s3020me OUTP=s3020me0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020me)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.374149-2 -1 IMP:N=1
6- 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 57 $ INNER FUEL ZONE
12- 2 SO 117 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
22- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
23- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
24- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
25- 92238.50c 4.406469-3 93237.50c 5.048015-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020me)

probid = 04/30/96 18:00:32

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 25 inactive cycles with 100297 neutron histories and 50 active cycles with 199475 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299772 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97870 with an estimated standard deviation of .00143

the estimated 68, 95, & 99 percent keff confidence intervals are .97726 to .98014, .97582 to .98159, and .97486 to .98255
the estimated collision/absorption neutron removal lifetime = $7.34\text{E-}05$ seconds with an estimated standard deviation of $3.99\text{E-}07$

1mcnp version 4a ld=10/01/93 04/26/96 18:52:57

probid = 04/26/96 18:52:57

INP=s3020md OUTP=s3020mdo

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mc)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 61 $ INNER FUEL ZONE
12- 2 SO 121 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
22- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
23- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
24- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
25- 92238.50c 4.406469-3 93237.50c 5.048015-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mc)

probid = 04/26/96 18:52:57

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 25 inactive cycles with 100232 neutron histories and 50 active cycles with 199265 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299497 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99496 with an estimated standard deviation of .00137

the estimated 68, 95, & 99 percent keff confidence intervals are .99359 to .99634, .99221 to .99771, and .99129 to .99863
the estimated collision/absorption neutron removal lifetime = $6.96\text{E-}05$ seconds with an estimated standard deviation of $3.58\text{E-}07$

1mcnp version 4a ld=10/01/93 04/26/96 17:18:56

probid = 04/26/96 17:18:56

INP=s3020mb OUTP=s3020mb0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mb)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 70 $ INNER FUEL ZONE
12- 2 SO 130 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRG 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
22- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
23- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
24- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
25- 92238.50c 4.406469-3 93237.50c 5.048015-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mb)

probid = 04/26/96 17:18:56

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 25 inactive cycles with 100201 neutron histories and 50 active cycles with 199091 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299292 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.02021 with an estimated standard deviation of .00158

the estimated 68, 95, & 99 percent keff confidence intervals are 1.01862 to 1.02179, 1.01704 to 1.02338, and 1.01598 to 1.02444
the estimated collision/absorption neutron removal lifetime = $6.38\text{E-}05$ seconds with an estimated standard deviation of $2.57\text{E-}07$

1mcnp version 4a ld=10/01/93 04/26/96 16:36:42

 INP=s3020ma OUTP=s3020mao

probid = 04/26/96 16:36:42

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020ma)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 77 $ INNER FUEL ZONE
12- 2 SO 137 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
22- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
23- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
24- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
25- 92238.50c 4.406469-3 93237.50c 5.048015-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020ma)

probid = 04/26/96 16:36:42

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 25 inactive cycles with 100226 neutron histories and 50 active cycles with 199837 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300063 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.02899 with an estimated standard deviation of .00119

the estimated 68, 95, & 99 percent keff confidence intervals are 1.02779 to 1.03018, 1.02660 to 1.03138, and 1.02580 to 1.03218
the estimated collision/absorption neutron removal lifetime = $6.05\text{E-}05$ seconds with an estimated standard deviation of $2.69\text{E-}07$

1mcnp version 4a ld=10/01/93 05/03/96 16:29:24

probid = 05/03/96 16:29:24

INP=s3020aa OUP=s3020aa0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020aa)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.237774-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 60 $ INNER FUEL ZONE
12- 2 SO 120 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020aa)

probid = 05/03/96 16:29:24

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
this problem has run 40 inactive cycles with 160615 neutron histories and 200 active cycles with 801227 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 961842 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .95784 with an estimated standard deviation of .00072

the estimated 68, 95, & 99 percent keff confidence intervals are .95712 to .95855, .95641 to .95927, and .95594 to .95973
the estimated collision/absorption neutron removal lifetime = $8.01\text{E-}05$ seconds with an estimated standard deviation of $1.94\text{E-}07$

1mcnp version 4a ld=10/01/93 05/03/96 19:46:17

probid = 05/03/96 19:46:17

INP=s3020ob OUTP=s3020ob0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020ob)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.237774-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 65 $ INNER FUEL ZONE
12- 2 SO 125 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020ob)

probid = 05/03/96 19:46:17

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
 this problem has run 40 inactive cycles with 160174 neutron histories and 200 active cycles with 798926 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 959100 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

warning. there appears to be decreasing trend in the average col/abs/tl keff estimator over the last 10 active cycles.
 the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97469 with an estimated standard deviation of .00069

the estimated 68, 95, & 99 percent keff confidence intervals are .97399 to .97538, .97331 to .97607, and .97286 to .97652
the estimated collision/absorption neutron removal lifetime = $7.53\text{E-}05$ seconds with an estimated standard deviation of $1.85\text{E-}07$

1mcnp version 4a ld=10/01/93 05/03/96 22:25:22

probid = 05/03/96 22:25:22

INP=s3020oc OUTP=s3020oc0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020oc)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.237774-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 70 $ INNER FUEL ZONE
12- 2 SO 130 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020oc)

probid = 05/03/96 22:25:22

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
this problem has run 40 inactive cycles with 159913 neutron histories and 200 active cycles with 800364 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 960277 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98732 with an estimated standard deviation of .00074

the estimated 68, 95, & 99 percent keff confidence intervals are .98657 to .98806, .98583 to .98880, and .98535 to .98929
the estimated collision/absorption neutron removal lifetime = $7.18\text{E-}05$ seconds with an estimated standard deviation of $1.74\text{E-}07$

1mcnp version 4a ld=10/01/93 05/04/96 01:00:16

probid = 05/04/96 01:00:16

INP=s3020od OUTP=s3020od0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020od)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.237774-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 75 $ INNER FUEL ZONE
12- 2 SO 135 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020od)

probid = 05/04/96 01:00:16

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
 this problem has run 40 inactive cycles with 160078 neutron histories and 200 active cycles with 799513 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 959591 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99855 with an estimated standard deviation of .00072

the estimated 68, 95, & 99 percent keff confidence intervals are .99783 to .99927, .99711 to .99999, and .99664 to 1.00046
the estimated collision/absorption neutron removal lifetime = 6.87E-05 seconds with an estimated standard deviation of 1.63E-07

1mcnp version 4a ld=10/01/93 05/04/96 03:37:08

probid = 05/04/96 03:37:08

INP=s3020oe OUP=s3020oe0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020oe)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.237774-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 80 $ INNER FUEL ZONE
12- 2 SO 140 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020oe)

probid = 05/04/96 03:37:08

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
 this problem has run 40 inactive cycles with 160532 neutron histories and 200 active cycles with 799503 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 960035 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01003 with an estimated standard deviation of .00070

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00933 to 1.01073, 1.00864 to 1.01142, and 1.00819 to 1.01187
the estimated collision/absorption neutron removal lifetime = $6.55\text{E-}05$ seconds with an estimated standard deviation of $1.56\text{E-}07$

1mcnp version 4a ld=10/01/93 05/04/96 06:06:23

 INP=s3020of OUTP=s3020of0

probid = 05/04/96 06:06:23

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020of)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.237774-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 85 $ INNER FUEL ZONE
12- 2 SO 145 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 40 240
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .83 17 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.219794-2 8016.50c 4.282386-2 11023.50c 3.267412-4
22- 12000.50c 1.919611-4 13027.50c 2.163779-3 14000.50c 9.467317-3
23- 19000.50c 4.614027-4 20000.50c 4.726782-4 26000.55c 1.165032-4
24- 92234.50c 9.975705-7 92235.50c 8.128734-5 92236.50c 1.945052-5
25- 92238.50c 4.049188-3 93237.50c 4.638717-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020of)

probid = 05/04/96 06:06:23

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 40 cycles and run a total of 240 cycles with nominally 4000 neutrons per cycle.
 this problem has run 40 inactive cycles with 160496 neutron histories and 200 active cycles with 800373 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 960869 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01583 with an estimated standard deviation of .00071

the estimated 68, 95, & 99 percent keff confidence intervals are 1.01512 to 1.01654, 1.01442 to 1.01724, and 1.01396 to 1.01770
the estimated collision/absorption neutron removal lifetime = $6.36\text{E-}05$ seconds with an estimated standard deviation of $1.45\text{E-}07$

1mcnp version 4a ld=10/01/93 04/30/96 20:36:50

probid = 04/30/96 20:36:50

INP=3E30.9C OUTP=3E3.9C.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02
2- C .90 k-eff Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 59.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 119.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
24- 92238.50C 3.572813-3 93237.50C 4.092986-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02 probid = 04/30/96 20:36:50

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
this problem has run 3 inactive cycles with 1415 neutron histories and 1000 active cycles with 499868 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501283 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .89801 with an estimated standard deviation of .00092
the estimated 68, 95, & 99 percent keff confidence intervals are .89709 to .89893, .89618 to .89983, and .89559 to .90043
the estimated collision/absorption neutron removal lifetime = 9.78E-05 seconds with an estimated standard deviation of 2.89E-07

1mcnp version 4a ld=10/01/93 05/01/96 21:33:51

probid = 05/01/96 21:33:51

INP=3E30.9C OUTP=3E.9C.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02
2- C .985 k-eff Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 97.86 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 157.86 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
24- 92238.50C 3.572813-3 93237.50C 4.092986-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02

probid = 05/01/96 21:33:51

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1762 neutron histories and 1000 active cycles with 499963 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501725 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98461 with an estimated standard deviation of .00089
the estimated 68, 95, & 99 percent keff confidence intervals are .98372 to .98549, .98284 to .98637, and .98226 to .98695
the estimated collision/absorption neutron removal lifetime = 6.95E-05 seconds with an estimated standard deviation of 2.15E-07

1mcnp version 4a ld=10/01/93 05/02/96 13:44:17

probid = 05/02/96 13:44:17

inp=s3020a outp=s3020ao

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 15% UO2 (s3020a)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 7.994531-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 103 $ INNER FUEL ZONE
12- 2 SO 163 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .85 .15 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.704962-2 8016.50c 4.359266-2 11023.50c 3.870375-4
22- 12000.50c 2.273853-4 13027.50c 2.563079-3 14000.50c 1.121440-2
23- 19000.50c 5.465492-4 20000.50c 5.599054-4 26000.55c 1.380025-4
24- 92234.50c 8.802093-7 92235.50c 7.172412-5 92236.50c 1.716222-5
25- 92238.50c 3.572813-3 93237.50c 4.092986-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 15% UO2 (s3020a)

probid = 05/02/96 13:44:17

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 20 inactive cycles with 80438 neutron histories and 55 active cycles with 219449 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299887 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98934 with an estimated standard deviation of .00137

the estimated 68, 95, & 99 percent keff confidence intervals are .98796 to .99071, .98658 to .99209, and .98567 to .99300
the estimated collision/absorption neutron removal lifetime = $6.49\text{E-}05$ seconds with an estimated standard deviation of $2.47\text{E-}07$

1mcnp version 4a ld=10/01/93 04/18/96 13:17:28

probid = 04/18/96 13:17:28

INP=3.0EC OUTP=3.0E.CO

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02
2- C Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 113.15 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 173.15 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 13 138
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
24- 92238.50C 3.572813-3 93237.50C 4.092986-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 15% U-Np 02 probid = 04/18/96 13:17:28

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 13 cycles and run a total of 138 cycles with nominally 2000 neutrons per cycle.
this problem has run 13 inactive cycles with 25682 neutron histories and 125 active cycles with 250101 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 275783 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99847 with an estimated standard deviation of .00118
the estimated 68, 95, & 99 percent keff confidence intervals are .99729 to .99965, .99612 to 1.00082, and .99535 to 1.00159
the estimated collision/absorption neutron removal lifetime = 6.44E-05 seconds with an estimated standard deviation of 2.63E-07

1mcnp version 4a ld=10/01/93 04/18/96 15:05:39

probid = 04/18/96 15:05:39

INP=3.OEC OUTP=3.OE.CO

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 15% U-Np O2
2- C Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 114.51 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 174.51 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 13 138
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
24- 92238.50C 3.572813-3 93237.50C 4.092986-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 15% U-Np O2

probid = 04/18/96 15:05:39

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 13 cycles and run a total of 138 cycles with nominally 2000 neutrons per cycle.
this problem has run 13 inactive cycles with 25772 neutron histories and 125 active cycles with 249934 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 275706 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99925 with an estimated standard deviation of .00127
the estimated 68, 95, & 99 percent keff confidence intervals are .99798 to 1.00053, .99672 to 1.00179, and .99590 to 1.00261
the estimated collision/absorption neutron removal lifetime = 6.41E-05 seconds with an estimated standard deviation of 2.55E-07

1mcnp version 4a ld=10/01/93 04/18/96 12:22:24

 INP=3.OEC OUTP=3.OE.CO

probid = 04/18/96 12:22:24

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 15% U-Np 02
2- C Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453114353-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 123.15 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 183.15 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 13 138
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 8.802093-7 92235.50C 7.172412-5 92236.50C 1.716222-5 $ Fi
24- 92238.50C 3.572813-3 93237.50C 4.092986-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp
  
```

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 30% Water 15% U-Np 02 probid = 04/18/96 12:22:24

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 13 cycles and run a total of 138 cycles with nominally 2000 neutrons per cycle.
 this problem has run 13 inactive cycles with 26087 neutron histories and 125 active cycles with 249887 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 275974 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00875 with an estimated standard deviation of .00116
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00759 to 1.00992, 1.00644 to 1.01107, and 1.00568 to 1.01183
the estimated collision/absorption neutron removal lifetime = 6.17E-05 seconds with an estimated standard deviation of 2.64E-07

1mcnp version 4a ld=10/01/93 05/02/96 07:39:43

 inp=s30e12h outp=s30e12h0

probid = 05/02/96 07:39:43

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 180 $ FISSILE SPHERE
13- 2 SO 240 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 92237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp
 1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 05/02/96 07:39:43

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120473 neutron histories and 100 active cycles with 398791 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519264 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97549 with an estimated standard deviation of .00097
the estimated 68, 95, & 99 percent keff confidence intervals are .97451 to .97646, .97355 to .97742, and .97292 to .97805
the estimated collision/absorption neutron removal lifetime = 7.04E-05 seconds with an estimated standard deviation of 1.93E-07

1mcnp version 4a ld=10/01/93 05/02/96 09:39:40

probid = 05/02/96 09:39:40

inp=s30e12g outp=s30e12go

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 220 $ FISSILE SPHERE
13- 2 SO 280 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 05/02/96 09:39:40

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120371 neutron histories and 100 active cycles with 399911 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520282 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98489 with an estimated standard deviation of .00086
the estimated 68, 95, & 99 percent keff confidence intervals are .98403 to .98575, .98318 to .98660, and .98262 to .98716
the estimated collision/absorption neutron removal lifetime = 6.59E-05 seconds with an estimated standard deviation of 1.89E-07

1mcnp version 4a ld=10/01/93 05/01/96 14:08:35

probid = 05/01/96 14:08:35

inp=s30e12f outp=s30e12f0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 250 $ FISSILE SPHERE
13- 2 SO 310 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02

probid = 05/01/96 14:08:35

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
this problem has run 30 inactive cycles with 120085 neutron histories and 100 active cycles with 398167 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 518252 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98870 with an estimated standard deviation of .00094
the estimated 68, 95, & 99 percent keff confidence intervals are .98777 to .98964, .98684 to .99057, and .98623 to .99118
the estimated collision/absorption neutron removal lifetime = 6.52E-05 seconds with an estimated standard deviation of 1.91E-07

1mcnp version 4a ld=10/01/93 05/01/96 08:43:08

 inp=s30e12e outp=s30e12e0

probid = 05/01/96 08:43:08

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 300 $ FISSILE SPHERE
13- 2 SO 360 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 05/01/96 08:43:08

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 119681 neutron histories and 100 active cycles with 399203 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 518884 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99516 with an estimated standard deviation of .00095
the estimated 68, 95, & 99 percent keff confidence intervals are .99421 to .99611, .99327 to .99705, and .99265 to .99767
the estimated collision/absorption neutron removal lifetime = 6.16E-05 seconds with an estimated standard deviation of 1.57E-07

1mcnp version 4a ld=10/01/93 04/24/96 12:55:39

 inp=s30e12b outp=s30e12b0

probid = 04/24/96 12:55:39

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 325 $ FISSILE SPHERE
13- 2 SO 385 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 04/24/96 12:55:39

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120156 neutron histories and 100 active cycles with 400694 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520850 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99753 with an estimated standard deviation of .00095
the estimated 68, 95, & 99 percent keff confidence intervals are .99658 to .99848, .99564 to .99942, and .99502 to 1.00004
the estimated collision/absorption neutron removal lifetime = 6.15E-05 seconds with an estimated standard deviation of 1.52E-07

1mcnp version 4a ld=10/01/93 04/24/96 10:46:06

probid = 04/24/96 10:46:06

inp=s30e12a outp=s30e12a0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 345 $ FISSILE SPHERE
13- 2 SO 405 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 04/24/96 10:46:06

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120272 neutron histories and 100 active cycles with 398955 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519227 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 warning. the k(trk length) cycle values do not appear normally distributed at the 99 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00036 with an estimated standard deviation of .00084
the estimated 68, 95, & 99 percent keff confidence intervals are .99952 to 1.00120, .99869 to 1.00203, and .99814 to 1.00258
the estimated collision/absorption neutron removal lifetime = 6.09E-05 seconds with an estimated standard deviation of 1.49E-07

1mcnp version 4a ld=10/01/93 04/24/96 14:18:50

probid = 04/24/96 14:18:50

inp=s30e12c outp=s30e12c0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 365 $ FISSILE SPHERE
13- 2 SO 425 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02 probid = 04/24/96 14:18:50

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120681 neutron histories and 100 active cycles with 400391 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 521072 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99869 with an estimated standard deviation of .00098
the estimated 68, 95, & 99 percent keff confidence intervals are .99771 to .99967, .99674 to 1.00064, and .99610 to 1.00127
the estimated collision/absorption neutron removal lifetime = 6.04E-05 seconds with an estimated standard deviation of 1.46E-07

1mcnp version 4a ld=10/01/93 04/24/96 15:28:49

 inp=s30e12d outp=s30e12d0

probid = 04/24/96 15:28:49

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02
2- C Critical Size Optimization Confirmation
3- C
4- C SPHERE
5- 1 1 7.13439813085-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 7.10829224000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 SO 385 $ FISSILE SPHERE
13- 2 SO 445 $ REFLECTOR
14- C
15-
16- MODE N
17- KCODE 4000 1 30 130
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 6.806952-7 92235.50C 5.546665-5 92236.50C 1.327212-5 $ Fi
24- 92238.50C 2.762975-3 93237.50C 3.165242-6 8016.50C 4.042554-2 $ At
25- 1001.50C 1.182107-2 $ an
26- 14000.50C 1.166297-2 13027.50C 2.665602-3 $ Ca
27- 26000.55C 1.435226-4 12000.50C 2.364807-4 20000.50C 5.823016-4 $ Wi
28- 11023.50C 4.025190-4 19000.50C 5.684111-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 1.337225-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 3.931496-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 11.6% U-Np 02

probid = 04/24/96 15:28:49

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120407 neutron histories and 100 active cycles with 399728 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520135 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00198 with an estimated standard deviation of .00092
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00106 to 1.00290, 1.00015 to 1.00380, and .99956 to 1.00440
the estimated collision/absorption neutron removal lifetime = 5.99E-05 seconds with an estimated standard deviation of 1.34E-07

1mcnp version 4a ld=10/01/93 05/29/96 12:55:21

probid = 05/29/96 12:55:21

inp=s3020mh outp=s3020mh0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 15% UO2 (s3020mh)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.418847-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 61 $ INNER FUEL ZONE
12- 2 SO 121 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .85 .15 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.671107-2 8016.50c 4.186941-2 11023.50c 2.955762-4
22- 12000.50c 1.736516-4 13027.50c 1.957395-3 14000.50c 8.564310-3
23- 19000.50c 4.173934-4 20000.50c 4.275934-4 26000.55c 1.053910-4
24- 92234.50c 8.802093-7 92235.50c 7.172412-5 92236.50c 1.716222-5
25- 92238.50c 3.572813-3 93237.50c 4.092986-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 15% UO2 (s3020mh)

probid = 05/29/96 12:55:21

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 25 inactive cycles with 100223 neutron histories and 50 active cycles with 200748 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300971 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98786 with an estimated standard deviation of .00152

the estimated 68, 95, & 99 percent keff confidence intervals are .98633 to .98939, .98481 to .99092, and .98378 to .99194
the estimated collision/absorption neutron removal lifetime = $7.80\text{E-}05$ seconds with an estimated standard deviation of $2.94\text{E-}07$

1mcnp version 4a ld=10/01/93 05/29/96 14:44:20

probid = 05/29/96 14:44:20

inp=s3020mi outp=s3020mi0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 20% UO2 (s3020mi)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.354993-2 -1 IMP:N=1
6- 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 61 $ INNER FUEL ZONE
12- 2 SO 121 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 25 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .80 20 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.513983-2 8016.50c 4.228232-2 11023.50c 2.781893-4
22- 12000.50c 1.634368-4 13027.50c 1.842254-3 14000.50c 8.060527-3
23- 19000.50c 3.928409-4 20000.50c 4.024409-4 26000.55c 9.199150-5
24- 92234.50c 1.173612-6 92235.50c 9.563216-5 92236.50c 2.288296-5
25- 92238.50c 4.763750-3 93237.50c 5.457314-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 20% UO2 (s3020mi)

probid = 05/29/96 14:44:20

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 25 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 25 inactive cycles with 100120 neutron histories and 50 active cycles with 199728 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299848 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99245 with an estimated standard deviation of .00157

the estimated 68, 95, & 99 percent keff confidence intervals are .99087 to .99402, .98929 to .99560, and .98824 to .99666
the estimated collision/absorption neutron removal lifetime = $6.72\text{E-}05$ seconds with an estimated standard deviation of $3.42\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 16:24:18

probid = 05/01/96 16:24:18

inp=s3530i outp=s3530io

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530i)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.002310-2 -1 IMP:N=1
6- 2 8.111211-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 120 $ INNER FUEL ZONE
12- 2 SO 180 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530i)

probid = 05/01/96 16:24:18

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79981 neutron histories and 55 active cycles with 219362 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299343 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98207 with an estimated standard deviation of .00147

the estimated 68, 95, & 99 percent keff confidence intervals are .98060 to .98355, .97913 to .98502, and .97815 to .98600
the estimated collision/absorption neutron removal lifetime = $6.60\text{E-}05$ seconds with an estimated standard deviation of $2.63\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 15:25:40

 inp=s3530h outp=s3530ho

probid = 05/01/96 15:25:40

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530h)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 130 $ INNER FUEL ZONE
12- 2 SO 190 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530h)

probid = 05/01/96 15:25:40

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79436 neutron histories and 55 active cycles with 219660 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299096 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98774 with an estimated standard deviation of .00107

the estimated 68, 95, & 99 percent keff confidence intervals are .98666 to .98882, .98559 to .98989, and .98488 to .99060
the estimated collision/absorption neutron removal lifetime = $6.40\text{E-}05$ seconds with an estimated standard deviation of $2.65\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 14:19:52

 inp=s3530g outp=s3530g0

probid = 05/01/96 14:19:52

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530g)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 134 $ INNER FUEL ZONE
12- 2 SO 194 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530g)

probid = 05/01/96 14:19:52

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79472 neutron histories and 55 active cycles with 219457 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 298929 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99010 with an estimated standard deviation of .00127

the estimated 68, 95, & 99 percent keff confidence intervals are .98883 to .99138, .98756 to .99265, and .98671 to .99349
the estimated collision/absorption neutron removal lifetime = 6.27E-05 seconds with an estimated standard deviation of 2.43E-07

1mcnp version 4a ld=10/01/93 05/01/96 11:32:55

 inp=s3530f outp=s3530fo

probid = 05/01/96 11:32:55

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530f)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 140 $ INNER FUEL ZONE
12- 2 SO 200 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530f)

probid = 05/01/96 11:32:55

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79630 neutron histories and 55 active cycles with 219242 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 298872 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99460 with an estimated standard deviation of .00130

the estimated 68, 95, & 99 percent keff confidence intervals are .99329 to .99591, .99199 to .99721, and .99112 to .99808
the estimated collision/absorption neutron removal lifetime = $6.23\text{E-}05$ seconds with an estimated standard deviation of $2.52\text{E-}07$

1mcnp version 4a ld=10/01/93 04/17/96 08:54:32

 inp=s3530b outp=s3530b0

probid = 04/17/96 08:54:32

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530b)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 150 $ INNER FUEL ZONE
12- 2 SO 210 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530b)

probid = 04/17/96 08:54:32

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27939 neutron histories and 30 active cycles with 119658 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147597 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99714 with an estimated standard deviation of .00149

the estimated 68, 95, & 99 percent keff confidence intervals are .99563 to .99865, .99408 to 1.00020, and .99300 to 1.00128
the estimated collision/absorption neutron removal lifetime = $6.05\text{E-}05$ seconds with an estimated standard deviation of $3.64\text{E-}07$

1mcnp version 4a ld=10/01/93 04/17/96 10:04:27

probid = 04/17/96 10:04:27

inp=s3530c outp=s3530c0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530c)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.002310-2 -1 IMP:N=1
6- 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 151 $ INNER FUEL ZONE
12- 2 SO 211 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530c)

probid = 04/17/96 10:04:27

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28110 neutron histories and 30 active cycles with 120590 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148700 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99695 with an estimated standard deviation of .00203

the estimated 68, 95, & 99 percent keff confidence intervals are .99489 to .99900, .99279 to 1.00110, and .99133 to 1.00256
the estimated collision/absorption neutron removal lifetime = $6.12\text{E-}05$ seconds with an estimated standard deviation of $3.11\text{E-}07$

1mcnp version 4a ld=10/01/93 04/17/96 11:02:51

probid = 04/17/96 11:02:51

inp=s3530d outp=s3530d0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530d)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.002310-2 -1 IMP:N=1
6- 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 152 $ INNER FUEL ZONE
12- 2 SO 212 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530d)

probid = 04/17/96 11:02:51

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28108 neutron histories and 30 active cycles with 119667 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147775 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99551 with an estimated standard deviation of .00169

the estimated 68, 95, & 99 percent keff confidence intervals are .99380 to .99722, .99205 to .99897, and .99083 to 1.00018
the estimated collision/absorption neutron removal lifetime = $6.03\text{E-}05$ seconds with an estimated standard deviation of $3.09\text{E-}07$

1mcnp version 4a ld=10/01/93 04/17/96 13:40:06

probid = 04/17/96 13:40:06

inp=s3530e outp=s3530e0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530e)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 2 8.111211-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 153 $ INNER FUEL ZONE
12- 2 SO 213 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530e)

probid = 04/17/96 13:40:06

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 28463 neutron histories and 30 active cycles with 119992 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148455 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99939 with an estimated standard deviation of .00184

the estimated 68, 95, & 99 percent keff confidence intervals are .99752 to 1.00125, .99560 to 1.00317, and .99428 to 1.00449
the estimated collision/absorption neutron removal lifetime = 6.02E-05 seconds with an estimated standard deviation of 3.12E-07

1mcnp version 4a ld=10/01/93 04/17/96 14:12:23

probid = 04/17/96 14:12:23

inp=s3530a outp=s3530a0

```

1- Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530a)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.002310-2 -1 IMP:N=1
6- 2 8.111211-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 154.9 $ INNER FUEL ZONE
12- 2 SO 215 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .86 .14 vol% UO2
20- c 3.5% Original Enrichment/ 30 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.725021-2 8016.50c 4.353035-2 11023.50c 3.915909-4
22- 12000.50c 2.300604-4 13027.50c 2.593233-3 14000.50c 1.134633-2
23- 19000.50c 5.529791-4 20000.50c 5.664925-4 26000.55c 1.396261-4
24- 92234.50c 1.216825-6 92235.50c 6.479434-5 92236.50c 2.236042-5
25- 92238.50c 3.327729-3 93237.50c 6.127100-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 2.005838-2 8016.50c 4.265802-2 11023.50c 4.553382-4
29- 12000.50c 2.675121-4 13027.50c 3.015387-3 14000.50c 1.319341-2
30- 19000.50c 6.429990-4 20000.50c 6.587122-4 26000.55c 1.623559-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 14% UO2 (s3530a)

probid = 04/17/96 14:12:23

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
this problem has run 7 inactive cycles with 27814 neutron histories and 30 active cycles with 121022 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148836 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00132 with an estimated standard deviation of .00201

the estimated 68, 95, & 99 percent keff confidence intervals are .99928 to 1.00336, .99720 to 1.00544, and .99576 to 1.00688
the estimated collision/absorption neutron removal lifetime = $6.04\text{E-}05$ seconds with an estimated standard deviation of $2.73\text{E-}07$

1mcnp version 4a ld=10/01/93 05/03/96 10:49:38

probid = 05/03/96 10:49:38

INP=4.OEC OUTP=4EC.O

```

1- FarField Criticality - Sphere of Transmuted 4.OE 40GWD 30% Water 15% U-Np 02
2- C Criticality
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water, Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 160.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 220.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 4.OE 40GWD 30% Water 15% U-Np 02 probid = 05/03/96 10:49:38

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1510 neutron histories and 1000 active cycles with 499501 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501011 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98060 with an estimated standard deviation of .00088
the estimated 68, 95, & 99 percent keff confidence intervals are .97971 to .98148, .97884 to .98235, and .97827 to .98293
the estimated collision/absorption neutron removal lifetime = 5.68E-05 seconds with an estimated standard deviation of 1.50E-07

1mcnp version 4a ld=10/01/93 05/01/96 19:21:29

probid = 05/01/96 19:21:29

INP=4E30.9RS OUTP=4E.9RS.0

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C .985 k-eff Reflector Savings
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 187.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 247.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 92237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02 probid = 05/01/96 19:21:29

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1462 neutron histories and 1000 active cycles with 500449 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501911 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98734 with an estimated standard deviation of .00084
the estimated 68, 95, & 99 percent keff confidence intervals are .98650 to .98818, .98566 to .98901, and .98512 to .98956
the estimated collision/absorption neutron removal lifetime = 5.41E-05 seconds with an estimated standard deviation of 1.44E-07

1mcnp version 4a ld=10/01/93 04/20/96 13:32:58

probid = 04/20/96 13:32:58

INP=4.0EC OUTP=4.0E.CO

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C Criticality
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 219.08 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 379.08 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 33 233
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02 probid = 04/20/96 13:32:58

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 33 cycles and run a total of 233 cycles with nominally 2000 neutrons per cycle.
this problem has run 33 inactive cycles with 66066 neutron histories and 200 active cycles with 399907 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 465973 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99433 with an estimated standard deviation of .00093
the estimated 68, 95, & 99 percent keff confidence intervals are .99340 to .99527, .99248 to .99619, and .99187 to .99680
the estimated collision/absorption neutron removal lifetime = 5.15E-05 seconds with an estimated standard deviation of 1.29E-07

1mcnp version 4a ld=10/01/93 04/20/96 14:48:26

probid = 04/20/96 14:48:26

INP=4.0EC OUTP=4.0E.CO

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C Criticality
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 275.35 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 335.35 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 33 233
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02

probid = 04/20/96 14:48:26

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 33 cycles and run a total of 233 cycles with nominally 2000 neutrons per cycle.
 this problem has run 33 inactive cycles with 66122 neutron histories and 200 active cycles with 398971 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 465093 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99869 with an estimated standard deviation of .00094
the estimated 68, 95, & 99 percent keff confidence intervals are .99775 to .99964, .99681 to 1.00057, and .99620 to 1.00119
the estimated collision/absorption neutron removal lifetime = 5.01E-05 seconds with an estimated standard deviation of 1.17E-07

1mcnp version 4a ld=10/01/93 04/19/96 07:02:56

probid = 04/19/96 07:02:56

INP=4.0ERS OUTP=4.0E.RSO

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C Reflector Savings
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 280.0 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 340.0 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 33 233
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02

probid = 04/19/96 07:02:56

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 33 cycles and run a total of 233 cycles with nominally 2000 neutrons per cycle.
this problem has run 33 inactive cycles with 65532 neutron histories and 200 active cycles with 399764 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 465296 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99892 with an estimated standard deviation of .00091
the estimated 68, 95, & 99 percent keff confidence intervals are .99801 to .99984, .99710 to 1.00074, and .99650 to 1.00134
the estimated collision/absorption neutron removal lifetime = 4.98×10^{-5} seconds with an estimated standard deviation of 1.35×10^{-7}

1mcnp version 4a ld=10/01/93 04/20/96 16:09:06

INP=4.0EC OUTP=4.0E.CO

probid = 04/20/96 16:09:06

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C Criticality
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 284.32 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 344.32 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 33 233
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02 probid = 04/20/96 16:09:06

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 33 cycles and run a total of 233 cycles with nominally 2000 neutrons per cycle.
this problem has run 33 inactive cycles with 66019 neutron histories and 200 active cycles with 399041 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 465060 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99933 with an estimated standard deviation of .00093
the estimated 68, 95, & 99 percent keff confidence intervals are .99840 to 1.00026, .99748 to 1.00118, and .99688 to 1.00179
the estimated collision/absorption neutron removal lifetime = 4.99E-05 seconds with an estimated standard deviation of 1.24E-07

1mcnp version 4a ld=10/01/93 04/20/96 11:59:37

probid = 04/20/96 11:59:37

INP=4.0EC OUTP=4.0E.CO

```

1- FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02
2- C Criticality
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 293.22 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 353.22 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 2000 1 33 233
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 4.0E 40GWD 30% Water 15% U-Np 02

probid = 04/20/96 11:59:37

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 33 cycles and run a total of 233 cycles with nominally 2000 neutrons per cycle.
 this problem has run 33 inactive cycles with 66055 neutron histories and 200 active cycles with 399655 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 465710 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00119 with an estimated standard deviation of .00099
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00020 to 1.00219, .99921 to 1.00317, and .99857 to 1.00382
the estimated collision/absorption neutron removal lifetime = 4.99E-05 seconds with an estimated standard deviation of 1.35E-07

1mcnp version 4a ld=10/01/93 05/02/96 08:13:07

probid = 05/02/96 08:13:07

INP=4E3015C OUTP=4E30C.O

```

1- FarField Criticality - Sphere of Transmuted 4.OE 40GWD 30% Water 15% U-Np 02
2- C k-eff Critical Radius
3- C
4- C SPHERE
5- 1 1 7.99453107100-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.11121144000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 310.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 370.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 1.870334-6 92235.50C 6.773585-5 92236.50C 3.026400-5 $ Fi
24- 92238.50C 3.557954-3 93237.50C 8.847626-6 8016.50C 4.359266-2 $ At
25- 1001.50C 1.704962-2 $ an
26- 14000.50C 1.121440-2 13027.50C 2.563079-3 $ Ca
27- 26000.55C 1.380025-4 12000.50C 2.273853-4 20000.50C 5.599054-4 $ Wi
28- 11023.50C 3.870375-4 19000.50C 5.465492-4 $ 30
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 2.005838-2 14000.50C 1.319341-2 13027.50C 3.015387-3 $ Ca
31- 8016.50C 4.265802-2 $ Wi
32- 26000.55C 1.623559-4 12000.50C 2.675121-4 20000.50C 6.587122-4 $ 30
33- 11023.50C 4.553382-4 19000.50C 6.429990-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 4.OE 40GWD 30% Water 15% U-Np 02 probid = 05/02/96 08:13:07

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1459 neutron histories and 1000 active cycles with 499832 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501291 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00170 with an estimated standard deviation of .00086
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00084 to 1.00256, .99999 to 1.00341, and .99943 to 1.00397
the estimated collision/absorption neutron removal lifetime = 4.89E-05 seconds with an estimated standard deviation of 1.03E-07

1mcnp version 4a ld=10/01/93 04/30/96 20:14:20

probid = 04/30/96 20:14:20

INP=s3020nh OUTP=s3020nh

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nh)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.508241-2 -1 IMP:N=1
6- 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 115 $ INNER FUEL ZONE
12- 2 SO 275 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nh)

probid = 04/30/96 20:14:20

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79977 neutron histories and 55 active cycles with 220592 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300569 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .96843 with an estimated standard deviation of .00108

the estimated 68, 95, & 99 percent keff confidence intervals are .96735 to .96951, .96627 to .97059, and .96555 to .97131
the estimated collision/absorption neutron removal lifetime = $9.39\text{E-}05$ seconds with an estimated standard deviation of $2.64\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 12:58:01

 inp=s3020ni outp=s3020ni0

probid = 05/01/96 12:58:01

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ni)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 150 $ INNER FUEL ZONE
12- 2 SO 210 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ni)

probid = 05/01/96 12:58:01

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80072 neutron histories and 55 active cycles with 220019 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300091 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98553 with an estimated standard deviation of .00104

the estimated 68, 95, & 99 percent keff confidence intervals are .98448 to .98657, .98344 to .98762, and .98274 to .98831
the estimated collision/absorption neutron removal lifetime = 9.02E-05 seconds with an estimated standard deviation of 1.99E-07

1mcnp version 4a ld=10/01/93 04/26/96 17:37:54

 INP=s3020nb OUP=s3020nb

probid = 04/26/96 17:37:54

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nb)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 160 $ INNER FUEL ZONE
12- 2 SO 220 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nb)

probid = 04/26/96 17:37:54

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80043 neutron histories and 55 active cycles with 220187 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300230 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99081 with an estimated standard deviation of .00099

the estimated 68, 95, & 99 percent keff confidence intervals are .98981 to .99181, .98882 to .99280, and .98816 to .99347
the estimated collision/absorption neutron removal lifetime = 8.94E-05 seconds with an estimated standard deviation of 2.33E-07

1mcnp version 4a ld=10/01/93 04/26/96 18:41:03

 INP=s3020nc OUTP=s3020nc0

probid = 04/26/96 18:41:03

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nc)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 175 $ INNER FUEL ZONE
12- 2 SO 235 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nc)

probid = 04/26/96 18:41:03

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80323 neutron histories and 55 active cycles with 219186 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299509 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99147 with an estimated standard deviation of .00090

the estimated 68, 95, & 99 percent keff confidence intervals are .99056 to .99237, .98966 to .99328, and .98906 to .99388
the estimated collision/absorption neutron removal lifetime = $8.92\text{E-}05$ seconds with an estimated standard deviation of $2.01\text{E-}07$

1mcnp version 4a ld=10/01/93 04/26/96 19:37:04

 INP=s3020nd OUTP=s3020nd

probid = 04/26/96 19:37:04

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nd)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 190 $ INNER FUEL ZONE
12- 2 SO 250 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nd)

probid = 04/26/96 19:37:04

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80408 neutron histories and 55 active cycles with 219217 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299625 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99673 with an estimated standard deviation of .00086

the estimated 68, 95, & 99 percent keff confidence intervals are .99586 to .99759, .99500 to .99845, and .99443 to .99902
the estimated collision/absorption neutron removal lifetime = $8.78\text{E-}05$ seconds with an estimated standard deviation of $1.84\text{E-}07$

1mcnp version 4a ld=10/01/93 04/26/96 20:39:40

 INP=s3020ne OUTP=s3020ne0

probid = 04/26/96 20:39:40

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ne)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 205 $ INNER FUEL ZONE
12- 2 SO 265 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ne)

probid = 04/26/96 20:39:40

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80219 neutron histories and 55 active cycles with 220187 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300406 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99792 with an estimated standard deviation of .00114

the estimated 68, 95, & 99 percent keff confidence intervals are .99677 to .99906, .99563 to 1.00021, and .99487 to 1.00097
the estimated collision/absorption neutron removal lifetime = $8.80\text{E-}05$ seconds with an estimated standard deviation of $1.97\text{E-}07$

1mcnp version 4a ld=10/01/93 04/29/96 07:57:09

probid = 04/29/96 07:57:09

inp=s3020nf outp=s3020nf0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nf)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.508241-2 -1 IMP:N=1
6- 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 220 $ INNER FUEL ZONE
12- 2 SO 280 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 92237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020nf)

probid = 04/29/96 07:57:09

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 20 inactive cycles with 80579 neutron histories and 55 active cycles with 219949 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300528 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99735 with an estimated standard deviation of .00077

the estimated 68, 95, & 99 percent keff confidence intervals are .99657 to .99812, .99579 to .99890, and .99528 to .99942
the estimated collision/absorption neutron removal lifetime = $8.74\text{E-}05$ seconds with an estimated standard deviation of $1.60\text{E-}07$

1mcnp version 4a ld=10/01/93 08/19/96 09:54:48

 inp=s3020ng outp=s3020ngo

probid = 08/19/96 09:54:48

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ng)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.508241-2 -1 IMP:N=1
6- 2 2 8.610406-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 235 $ INNER FUEL ZONE
12- 2 SO 290 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (47 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.891081-2 8016.50c 4.129133-2 11023.50c 3.199177-4
22- 12000.50c 1.879523-4 13027.50c 2.118592-3 14000.50c 9.269606-3
23- 19000.50c 4.517670-4 20000.50c 4.628070-4 26000.55c 1.140702-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
29- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
30- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 8% UO2 (s3020ng)

probid = 08/19/96 09:54:48

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80182 neutron histories and 55 active cycles with 219839 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300021 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent

the final estimated combined collision/absorption/track-length keff = 1.00196 with an estimated standard deviation of .00112

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00083 to 1.00308, .99971 to 1.00420, and .99897 to 1.00494
the estimated collision/absorption neutron removal lifetime = $8.67\text{E-}05$ seconds with an estimated standard deviation of $1.88\text{E-}07$

1mcnp version 4a ld=10/01/93 05/07/96 13:47:55

probid = 05/07/96 13:47:55

inp=s3020ph outp=s3020ph0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020ph)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 140 $ INNER FUEL ZONE
12- 2 SO 200 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020ph)

probid = 05/07/96 13:47:55

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
this problem has run 30 inactive cycles with 119955 neutron histories and 100 active cycles with 400180 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520135 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
warning. the k(trk length) cycle values do not appear normally distributed at the 99 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98191 with an estimated standard deviation of .00078

the estimated 68, 95, & 99 percent keff confidence intervals are .98112 to .98269, .98035 to .98346, and .97984 to .98397
the estimated collision/absorption neutron removal lifetime = $9.27\text{E-}05$ seconds with an estimated standard deviation of $1.92\text{E-}07$

1mcnp version 4a ld=10/01/93 05/06/96 16:18:57

probid = 05/06/96 16:18:57

INP=s3020pa OUP=s3020pa0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pa)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.335845-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 150 $ INNER FUEL ZONE
12- 2 SO 210 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pa)

probid = 05/06/96 16:18:57

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120401 neutron histories and 100 active cycles with 399469 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519870 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98670 with an estimated standard deviation of .00075

the estimated 68, 95, & 99 percent keff confidence intervals are .98595 to .98745, .98520 to .98819, and .98471 to .98868
the estimated collision/absorption neutron removal lifetime = $9.20\text{E-}05$ seconds with an estimated standard deviation of $1.64\text{E-}07$

1mcnp version 4a ld=10/01/93 05/06/96 17:56:04

probid = 05/06/96 17:56:04

INP=s3020pb OUP=s3020pb0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pb)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 160 $ INNER FUEL ZONE
12- 2 SO 220 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pb)

probid = 05/06/96 17:56:04

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 119827 neutron histories and 100 active cycles with 400182 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520009 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98920 with an estimated standard deviation of .00080

the estimated 68, 95, & 99 percent keff confidence intervals are .98840 to .99000, .98760 to .99080, and .98708 to .99132
the estimated collision/absorption neutron removal lifetime = $9.11\text{E-}05$ seconds with an estimated standard deviation of $1.66\text{E-}07$

1mcnp version 4a ld=10/01/93 05/06/96 19:28:38

probid = 05/06/96 19:28:38

INP=s3020pc OUTP=s3020pc0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pc)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 175 $ INNER FUEL ZONE
12- 2 SO 235 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pc)

probid = 05/06/96 19:28:38

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120289 neutron histories and 100 active cycles with 399571 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519860 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99014 with an estimated standard deviation of .00086

the estimated 68, 95, & 99 percent keff confidence intervals are .98928 to .99101, .98843 to .99186, and .98787 to .99242
the estimated collision/absorption neutron removal lifetime = $9.04\text{E-}05$ seconds with an estimated standard deviation of $1.47\text{E-}07$

1mcnp version 4a ld=10/01/93 05/06/96 21:01:42

probid = 05/06/96 21:01:42

INP=s3020pd OUTP=s3020pd0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pd)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 190 $ INNER FUEL ZONE
12- 2 SO 250 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pd)

probid = 05/06/96 21:01:42

the initial fission neutron source distribution was read from the srctp file named srctp
the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
this problem has run 30 inactive cycles with 120116 neutron histories and 100 active cycles with 400181 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520297 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99760 with an estimated standard deviation of .00066

the estimated 68, 95, & 99 percent keff confidence intervals are .99694 to .99826, .99628 to .99892, and .99585 to .99935
the estimated collision/absorption neutron removal lifetime = $8.90\text{E-}05$ seconds with an estimated standard deviation of $1.74\text{E-}07$

1mcnp version 4a ld=10/01/93 05/06/96 22:33:58

probid = 05/06/96 22:33:58

INP=s3020pe OUTP=s3020pe0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pe)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 205 $ INNER FUEL ZONE
12- 2 SO 265 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pe)

probid = 05/06/96 22:33:58

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
this problem has run 30 inactive cycles with 120211 neutron histories and 100 active cycles with 399463 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519674 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99597 with an estimated standard deviation of .00088

the estimated 68, 95, & 99 percent keff confidence intervals are .99508 to .99685, .99421 to .99772, and .99364 to .99829
the estimated collision/absorption neutron removal lifetime = $8.93\text{E-}05$ seconds with an estimated standard deviation of $1.63\text{E-}07$

1mcnp version 4a ld=10/01/93 05/07/96 00:06:32

 INP=s3020pf OUTP=s3020pfo

probid = 05/07/96 00:06:32

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pf)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.335845-2 -1 IMP:N=1
6- 2 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 220 $ INNER FUEL ZONE
12- 2 SO 280 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT
  
```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pf)

probid = 05/07/96 00:06:32

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120304 neutron histories and 100 active cycles with 400085 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520389 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99911 with an estimated standard deviation of .00071

the estimated 68, 95, & 99 percent keff confidence intervals are .99840 to .99982, .99770 to 1.00053, and .99724 to 1.00099
the estimated collision/absorption neutron removal lifetime = $8.81\text{E-}05$ seconds with an estimated standard deviation of $1.36\text{E-}07$

1mcnp version 4a ld=10/01/93 05/07/96 01:37:42

probid = 05/07/96 01:37:42

INP=s3020pg OUTP=s3020pg0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pg)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.335845-2 -1 IMP:N=1
6- 2 8.423019-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 235 $ INNER FUEL ZONE
12- 2 SO 295 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 30 130
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 5 0 0 -5 -10 0 -10
17- C 0 -5 -20 -10 0 -13 0 -10 14 0 0 -15 -10 -5 -16 5 5 0 10 10 17
18- C MATERIAL SPECIFICATIONS
19- c (40 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- mt1 1001.50c 2.460494-2 8016.50c 4.216620-2 11023.50c 3.621710-4
22- 12000.50c 2.127762-4 13027.50c 2.398406-3 14000.50c 1.049389-2
23- 19000.50c 5.114344-4 20000.50c 5.239325-4 26000.55c 1.291361-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 40 vol% water in calico Hills tuff
28- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
29- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
30- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 8% UO2 (s3020pg)

probid = 05/07/96 01:37:42

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120294 neutron histories and 100 active cycles with 399788 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520082 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00354 with an estimated standard deviation of .00079

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00275 to 1.00434, 1.00197 to 1.00512, and 1.00145 to 1.00563
the estimated collision/absorption neutron removal lifetime = $8.77\text{E-}05$ seconds with an estimated standard deviation of $1.54\text{E-}07$

1mcnp version 4a ld=10/01/93 04/30/96 19:42:51

probid = 04/30/96 19:42:51

INP=s3020be OUTP=s3020be0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020be)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.033424-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 115 $ INNER FUEL ZONE
12- 2 SO 175 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 3000 1. 14 54
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .90 10 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
22- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
23- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
24- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
25- 92238.50c 2.381875-3 93237.50c 2.728657-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT
  
```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020be)

probid = 04/30/96 19:42:51

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 14 cycles and run a total of 54 cycles with nominally 3000 neutrons per cycle.
 this problem has run 14 inactive cycles with 42008 neutron histories and 40 active cycles with 119399 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 161407 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97905 with an estimated standard deviation of .00159

the estimated 68, 95, & 99 percent keff confidence intervals are .97745 to .98066, .97583 to .98227, and .97473 to .98337
the estimated collision/absorption neutron removal lifetime = $8.42\text{E-}05$ seconds with an estimated standard deviation of $4.50\text{E-}07$

1mcnp version 4a ld=10/01/93 04/23/96 08:15:20

probid = 04/23/96 08:15:20

inp=s3020ba outp=s3020ba0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020ba)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.033424-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 125 $ INNER FUEL ZONE
12- 2 SO 185 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 3000 1. 14 54
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .90 10 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
22- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
23- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
24- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
25- 92238.50c 2.381875-3 93237.50c 2.728657-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020ba)

probid = 04/23/96 08:15:20

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 14 cycles and run a total of 54 cycles with nominally 3000 neutrons per cycle.
 this problem has run 14 inactive cycles with 41724 neutron histories and 40 active cycles with 120165 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 161889 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99093 with an estimated standard deviation of .00177

the estimated 68, 95, & 99 percent keff confidence intervals are .98914 to .99272, .98733 to .99453, and .98611 to .99575
the estimated collision/absorption neutron removal lifetime = $8.15\text{E-}05$ seconds with an estimated standard deviation of $3.25\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 16:44:31

 INP=s3020bb OUTP=s3020bb

probid = 04/22/96 16:44:31

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bb)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.033424-2 -1 IMP:N=1
6- 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 140 $ INNER FUEL ZONE
12- 2 SO 200 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 3000 1. 14 54
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .90 10 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
22- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
23- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
24- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
25- 92238.50c 2.381875-3 93237.50c 2.728657-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bb)

probid = 04/22/96 16:44:31

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 14 cycles and run a total of 54 cycles with nominally 3000 neutrons per cycle.
 this problem has run 14 inactive cycles with 41846 neutron histories and 40 active cycles with 120232 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 162078 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99973 with an estimated standard deviation of .00144

the estimated 68, 95, & 99 percent keff confidence intervals are .99828 to 1.00119, .99681 to 1.00266, and .99581 to 1.00365
the estimated collision/absorption neutron removal lifetime = $7.92\text{E-}05$ seconds with an estimated standard deviation of $3.40\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 17:10:10

 INP=s3020bc OUTP=s3020bc0

probid = 04/22/96 17:10:10

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bc)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.033424-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 155 $ INNER FUEL ZONE
12- 2 SO 215 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 3000 1. 14 54
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .90 10 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
22- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
23- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
24- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
25- 92238.50c 2.381875-3 93237.50c 2.728657-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bc)

probid = 04/22/96 17:10:10

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 14 cycles and run a total of 54 cycles with nominally 3000 neutrons per cycle.
 this problem has run 14 inactive cycles with 42251 neutron histories and 40 active cycles with 119932 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 162183 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00461 with an estimated standard deviation of .00139

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00320 to 1.00601, 1.00178 to 1.00743, and 1.00082 to 1.00839
the estimated collision/absorption neutron removal lifetime = $7.73\text{E-}05$ seconds with an estimated standard deviation of $3.16\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 17:35:19

probid = 04/22/96 17:35:19

INP=s3020bd OUTP=s3020bd

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bd)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.033424-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 170 $ INNER FUEL ZONE
12- 2 SO 230 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 3000 1. 14 54
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .90 10 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.805254-2 8016.50c 4.328111-2 11023.50c 4.098044-4
22- 12000.50c 2.407609-4 13027.50c 2.713848-3 14000.50c 1.187407-2
23- 19000.50c 5.786991-4 20000.50c 5.928410-4 26000.55c 1.461203-4
24- 92234.50c 5.868062-7 92235.50c 4.781608-5 92236.50c 1.144148-5
25- 92238.50c 2.381875-3 93237.50c 2.728657-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 10% UO2 (s3020bd)

probid = 04/22/96 17:35:19

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 14 cycles and run a total of 54 cycles with nominally 3000 neutrons per cycle.
this problem has run 14 inactive cycles with 41673 neutron histories and 40 active cycles with 120050 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 161723 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00961 with an estimated standard deviation of .00155

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00804 to 1.01117, 1.00646 to 1.01276, and 1.00539 to 1.01383
the estimated collision/absorption neutron removal lifetime = 7.55E-05 seconds with an estimated standard deviation of 2.25E-07

1mcnp version 4a ld=10/01/93 05/02/96 09:23:19

probid = 05/02/96 09:23:19

inp=s3020ah outp=s3020ah0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ah)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.048982-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 180 $ INNER FUEL ZONE
12- 2 SO 240 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ah)

probid = 05/02/96 09:23:19

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 20 inactive cycles with 79950 neutron histories and 55 active cycles with 219827 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299777 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98327 with an estimated standard deviation of .00101

the estimated 68, 95, & 99 percent keff confidence intervals are .98226 to .98429, .98125 to .98530, and .98058 to .98597
the estimated collision/absorption neutron removal lifetime = $9.03\text{E-}05$ seconds with an estimated standard deviation of $2.12\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 16:46:48

 inp=s3020ag outp=s3020ag0

probid = 05/01/96 16:46:48

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ag)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.048982-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 220 $ INNER FUEL ZONE
12- 2 SO 280 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ag)

probid = 05/01/96 16:46:48

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79675 neutron histories and 55 active cycles with 220026 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299701 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99050 with an estimated standard deviation of .00111

the estimated 68, 95, & 99 percent keff confidence intervals are .98938 to .99162, .98827 to .99273, and .98753 to .99348
the estimated collision/absorption neutron removal lifetime = $8.85\text{E-}05$ seconds with an estimated standard deviation of $1.89\text{E-}07$

1mcnp version 4a ld=10/01/93 05/01/96 15:21:46

probid = 05/01/96 15:21:46

inp=s3020af outp=s3020af0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020af)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.048982-2 -1 IMP:N=1
6- 2 2 8.035742-2 1-2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 280 $ INNER FUEL ZONE
12- 2 SO 340 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020af)

probid = 05/01/96 15:21:46

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
this problem has run 20 inactive cycles with 80318 neutron histories and 55 active cycles with 219180 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299498 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99632 with an estimated standard deviation of .00108

the estimated 68, 95, & 99 percent keff confidence intervals are .99523 to .99740, .99415 to .99848, and .99344 to .99919
the estimated collision/absorption neutron removal lifetime = $8.72\text{E-}05$ seconds with an estimated standard deviation of $1.79\text{E-}07$

1mcnp version 4a ld=10/01/93 04/30/96 18:46:26

probid = 04/30/96 18:46:26

INP=s3020ae OUTP=s3020ae0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ae)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.048982-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 300 $ INNER FUEL ZONE
12- 2 SO 360 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ae)

probid = 04/30/96 18:46:26

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 79806 neutron histories and 55 active cycles with 219618 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 299424 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99778 with an estimated standard deviation of .00103

the estimated 68, 95, & 99 percent keff confidence intervals are .99675 to .99882, .99571 to .99985, and .99503 to 1.00054
the estimated collision/absorption neutron removal lifetime = $8.66\text{E-}05$ seconds with an estimated standard deviation of $2.14\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 14:49:34

 inp=s3020ad outp=s3020ado

probid = 04/22/96 14:49:34

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ad)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.048982-2 -1 IMP:N=1
6- 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 335 $ INNER FUEL ZONE
12- 2 SO 395 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- mt 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ad)

probid = 04/22/96 14:49:34

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 27947 neutron histories and 30 active cycles with 120000 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 147947 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99945 with an estimated standard deviation of .00139

the estimated 68, 95, & 99 percent keff confidence intervals are .99803 to 1.00086, .99658 to 1.00231, and .99558 to 1.00331
the estimated collision/absorption neutron removal lifetime = $8.55\text{E-}05$ seconds with an estimated standard deviation of $2.59\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 13:48:28

probid = 04/22/96 13:48:28

inp=s3020ac outp=s3020ac0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ac)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.048982-2 -1 IMP:N=1
6- 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 345 $ INNER FUEL ZONE
12- 2 SO 405 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 7 37
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT
1 initial source from file srctp

```

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ac)

probid = 04/22/96 13:48:28

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 7 cycles and run a total of 37 cycles with nominally 4000 neutrons per cycle.
 this problem has run 7 inactive cycles with 28028 neutron histories and 30 active cycles with 120580 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 148608 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99806 with an estimated standard deviation of .00144

the estimated 68, 95, & 99 percent keff confidence intervals are .99660 to .99952, .99511 to 1.00101, and .99407 to 1.00205
the estimated collision/absorption neutron removal lifetime = $8.64\text{E-}05$ seconds with an estimated standard deviation of $2.39\text{E-}07$

1mcnp version 4a ld=10/01/93 04/24/96 08:54:00

 inp=s3020ab outp=s3020abo

probid = 04/24/96 08:54:00

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ab)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 8.048982-2 -1 IMP:N=1
6- 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 355 $ INNER FUEL ZONE
12- 2 SO 415 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 20 75
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020ab)

probid = 04/24/96 08:54:00

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 20 cycles and run a total of 75 cycles with nominally 4000 neutrons per cycle.
 this problem has run 20 inactive cycles with 80504 neutron histories and 55 active cycles with 220090 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 300594 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00201 with an estimated standard deviation of .00099

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00101 to 1.00301, 1.00002 to 1.00401, and .99935 to 1.00467
the estimated collision/absorption neutron removal lifetime = $8.54\text{E-}05$ seconds with an estimated standard deviation of $1.92\text{E-}07$

1mcnp version 4a ld=10/01/93 04/22/96 14:09:18

 inp=s3020aa outp=s3020aa0

probid = 04/22/96 14:09:18

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020aa)
2- C Calico Hills Tuff 1.746 g/cc .306 porosity - sphere surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.048982-2 -1 IMP:N=1
6- 2 2 8.035742-2 1 -2 IMP:N=1
7- C OUTSIDE WORLD
8- 3 0 2 IMP:N=0
9-
10- C SURFACE SPECIFICATIONS
11- 1 SO 365 $ INNER FUEL ZONE
12- 2 SO 425 $ INNER FUEL ZONE
13-
14- MODE N
15- KCODE 4000 1. 10 40
16- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
17- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
18- C MATERIAL SPECIFICATIONS
19- c (30 vol% water in calico Hills tuff) x .92 8 vol% UO2
20- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
21- m1 1001.50c 1.845371-2 8016.50c 4.315649-2 11023.50c 4.189111-4
22- 12000.50c 2.461111-4 13027.50c 2.774156-3 14000.50c 1.213794-2
23- 19000.50c 5.915591-4 20000.50c 6.060152-4 26000.55c 1.493674-4
24- 92234.50c 4.694450-7 92235.50c 3.825286-5 92236.50c 9.153184-6
25- 92238.50c 1.905500-3 93237.50c 2.182926-6
26- mt1 lwtr.01t
27- c 30 vol% water in calico Hills tuff
28- m2 1001.50c 3.142479-2 8016.50c 3.695585-2 11023.50c 2.964542-4
29- 12000.50c 1.741675-4 13027.50c 1.963209-3 14000.50c 8.589752-3
30- 19000.50c 4.186334-4 20000.50c 4.288637-4 26000.55c 1.057041-4
31- mt2 lwtr.01t
32- PRINT

```

1 initial source from file srctp
 1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 30% H2O/ 8% UO2 (s3020aa)

probid = 04/22/96 14:09:18

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 10 cycles and run a total of 40 cycles with nominally 4000 neutrons per cycle.
 this problem has run 10 inactive cycles with 40180 neutron histories and 30 active cycles with 119777 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 159957 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 warning. the k(trk length) cycle values do not appear normally distributed at the 99 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00209 with an estimated standard deviation of .00141

the estimated 68, 95, & 99 percent keff confidence intervals are 1.00066 to 1.00353, .99919 to 1.00499, and .99818 to 1.00601
the estimated collision/absorption neutron removal lifetime = $8.57\text{E-}05$ seconds with an estimated standard deviation of $2.42\text{E-}07$

1mcnp version 4a ld=10/01/93 04/29/96 10:55:36

 INP=3E47W08I OUTP=3E4708.0

probid = 04/29/96 10:55:36

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 47% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 8.50824092506-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
  
```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 4.129133-2 $ At
26- 1001.50C 2.891081-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT
  
```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 47% Water 8.0% U-Np 02 probid = 04/29/96 10:55:36

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1553 neutron histories and 500 active cycles with 250071 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251624 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01025 with an estimated standard deviation of .00091
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00934 to 1.01116, 1.00844 to 1.01206, and 1.00784 to 1.01265
the estimated collision/absorption neutron removal lifetime = 8.46E-05 seconds with an estimated standard deviation of 1.46E-07

1mcnp version 4a ld=10/01/93 04/27/96 15:54:54

probid = 04/27/96 15:54:54

INP=3E40W08I OUTP=3E4008.O

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 40% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 7.86236115346-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
  
```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.913840-2 $ At
26- 1001.50C 2.460494-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT
  
```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 40% Water 8.0% U-Np 02

probid = 04/27/96 15:54:54

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1592 neutron histories and 500 active cycles with 250396 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251988 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.02854 with an estimated standard deviation of .00090
the estimated 68, 95, & 99 percent keff confidence intervals are 1.02764 to 1.02944, 1.02675 to 1.03033, and 1.02616 to 1.03091
the estimated collision/absorption neutron removal lifetime = 8.61E-05 seconds with an estimated standard deviation of 1.50E-07

1mcnp version 4a ld=10/01/93 04/27/96 16:47:00

 INP=3E35W08I OUTP=3E3508.O

probid = 04/27/96 16:47:00

```

1- FarField Criticality - Sphere of Transmuted 3.OE 20GWD 35% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 7.40101845946-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11-
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
warning: this surface has been replaced by a surface of type so
16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.760059-2 $ At
26- 1001.50C 2.152933-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.OE 20GWD 35% Water 8.0% U-Np 02 probid = 04/27/96 16:47:00

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1546 neutron histories and 500 active cycles with 250601 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 252147 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.03566 with an estimated standard deviation of .00094
the estimated 68, 95, & 99 percent keff confidence intervals are 1.03472 to 1.03661, 1.03378 to 1.03754, and 1.03317 to 1.03816
the estimated collision/absorption neutron removal lifetime = 8.63E-05 seconds with an estimated standard deviation of 1.54E-07

1mcnp version 4a ld=10/01/93 04/27/96 17:32:06

probid = 04/27/96 17:32:06

INP=3E30W08I OUTP=3E3008.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 6.93967576546-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.606278-2 $ At
26- 1001.50C 1.845371-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 8.0% U-Np 02

probid = 04/27/96 17:32:06

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1490 neutron histories and 500 active cycles with 249800 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251290 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.04272 with an estimated standard deviation of .00097
the estimated 68, 95, & 99 percent keff confidence intervals are 1.04175 to 1.04368, 1.04079 to 1.04464, and 1.04016 to 1.04527
the estimated collision/absorption neutron removal lifetime = 8.67E-05 seconds with an estimated standard deviation of 1.53E-07

1mcnp version 4a ld=10/01/93 04/27/96 18:14:23

probid = 04/27/96 18:14:23

INP=3E25W081 OUTP=3E2508.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 25% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 6.47833307146-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.452497-2 $ At
26- 1001.50C 1.537809-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 25% Water 8.0% U-Np 02

probid = 04/27/96 18:14:23

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1500 neutron histories and 500 active cycles with 250102 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 251602 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.04320 with an estimated standard deviation of .00102
the estimated 68, 95, & 99 percent keff confidence intervals are 1.04217 to 1.04422, 1.04116 to 1.04523, and 1.04050 to 1.04589
the estimated collision/absorption neutron removal lifetime = 8.66E-05 seconds with an estimated standard deviation of 1.64E-07

the final estimated combined collision/absorption/track-length keff = 1.03318 with an estimated standard deviation of .00108
the estimated 68, 95, & 99 percent keff confidence intervals are 1.03210 to 1.03426, 1.03103 to 1.03533, and 1.03033 to 1.03603
the estimated collision/absorption neutron removal lifetime = 8.49E-05 seconds with an estimated standard deviation of 1.64E-07

1mcnp version 4a ld=10/01/93 04/27/96 18:54:26

 INP=3E20W08I OUTP=3E2008.0

probid = 04/27/96 18:54:26

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 6.01699037746-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- C 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C
  
```

warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.298716-2 $ At
26- 1001.50C 1.230247-2 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT
  
```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8.0% U-Np 02 probid = 04/27/96 18:54:26

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1413 neutron histories and 500 active cycles with 250887 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 252300 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

1mcnp version 4a ld=10/01/93 04/27/96 19:32:52

 INP=3E15W08I OUTP=3E1508.0

probid = 04/27/96 19:32:52

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 15% Water 8.0% U-Np 02
2- C k-inf Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 5.55564768346-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- C 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- C 30 0 2 IMP:N=0 $ Void
10- 30 0 1 IMP:N=0 $ Void
11- C
12- C SURFACES
13- 1* S 0 0 0 10.00 $ *Infinite FISSILE SPHERE
14- C 2 S 0 0 0 174.51 $ REFLECTOR
15- C

```

Warning. this surface has been replaced by a surface of type so

```

16-
17- MODE N
18- KCODE 500 1 3 503
19- KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1
20- 1 1 0 1 -1 0 1 0 1 1 0 -1
21- -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
22- 0 1 1 0 -1 1 0 1 -1 0 -1 -1
23- 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
24- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
25- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.144935-2 $ At
26- 1001.50C 9.226854-3 $ an
27- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
28- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
29- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
30- MT1 LWTR.01T $ Wa
31- C M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3
32- C 8016.50C 4.063067-2
33- C 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4
34- C 11023.50C 3.477367-4 19000.50C 4.910511-4
35- C MT3 LWTR.01T
36- PRINT

```

1 initial source from ksrc card.

print table 90

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 15% Water 8.0% U-Np 02 probid = 04/27/96 19:32:52

the initial fission neutron source distribution used the 23 source points that were input on the ksrc card.
 the criticality problem was scheduled to skip 3 cycles and run a total of 503 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1464 neutron histories and 500 active cycles with 251063 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 252527 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00676 with an estimated standard deviation of .00109
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00567 to 1.00786, 1.00459 to 1.00894, and 1.00388 to 1.00964
the estimated collision/absorption neutron removal lifetime = 8.21E-05 seconds with an estimated standard deviation of 1.53E-07

1mcnp version 4a ld=10/01/93 04/27/96 12:38:38

probid = 04/27/96 12:38:38

INP=3E47W08C OUTP=3C4708.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 47% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Volume Coefficient
3- C
4- C SPHERE
5- 1 1 8.50824092506-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 4.129133-2 $ At
25- 1001.50C 2.891081-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 47% Water 8.0% U-Np 02 probid = 04/27/96 12:38:38

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
this problem has run 3 inactive cycles with 1498 neutron histories and 1000 active cycles with 500461 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501959 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98706 with an estimated standard deviation of .00067
the estimated 68, 95, & 99 percent keff confidence intervals are .98638 to .98773, .98571 to .98840, and .98528 to .98884
the estimated collision/absorption neutron removal lifetime = 9.01E-05 seconds with an estimated standard deviation of 1.39E-07

1mcnp version 4a id=10701795 04/27/96 14:15:57

 INP=3E40W08C OUTP=3C4008.0

probid = 04/27/96 14:15:37

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 40% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Volume Coefficient
3- C
4- C SPHERE
5- 1 1 7.86236115346-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.913840-2 $ At
25- 1001.50C 2.460494-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 40% Water 8.0% U-Np 02 probid = 04/27/96 14:15:37

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1533 neutron histories and 1000 active cycles with 500377 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501910 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99684 with an estimated standard deviation of .00069
the estimated 68, 95, & 99 percent keff confidence intervals are .99615 to .99753, .99547 to .99821, and .99502 to .99866
the estimated collision/absorption neutron removal lifetime = 9.29E-05 seconds with an estimated standard deviation of 1.53E-07

1mcnp version 4a ld=10/01/93 05/02/96 13:25:45

 INP=3E35W08C OUTP=3E3508.0

probid = 05/02/96 13:25:45

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 35% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 7.40101845946-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.760059-2 $ At
25- 1001.50C 2.152933-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 35% Water 8.0% U-Np 02 probid = 05/02/96 13:25:45

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1433 neutron histories and 1000 active cycles with 500368 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501801 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00242 with an estimated standard deviation of .00075
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00167 to 1.00317, 1.00093 to 1.00391, and 1.00044 to 1.00439
the estimated collision/absorption neutron removal lifetime = 9.45E-05 seconds with an estimated standard deviation of 1.58E-07

1mcnp version 4a ld=10/01/93 05/02/96 14:50:47

probid = 05/02/96 14:50:47

INP=3E30W08C OUTP=3E3008.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 6.93967576546-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 92237.50C 2.182926-6 8016.50C 3.606278-2 $ At
25- 1001.50C 1.845371-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 30% Water 8.0% U-Np 02 probid = 05/02/96 14:50:47

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1441 neutron histories and 1000 active cycles with 499950 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501391 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.00163 with an estimated standard deviation of .00079
the estimated 68, 95, & 99 percent keff confidence intervals are 1.00084 to 1.00242, 1.00006 to 1.00320, and .99955 to 1.00371
the estimated collision/absorption neutron removal lifetime = 9.66E-05 seconds with an estimated standard deviation of 1.63E-07

1mcnp version 4a ld=10/01/93 05/02/96 16:50:03

 INP=3E25W08C OUTP=3E2508.0

probid = 05/02/96 16:50:03

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 25% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 6.47833307146-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.452497-2 $ At
25- 1001.50C 1.537809-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 25% Water 8.0% U-Np 02 probid = 05/02/96 16:50:03

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1488 neutron histories and 1000 active cycles with 500779 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 502267 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99189 with an estimated standard deviation of .00081
the estimated 68, 95, & 99 percent keff confidence intervals are .99108 to .99270, .99027 to .99351, and .98974 to .99404
the estimated collision/absorption neutron removal lifetime = 9.80×10^{-5} seconds with an estimated standard deviation of 1.72×10^{-7}

1mcnp version 4a ld=10/01/93 05/02/96 18:10:20

probid = 05/02/96 18:10:20

INP=3E20W08C OUTP=3E2008.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 6.01699037746-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.298716-2 $ At
25- 1001.50C 1.230247-2 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT
1 initial source from file srctp

```

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 20% Water 8.0% U-Np 02 probid = 05/02/96 18:10:20

the initial fission neutron source distribution was read from the srctp file named srctp .
the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
this problem has run 3 inactive cycles with 1418 neutron histories and 1000 active cycles with 499908 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 501326 fission neutron source histories.
all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97117 with an estimated standard deviation of .00082
the estimated 68, 95, & 99 percent keff confidence intervals are .97036 to .97199, .96955 to .97280, and .96902 to .97333
the estimated collision/absorption neutron removal lifetime = 9.98×10^{-5} seconds with an estimated standard deviation of 1.87×10^{-7}

1mcnp version 4a ld=10/01/93 05/02/96 19:26:16

probid = 05/02/96 19:26:16

INP=3E15W08C OUTP=3E1508.0

```

1- FarField Criticality - Sphere of Transmuted 3.0E 20GWD 15% Water 8.0% U-Np 02
2- C k-eff Optimization For Positive Water Coefficient
3- C
4- C SPHERE
5- 1 1 5.55564768346-2 -1 IMP:N=1 $ Uranium/Tuff/Water
6- 5 3 8.61040596000-2 1 -2 IMP:N=1 $ Tuff/Water Reflector
7- C
8- C OUTSIDE WORLD
9- 30 0 2 IMP:N=0 $ Void
10-
11- C SURFACES
12- 1 S 0 0 0 150.00 $ FISSILE SPHERE
warning. this surface has been replaced by a surface of type so
13- 2 S 0 0 0 210.00 $ REFLECTOR
14- C
warning. this surface has been replaced by a surface of type so
15-
16- MODE N
17- KCODE 500 1 3 1003
18- C KSRC 0 0 0 1 0 0 -1 0 0 0 1 0 0 -1 0 0 0 1 0
19- C 1 1 0 1 -1 0 1 0 1 1 0 -1
20- C -1 1 0 -1 -1 0 -1 0 1 -1 0 -1
21- C 0 1 1 0 -1 1 0 1 -1 0 -1 -1
22- C 1 1 1 -1 1 1 -1 -1 1 -1 -1 -1
23- M1 92234.50C 4.694450-7 92235.50C 3.825286-5 92236.50C 9.153184-6 $ Fi
24- 92238.50C 1.905500-3 93237.50C 2.182926-6 8016.50C 3.144935-2 $ At
25- 1001.50C 9.226854-3 $ an
26- 14000.50C 9.269607-3 13027.50C 2.118592-3 $ Ca
27- 26000.55C 1.140702-4 12000.50C 1.879523-4 20000.50C 4.628070-4 $ Wi
28- 11023.50C 3.199178-4 19000.50C 4.517670-4 $ 47
29- MT1 LWTR.01T $ Wa
30- M3 1001.50C 3.142479-2 14000.50C 1.007566-2 13027.50C 2.302817-3 $ Ca
31- 8016.50C 4.063067-2 $ Wi
32- 26000.55C 1.239894-4 12000.50C 2.042960-4 20000.50C 5.030511-4 $ 47
33- 11023.50C 3.477367-4 19000.50C 4.910511-4 $
34- MT3 LWTR.01T $ Wa
35- PRINT

```

1 initial source from file srctp

1keff results for: FarField Criticality - Sphere of Transmuted 3.0E 20GWD 15% Water 8.0% U-Np 02 probid = 05/02/96 19:26:16

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 3 cycles and run a total of 1003 cycles with nominally 500 neutrons per cycle.
 this problem has run 3 inactive cycles with 1435 neutron histories and 1000 active cycles with 500781 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 502216 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level.

the final estimated combined collision/absorption/track-length keff = .93067 with an estimated standard deviation of .00088
the estimated 68, 95, & 99 percent keff confidence intervals are .92979 to .93156, .92892 to .93243, and .92835 to .93300
the estimated collision/absorption neutron removal lifetime = 1.01E-04 seconds with an estimated standard deviation of 1.93E-07

1mcnp version 4a ld=10/01/93 05/16/96 11:06:44

 inp=s3020mz outp=s3020mz0

probid = 05/16/96 11:06:44

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mz)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.509901-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 40. $ INNER FUEL ZONE
13- 2 SO 80. $ INNER FUEL ZONE
14- 3 SO 140. $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .9213 7.87 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 2.895166-2 8016.50c 4.128059-2 11023.50c 3.203698-4
32- 12000.50c 1.882179-4 13027.50c 2.121585-3 14000.50c 9.282705-3
33- 19000.50c 4.524054-4 20000.50c 4.634610-4 26000.55c 1.142314-4
34- 92234.50c 4.618165-7 92235.50c 3.763125-5 92236.50c 9.004445-6
35- 92238.50c 1.874536-3 93237.50c 2.147453-6
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mz)

probid = 05/16/96 11:06:44

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120411 neutron histories and 100 active cycles with 399532 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519943 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98472 with an estimated standard deviation of .00090
the estimated 68, 95, & 99 percent keff confidence intervals are .98382 to .98562, .98293 to .98651, and .98235 to .98709
the estimated collision/absorption neutron removal lifetime = 8.37E-05 seconds with an estimated standard deviation of 2.37E-07

1mcnp version 4a ld=10/01/93 05/16/96 07:29:34

probid = 05/16/96 07:29:34

inp=s3020my outp=s3020my0

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020my)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.509901-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 50. $ INNER FUEL ZONE
13- 2 SO 100. $ INNER FUEL ZONE
14- 3 SO 160. $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .9213 7.87 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 2.895166-2 8016.50c 4.128059-2 11023.50c 3.203698-4
32- 12000.50c 1.882179-4 13027.50c 2.121585-3 14000.50c 9.282705-3
33- 19000.50c 4.524054-4 20000.50c 4.634610-4 26000.55c 1.142314-4
34- 92234.50c 4.618165-7 92235.50c 3.763125-5 92236.50c 9.004445-6
35- 92238.50c 1.874536-3 93237.50c 2.147453-6
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020my)

probid = 05/16/96 07:29:34

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120414 neutron histories and 100 active cycles with 400502 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520916 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.01402 with an estimated standard deviation of .00089
the estimated 68, 95, & 99 percent keff confidence intervals are 1.01313 to 1.01491, 1.01225 to 1.01580, and 1.01167 to 1.01638
the estimated collision/absorption neutron removal lifetime = 7.57E-05 seconds with an estimated standard deviation of 1.83E-07

1mcnp version 4a ld=10/01/93 05/15/96 16:51:53

 inp=s3020mx outp=s3020mx0

probid = 05/15/96 16:51:53

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mx)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.509901-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 57.4 $ INNER FUEL ZONE
13- 2 SO 114.8 $ INNER FUEL ZONE
14- 3 SO 174.8 $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .9213 7.87 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 2.895166-2 8016.50c 4.128059-2 11023.50c 3.203698-4
32- 12000.50c 1.882179-4 13027.50c 2.121585-3 14000.50c 9.282705-3
33- 19000.50c 4.524054-4 20000.50c 4.634610-4 26000.55c 1.142314-4
34- 92234.50c 4.618165-7 92235.50c 3.763125-5 92236.50c 9.004445-6
35- 92238.50c 1.874536-3 93237.50c 2.147453-6
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mx)

probid = 05/15/96 16:51:53

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120424 neutron histories and 100 active cycles with 400380 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520804 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = 1.03012 with an estimated standard deviation of .00096
the estimated 68, 95, & 99 percent keff confidence intervals are 1.02916 to 1.03108, 1.02820 to 1.03204, and 1.02758 to 1.03267
the estimated collision/absorption neutron removal lifetime = 7.10E-05 seconds with an estimated standard deviation of 1.62E-07

1mcnp version 4a ld=10/01/93 05/16/96 12:46:13

 inp=s3020ms outp=s3020ms0

probid = 05/16/96 12:46:13

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mr)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.577020-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 53.0 $ INNER FUEL ZONE
13- 2 SO 106.0 $ INNER FUEL ZONE
14- 3 SO 166.0 $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- mt1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .973857 2.6143 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 3.060325-2 8016.50c 4.084656-2 11023.50c 3.386458-4
32- 12000.50c 1.989551-4 13027.50c 2.242615-3 14000.50c 9.812251-3
33- 19000.50c 4.782136-4 20000.50c 4.898998-4 26000.55c 1.207479-4
34- 92234.50c 1.534087-7 92235.50c 1.250056-5 92236.50c 2.991146-6
35- 92238.50c 6.226936-4 93237.50c 7.133528-7
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mr)

probid = 05/16/96 12:46:13

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 119975 neutron histories and 100 active cycles with 399641 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519616 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .97622 with an estimated standard deviation of .00087
the estimated 68, 95, & 99 percent keff confidence intervals are .97535 to .97710, .97449 to .97796, and .97392 to .97853
the estimated collision/absorption neutron removal lifetime = 7.81E-05 seconds with an estimated standard deviation of 1.98E-07

1mcnp version 4a ld=10/01/93 05/16/96 11:07:55

 inp=s3020mr outp=s3020mr0

probid = 05/16/96 11:07:55

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mr)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.577020-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 55.0 $ INNER FUEL ZONE
13- 2 SO 110.0 $ INNER FUEL ZONE
14- 3 SO 170.0 $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .973857 2.6143 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 3.060325-2 8016.50c 4.084656-2 11023.50c 3.386458-4
32- 12000.50c 1.989551-4 13027.50c 2.242615-3 14000.50c 9.812251-3
33- 19000.50c 4.782136-4 20000.50c 4.898998-4 26000.55c 1.207479-4
34- 92234.50c 1.534087-7 92235.50c 1.250056-5 92236.50c 2.991146-6
35- 92238.50c 6.226936-4 93237.50c 7.133528-7
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

```

1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mr)

probid = 05/16/96 11:07:55

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120047 neutron histories and 100 active cycles with 400573 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 520620 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .98701 with an estimated standard deviation of .00091
the estimated 68, 95, & 99 percent keff confidence intervals are .98610 to .98792, .98520 to .98883, and .98461 to .98942
the estimated collision/absorption neutron removal lifetime = 7.62E-05 seconds with an estimated standard deviation of 2.09E-07

1mcnp version 4a ld=10/01/93 05/16/96 08:18:27

 inp=s3020mq outp=s3020mq

probid = 05/16/96 08:18:27

```

1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mq)
2- C Calico Hills Tuff 1.137 g/cc .47 porosity - shells surrounded by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.374149-2 -1 IMP:N=1
6- 2 2 8.577020-2 1 -2 IMP:N=1
7- 3 3 8.610406-2 2 -3 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 3 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 SO 57.4 $ INNER FUEL ZONE
13- 2 SO 114.8 $ INNER FUEL ZONE
14- 3 SO 174.8 $ INNER FUEL ZONE
15-
16- MODE N
17- KCODE 4000 1. 30 130
18- C KSRC 0 0 1 0 0 10 0 0 -20 0 0 29 0 20 15 0 0 -55 -10 0 -40
19- C 0 -50 -20 -30 0 -13 0 -10 60 0 0 -25 -30 -15 -56 5 5 0 10 30 17
20- C MATERIAL SPECIFICATIONS
21- c (47 vol% water in calico Hills tuff) x .815 18.5 vol% UO2
22- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
23- m1 1001.50c 2.561121-2 8016.50c 4.215845-2 11023.50c 2.834054-4
24- 12000.50c 1.665012-4 13027.50c 1.876796-3 14000.50c 8.211662-3
25- 19000.50c 4.002067-4 20000.50c 4.099866-4 26000.55c 1.010513-4
26- 92234.50c 1.085591-6 92235.50c 8.845975-5 92236.50c 2.116674-5
27- 92238.50c 4.406469-3 93237.50c 5.048015-6
28- mt1 lwtr.01t
29- c (47 vol% water in calico Hills tuff) x .973857 2.6143 vol% UO2
30- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
31- m2 1001.50c 3.060325-2 8016.50c 4.084656-2 11023.50c 3.386458-4
32- 12000.50c 1.989551-4 13027.50c 2.242615-3 14000.50c 9.812251-3
33- 19000.50c 4.782136-4 20000.50c 4.898998-4 26000.55c 1.207479-4
34- 92234.50c 1.534087-7 92235.50c 1.250056-5 92236.50c 2.991146-6
35- 92238.50c 6.226936-4 93237.50c 7.133528-7
36- mt2 lwtr.01t
37- c 47 vol% water in calico Hills tuff
38- m3 1001.50c 3.142479-2 8016.50c 4.063067-2 11023.50c 3.477367-4
39- 12000.50c 2.042960-4 13027.50c 2.302817-3 14000.50c 1.007566-2
40- 19000.50c 4.910511-4 20000.50c 5.030511-4 26000.55c 1.239894-4
41- mt3 lwtr.01t
42- PRINT

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1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 18.5% UO2 (s3020mq)

probid = 05/16/96 08:18:27

the initial fission neutron source distribution was read from the srctp file named srctp
 the criticality problem was scheduled to skip 30 cycles and run a total of 130 cycles with nominally 4000 neutrons per cycle.
 this problem has run 30 inactive cycles with 120338 neutron histories and 100 active cycles with 398819 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 519157 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
the k(absorption) cycle values appear normally distributed at the 99 percent confidence level, but not at 95 percent
the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .99386 with an estimated standard deviation of .00092
the estimated 68, 95, & 99 percent keff confidence intervals are .99293 to .99478, .99202 to .99570, and .99142 to .99630
the estimated collision/absorption neutron removal lifetime = 7.41E-05 seconds with an estimated standard deviation of 1.83E-07

1mcnp version 4a ld=10/01/93 05/28/96 12:45:58

probid = 05/28/96 12:45:58

inp=c3020nb outp=c3020nb0

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1- Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 4.6% UO2 (c3020nb)
2- C Calico Hills Tuff 1.5095 g/cc .40 porosity - inf cylinder reflected by tuff
3- C CELL SPECIFICATIONS
4- C INNER WATER REGION
5- 1 1 8.372894-2 -1 3 -4 IMP:N=1
6- 2 2 8.423019-2 1 -2 3 -4 IMP:N=1
7- C 3 2 8.610406-2 -2 4 -5 IMP:N=1
8- C OUTSIDE WORLD
9- 4 0 2:-3:4 IMP:N=0
10-
11- C SURFACE SPECIFICATIONS
12- 1 cz 61 $ INNER FUEL ZONE
13- 2 cz 121 $ reflector
14- 3* pz 0 $ center
15- 4* pz 385 $ end
16- 5 pz 445 $ reflector
17-
18- MODE N
19- KCODE 4000 1. 25 125
20- C KSRC 0 0 1 0 0 10 0 0 20 0 0 29 0 20 15 0 0 55 -10 0 40
21- C 0 -5 20 -30 0 13 0 -10 26 5 50 125 -3 15 56 5 5 80 10 30 17
22- C 0 0 100 0 0 200 0 0 20 0 0 290 0 20 150 0 0 355 -10 0 240
23- C 0 -5 220 -30 0 313 0 -10 260 5 -30 325 -3 15 356 5 5 380 10 30 317
24- C MATERIAL SPECIFICATIONS
25- c (40 vol% water in calico Hills tuff) x .954 4.6 vol% UO2
26- c 3.0% Original Enrichment/ 20 GWD/MT decayed to Uranium isotopes
27- m1 1001.50c 2.551426-2 8016.50c 4.191775-2 11023.50c 3.75556-4
28- 12000.50c 2.206397-4 13027.50c 2.487043-3 14000.50c 1.088171-2
29- 19000.50c 5.303352-4 20000.50c 5.432952-4 26000.55c 1.339085-4
30- 92234.50c 2.699309-7 92235.50c 2.199540-5 92236.50c 5.263081-6
31- 92238.50c 1.095663-3 93237.50c 1.255182-6
32- mt1 lwtr.01t
33- c 40 vol% water in calico Hills tuff
34- m2 1001.50c 2.674450-2 8016.50c 4.158162-2 11023.50c 3.936641-4
35- 12000.50c 2.312785-4 13027.50c 2.606963-3 14000.50c 1.140641-2
36- 19000.50c 5.559069-4 20000.50c 5.694918-4 26000.55c 1.403653-4
37- mt2 lwtr.01t
38- PRINT

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1 initial source from file srctp

1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 4.6% UO2 (c3020nb)

probid = 05/28/96 12:45:58

the initial fission neutron source distribution was read from the srctp file named srctp .
 the criticality problem was scheduled to skip 25 cycles and run a total of 125 cycles with nominally 4000 neutrons per cycle.
 this problem has run 25 inactive cycles with 99796 neutron histories and 100 active cycles with 399700 neutron histories.

this calculation has completed the requested number of keff cycles using a total of 499496 fission neutron source histories.
 all cells with fissionable material were sampled and had fission neutron source points.

the results of the w test for normality applied to the individual collision, absorption, and track-length keff cycle values are:

the k(collision) cycle values appear normally distributed at the 95 percent confidence level
 the k(absorption) cycle values appear normally distributed at the 95 percent confidence level
 the k(trk length) cycle values appear normally distributed at the 95 percent confidence level

the final estimated combined collision/absorption/track-length keff = .79262 with an estimated standard deviation of .00077
the estimated 68, 95, & 99 percent keff confidence intervals are .79185 to .79338, .79109 to .79414, and .79059 to .79464
the estimated collision/absorption neutron removal lifetime = 1.45E-04 seconds with an estimated standard deviation of 2.63E-07