CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

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Table of Contents:

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 probablility 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 UO_2/H_2O/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 acceptablility 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

Parameter	Value
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_2O_3 Wt.-frac.	13.4
Fe_2O_3 Wt.-frac.	1.13
MnO Wt.-frac.	0.05
MgO Wt.-frac.	0.94
CaO Wt.-frac.	3.22
Na_2O Wt.-frac.	1.23
K_2O Wt.-frac.	2.64
P_2O_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

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)

Z	Element	Symbol	Isotope	MCNP ID	Atomic Weight
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 (g-mol)$^{-1}\times10^{24}$ (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 $U(Np)O_2$. 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) $U(Np)O_2$ isotopic composition calculation
   c) Number density calculations for Tuff/Water/UO_2 mixtures using spreadsheet

2) MCNP Criticality Cases
   a) k_∞ cases for various burnup/enrichment pairs in various Tuff/Water/UO_2 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/UO_2 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):

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

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:

EFPD = Burnup (MWd/MTU) x (MTU/Assembly) / (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:

Weight Fraction(I) = Atom Fraction(I) * Atomic Weight(A^I) / 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

	Weight Fraction in Fuel Metal		
Fuel Characteristics 1826.25 Day (5 Year) Decay	U-235	Pu-239	U-235 + Pu-239
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 $U(Np)O_2$ Isotopic Compositions

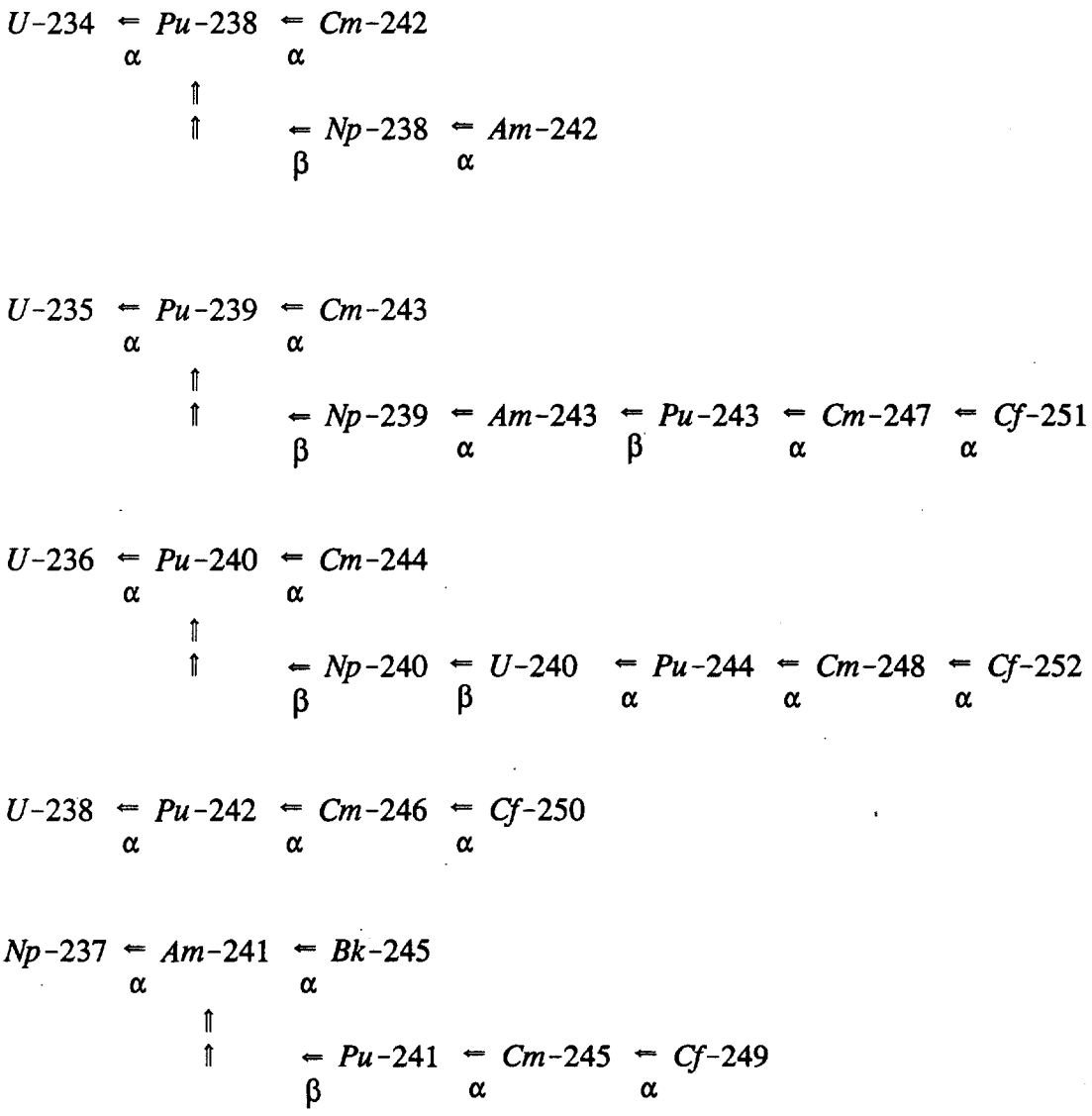
The uranium and neptunium isotopic compositions in the far-field originate with the six fuel burnup/enrichment pairs that are described above in Section 7.3.1. Attachments II-VII give the SAS2H results for the actinide isotopic fractions after decaying for 1826.25 days (5 years). For time periods of 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 UO_2 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 UO_2-NpO_2 structure at 100% UO_2 density (10.96 g/cm^3) 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/cm^3 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 (≈ 100,000 Years) Cubic Crystalline Concentrations				
	U-234	U-235	U-236	U-238	Np-237
3.0E-20GWd					
Atom Fraction	.00024	.01956	.00468	.97440	.00112
Number Density (atoms/barn-cm)	5.868062 - 6	4.781608 - 4	1.144148 - 4	2.381875 - 2	2.728657 - 5
3.5E-30GWd					
Atom Fraction	.00036	.01893	.00653	.97239	.00179
Number Density	8.691609 - 6	4.628167 - 4	1.597173 - 4	2.376949 - 2	4.376500 - 5
4.0E-40GWd					
Atom Fraction	.00051	.01847	.00825	.97035	.00241
Number Density	1.246889 - 5	4.515723 - 4	2.017600 - 4	2.371969 - 2	5.898417 - 5
4.2E-45GWd					
Atom Fraction	.00060	.01791	.00902	.96977	.00270
Number Density	1.463431 - 5	4.378063 - 4	2.204533 - 4	2.370558 - 2	6.599715 - 5
4.0E-45GWd					
Atom Fraction	.00059	.01676	.00881	.97114	.00270
Number Density	1.444231 - 5	4.097444 - 4	2.153653 - 4	2.373895 - 2	6.597651 - 5
4.5E-53GWd					
Atom Fraction	.00076	.01704	.01012	.96895	.00313
Number Density	1.865720 - 5	4.164425 - 4	2.473902 - 4	2.368540 - 2	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:

$$Natural\ UO_2\ (100\%\ Theoretical\ Density\ =\ 10.96\ gm/cm^3)$$

Atom Fractions			*Atomic Weights (g/mole)*		
U-234	=	0.000055	A^{234}	=	234.040904
U-235	=	0.0072	A^{235}	=	235.043915
U-238	=	0.992745	A^{238}	=	238.05077

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

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

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

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

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

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

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.

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

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

$$ND(H) = 6.686126 - 2$$
$$ND(O) = 3.343063 - 2$$

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 volitile 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)

Parameter		Value
Mean Density	(Dry)	1.746 g/cm^3
Porosity	(Mean)	0.306
SiO_2	(Wt.-frac.)	0.754
Al_2O_3	(Wt.-frac.)	0.146
Fe_2O_3	(Wt.-frac.)	0.012
MgO	(Wt.-frac.)	0.010
CaO	(Wt.-frac.)	0.035
Na_2O	(Wt.-frac.)	0.013
K_2O	(Wt.-frac.)	0.029
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:

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

Number Density (atoms/b-cm)		*Atomic Weights (atoms/mole)*		
$ND(O)$	= 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/cm^3 and a porosity of 0.306 for nominal tuff, a porosity of 0.47 has a density of

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

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

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 UO_2 - NpO_2 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.

$$Far-Field\ ND\,(UO_2 - NpO_2)_{Homogeneous} = .185 * ND\,(UO_2 - NpO_2)_{Heterogeneous}$$

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

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

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 $k_{eff} \pm 2\sigma$. 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. #	$k_\infty \pm 2\sigma$	Att. #	$k_\infty \pm 2\sigma$	Att. #	$k_\infty \pm 2\sigma$	UO_2 %	Att. #	$k_\infty \pm 2\sigma$	UO_2 %	Att. #	$k_\infty \pm 2\sigma$
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. #	$k_\infty \pm 2\sigma$	Att. #	$k_\infty \pm 2\sigma$	Att. #	$k_\infty \pm 2\sigma$
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

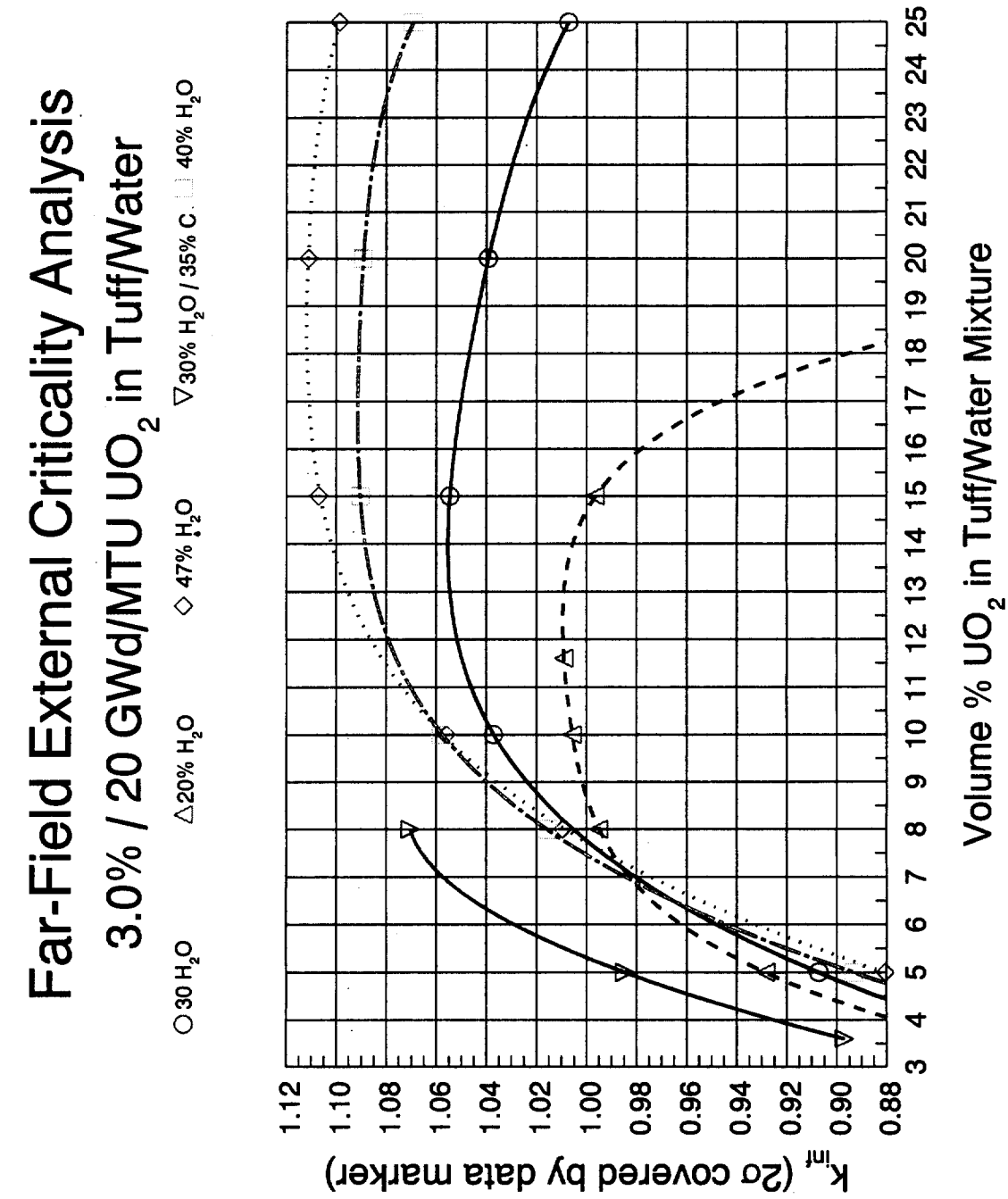

Far-Field External Criticality Analysis
3.0% / 20 GWd/MTU UO_2 in Tuff/Water
○30 H_2O
△20% H_2O
◇ 47% H_2O
▽30% H_2O / 35% C
40% H_2O
k_{inf} (2σ covered by data marker)
1.12
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Volume % UO_2 in Tuff/Water Mixture

FIGURE 7.4.1-1

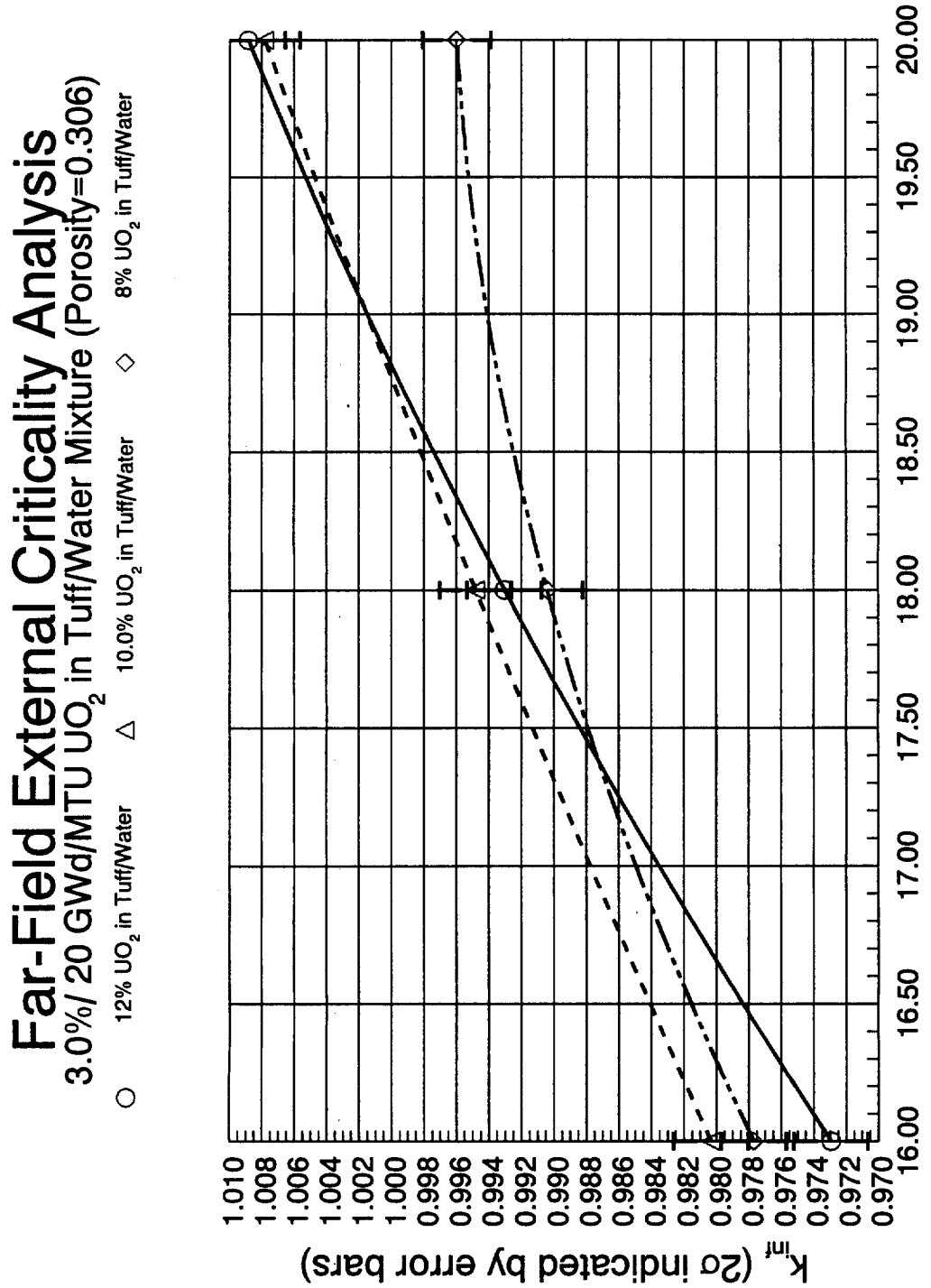

Far-Field External Criticality Analysis
3.0%/ 20 GWd/MTU UO_2 in Tuff/Water Mixture (Porosity=0.306)
○ 12% UO_2 in Tuff/Water
△ 10.0% UO_2 in Tuff/Water
◇ 8% UO_2 in Tuff/Water
k_{inf} (2σ indicated by error bars)
1.010
1.008
1.006
1.004
1.002
1.000
0.998
0.996
0.994
0.992
0.990
0.988
0.986
0.984
0.982
0.980
0.978
0.976
0.974
0.972
0.970
16.00
16.50
17.00
17.50
18.00
18.50
19.00
19.50
20.00
Volume % Water in Tuff/Water Mixture

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 ± .0033	5	IL	0.9065 ± .0026	5	LIII	0.8689 ± .0023	10	LIX	0.9809 ± .0023
8.8	XLIV	0.9990 ± .0034	10	L	0.9794 ± .0031	10	LIV	0.9966 ± .0027	15	LX	0.9935 ± .0026
10	XLV	1.0125 ± .0040	12	LI	0.9861 ± .0040	12	LV	1.0058 ± .0030	20	LXI	0.9744 ± .0022
14	XLVI	1.0316 ± .0037	14	LII	0.9804 ± .0032	14	LVI	1.0091 ± .0035	-	-	-
15	XLVII	1.0309 ± .0031	-	-	-	16	LVII	1.0092 ± .0025	-	-	-
16	XLVIII	1.0268 ± .0037	-	-	-	18	LVIII	1.0034 ± .0029	-	-	-

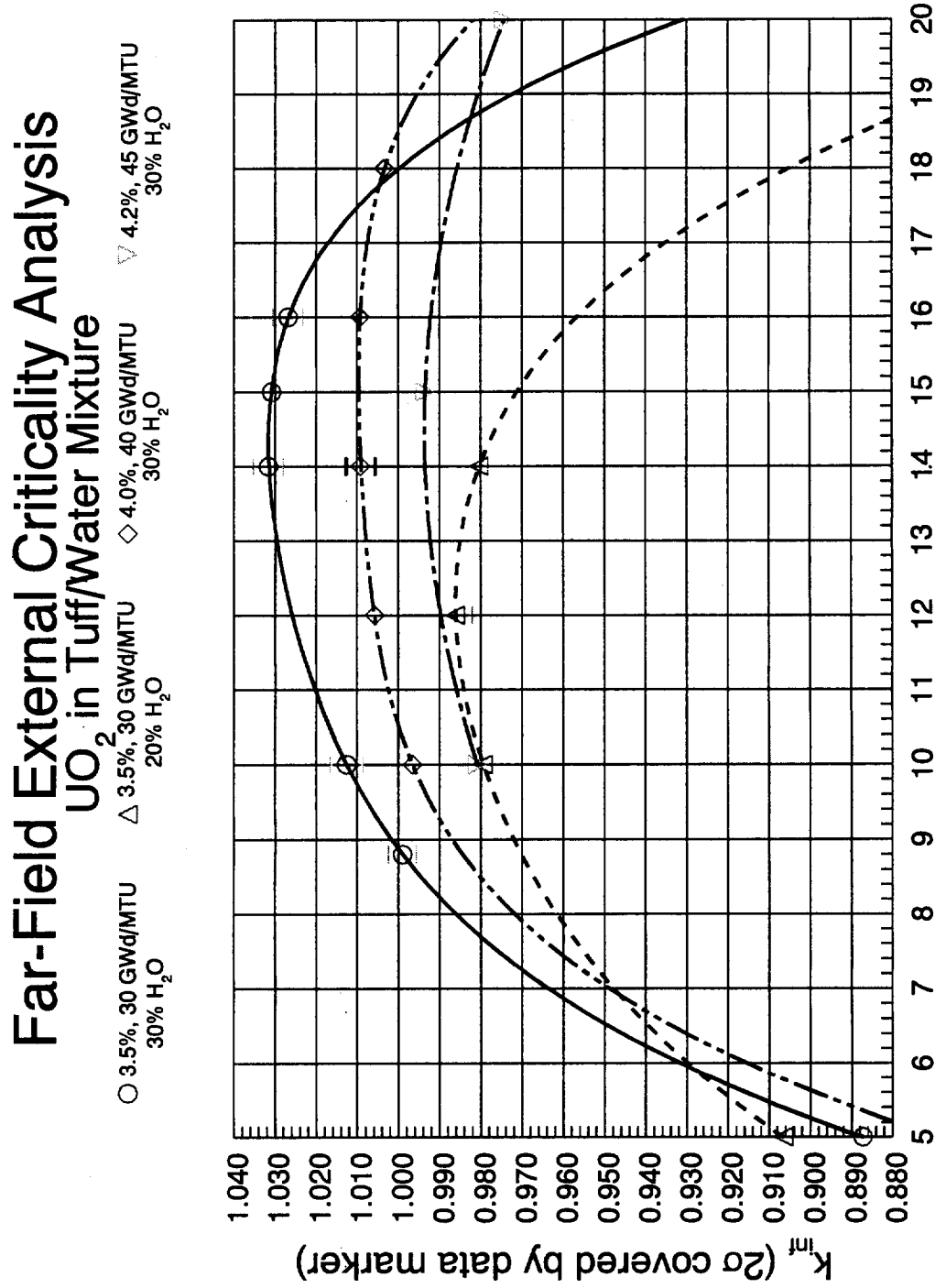

Far-Field External Criticality Analysis
UO_2 in Tuff/Water Mixture
○ 3.5%, 30 GWd/MTU 30% H_2O
△ 3.5%, 30 GWd/MTU 20% H_2O
◇ 4.0%, 40 GWd/MTU 30% H_2O
▽ 4.2%, 45 GWd/MTU 30% H_2O
k_{inf} (2σ covered by data marker)
1.040
1.030
1.020
1.010
1.000
0.990
0.980
0.970
0.960
0.950
0.940
0.930
0.920
0.910
0.900
0.890
0.880
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Volume % UO_2 in Tuff/Water Mixture

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:

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

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

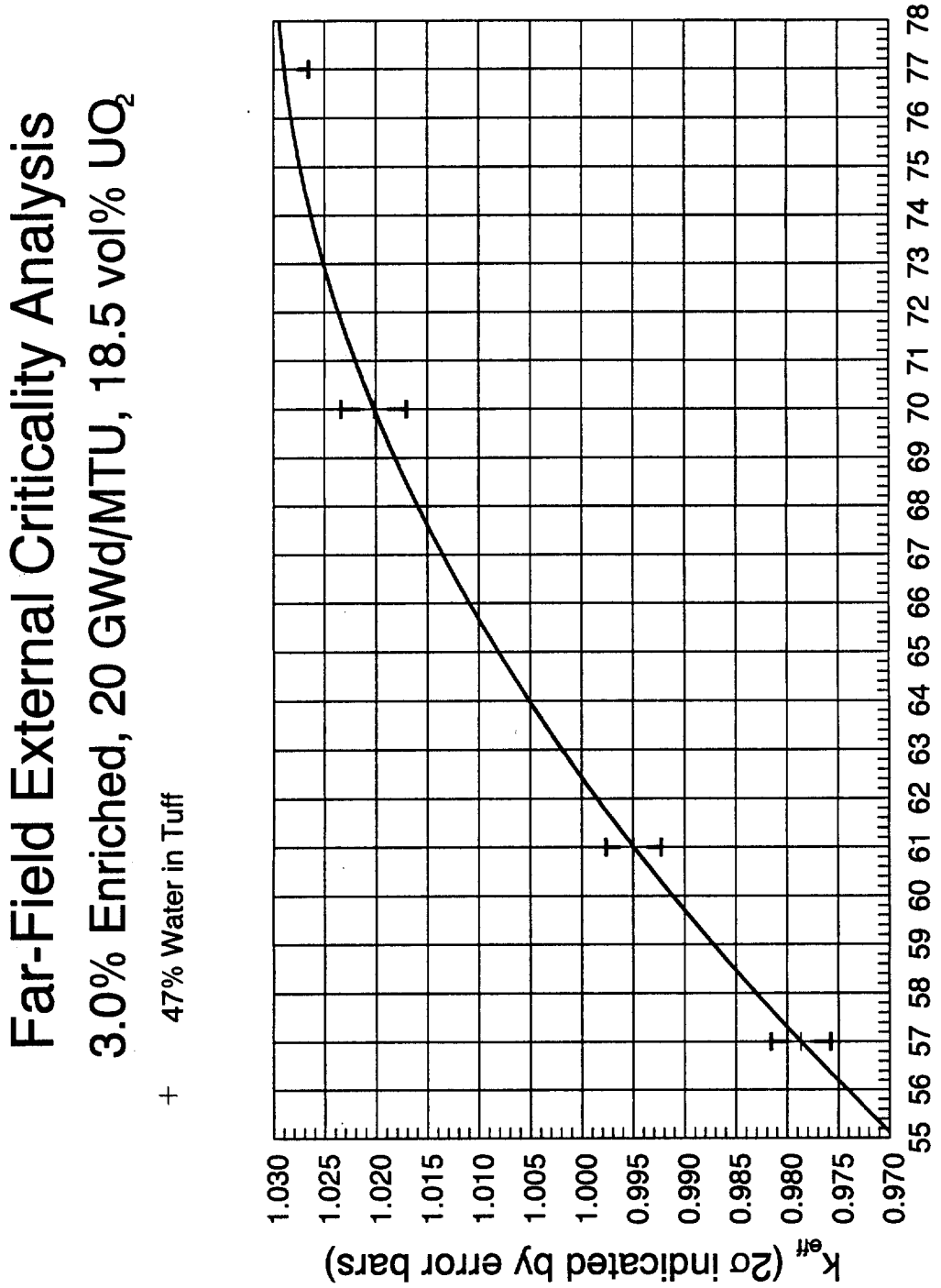

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 18.5 vol% UO_2
+ 47% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
0.970
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78
Sphere Radius (cm)

FIGURE 7.4.2-1

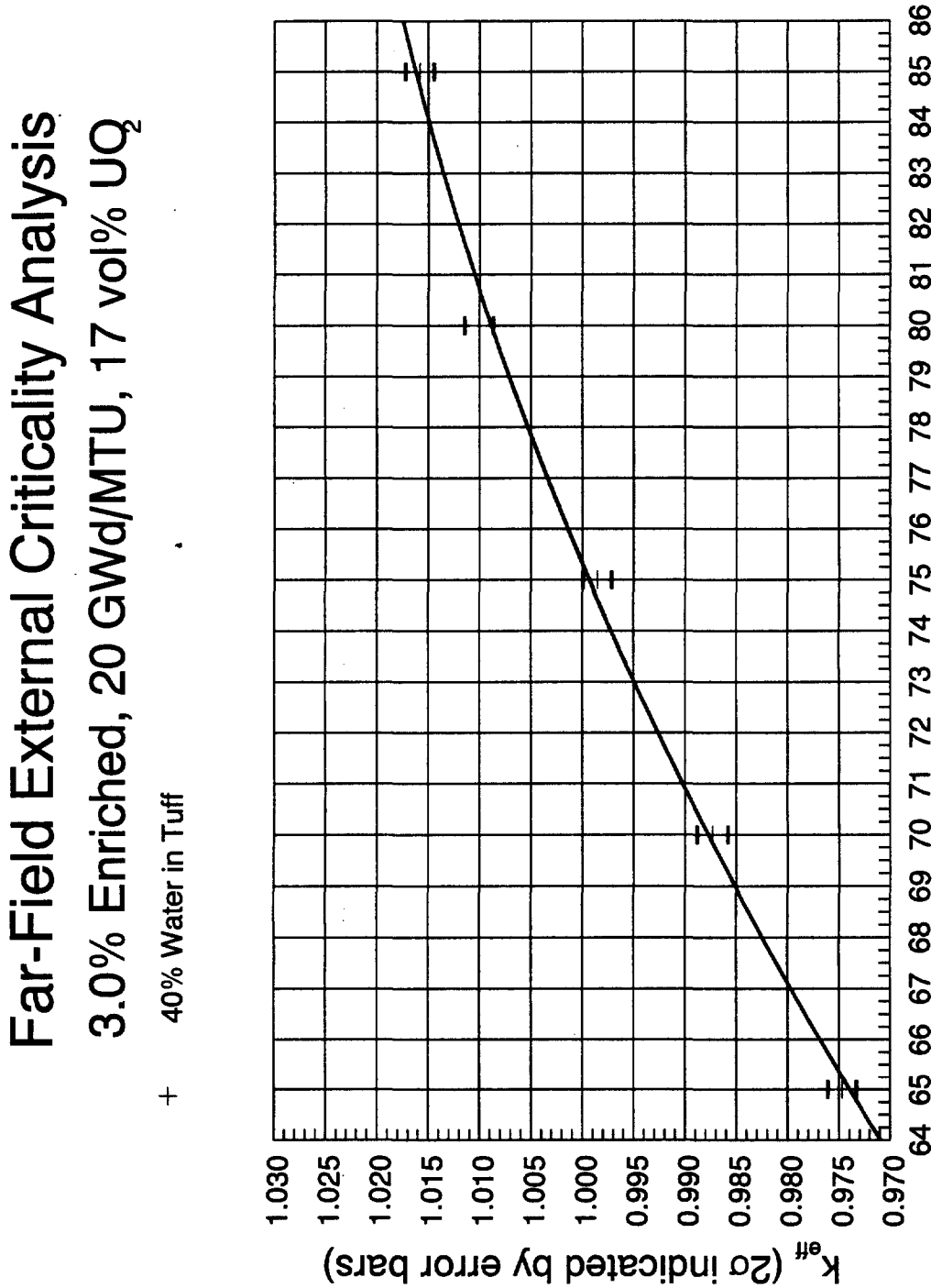

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 17 vol% UO_2
+ 40% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
0.970
64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
Sphere Radius (cm)

FIGURE 7.4.2-2

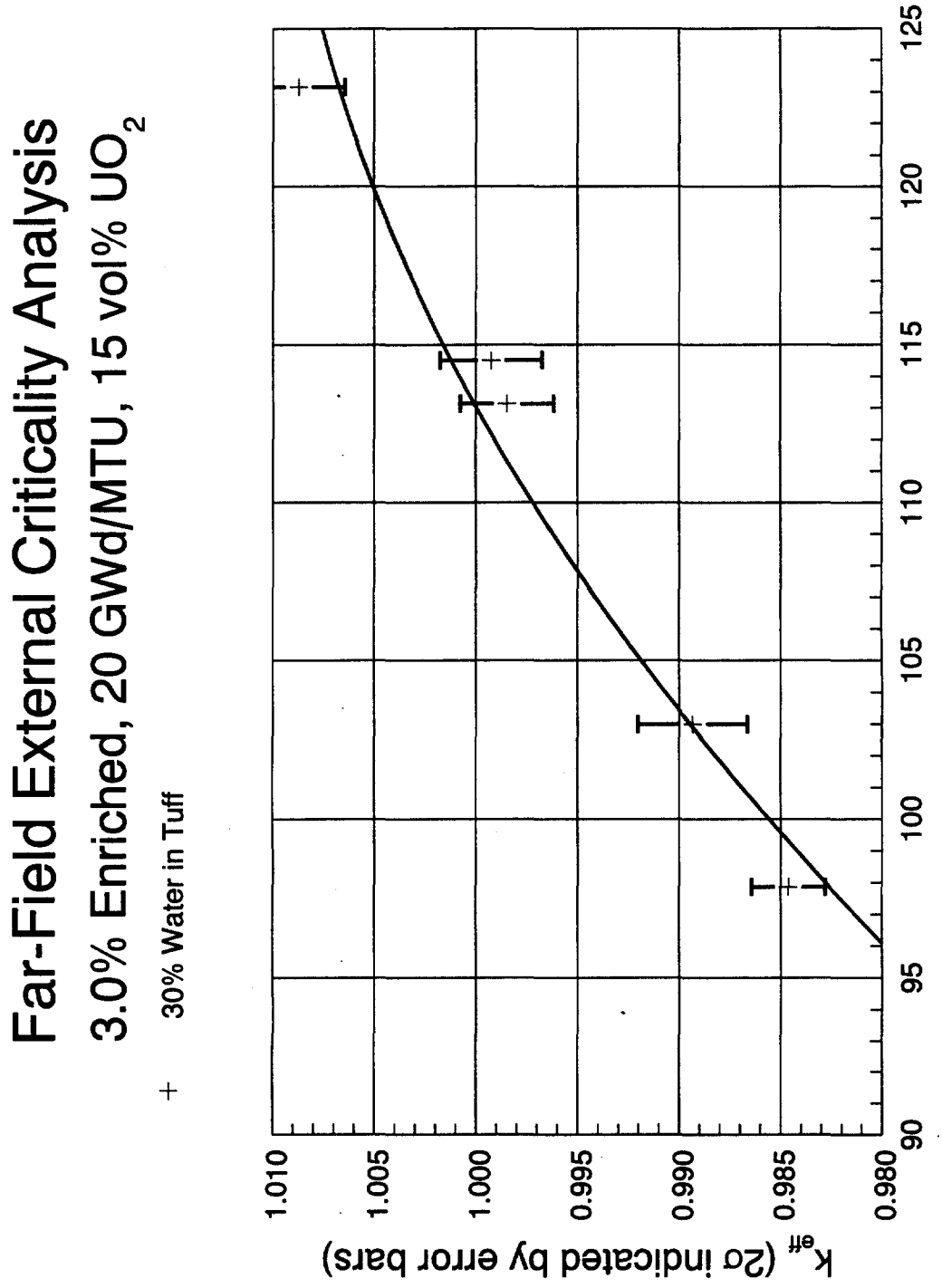

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 15 vol% UO_2
+ 30% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.010
1.005
1.000
0.995
0.990
0.985
0.980
90
95
100
105
110
115
120
125
Sphere Radius (cm)

FIGURE 7.4.2-3

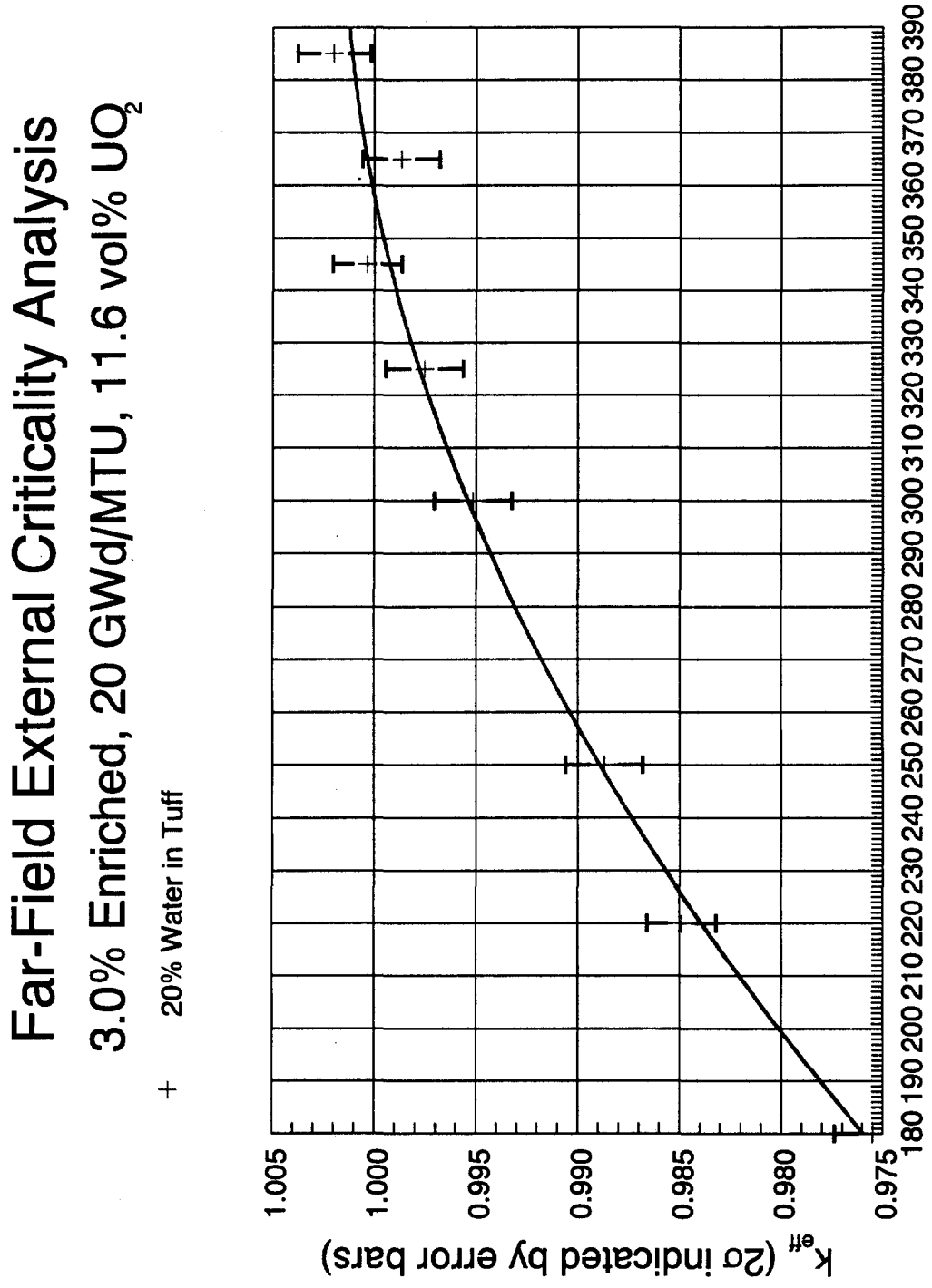

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 11.6 vol% UO2
+ 20% Water in Tuff
k_eff (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
0.975
180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390
Sphere Radius (cm)

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% UO_2. The results are shown in the Table 7.4.2-3 with those for the optimum case at 18.5% UO_2. These results indicate that the optimum UO_2 volume fraction identified in the infinite calculations is applicable to the finite calculations.

Table 7.4.2-3 Confirmation of Optimum UO_2 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 ± .0030
18.5	LXIII	0.9950 ± .0027
20	LXXXVII	0.9925 ± .0031

Multiple k_{eff} cases were also run for each of the optimum UO_2 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 ± .0029	160	XCVII	0.9806 ± .0018
130	LXXXIX	0.9877 ± .0021	187	XCVIII	0.9873 ± .0017
134	XC	0.9901 ± .0025	219.08	IC	0.9943 ± .0019
140	XCI	0.9946 ± .0026	275.35	C	0.9987 ± .0019
150	XCII	0.9971 ± .0030	280	CI	0.9989 ± .0018
151	XCIII	0.9970 ± .0041	284.32	CII	0.9993 ± .0019
152	XCIV	0.9955 ± .0034	293.22	CIII	1.0012 ± .0020
153	XCV	0.9994 ± .0037	310	CIV	1.0017 ± .0017
154.9	XCVI	1.0013 ± .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

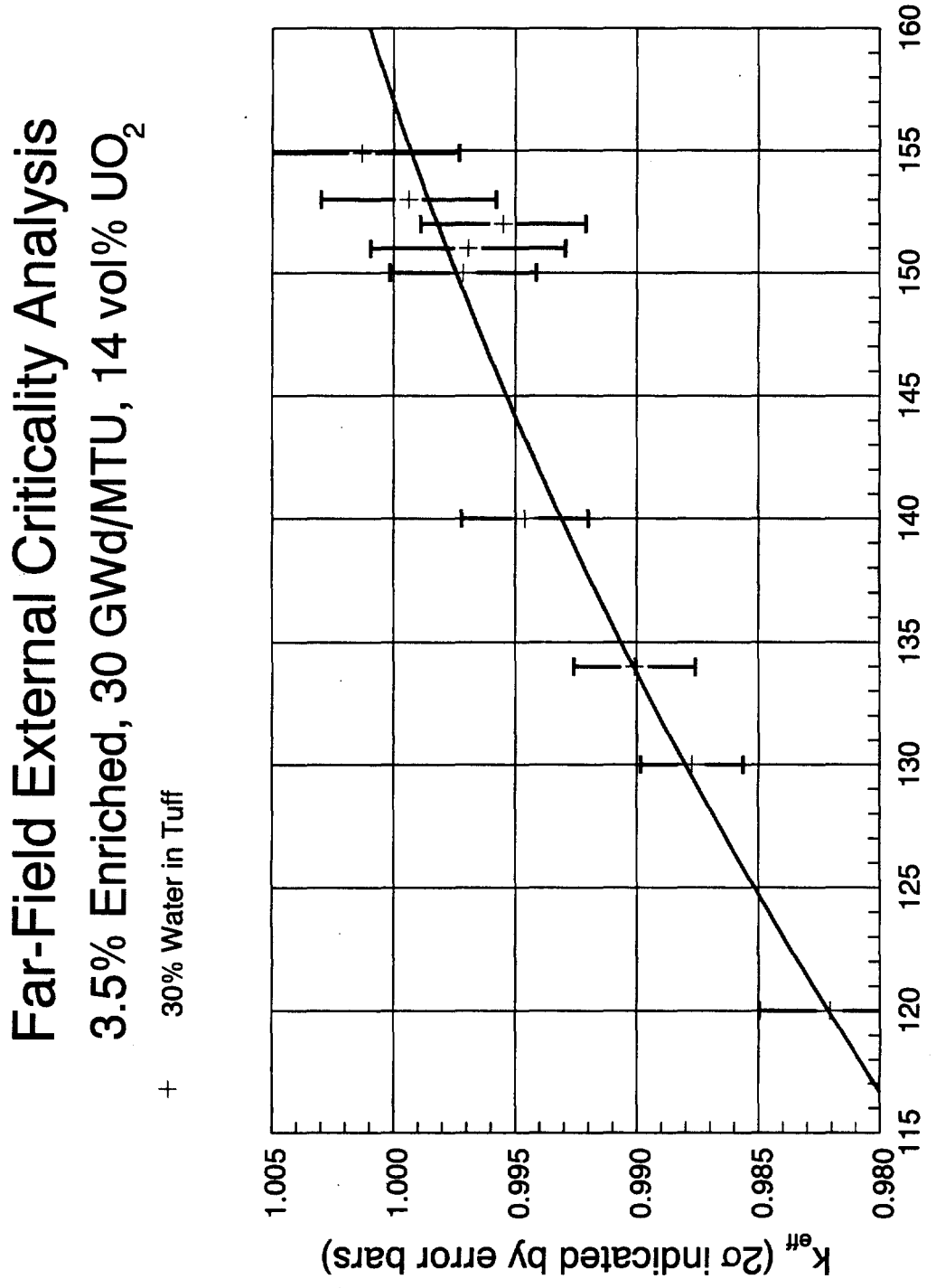

Far-Field External Criticality Analysis
3.5% Enriched, 30 GWd/MTU, 14 vol% UO_2
+ 30% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
115
120
125
130
135
140
145
150
155
160
Sphere Radius (cm)

FIGURE 7.4.2-5

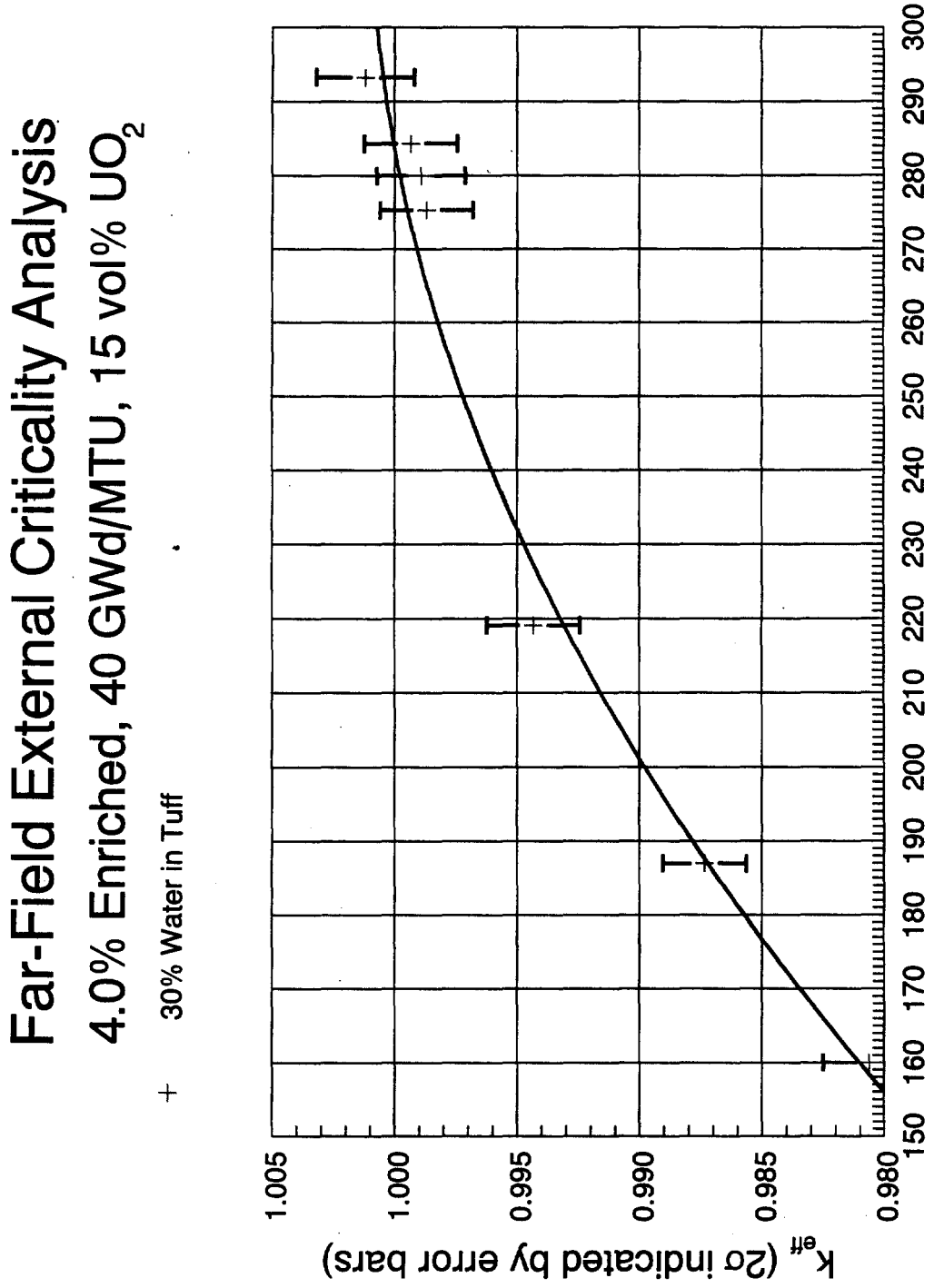

Far-Field External Criticality Analysis
4.0% Enriched, 40 GWd/MTU, 15 vol% UO_2
+ 30% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
Sphere Radius (cm)

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

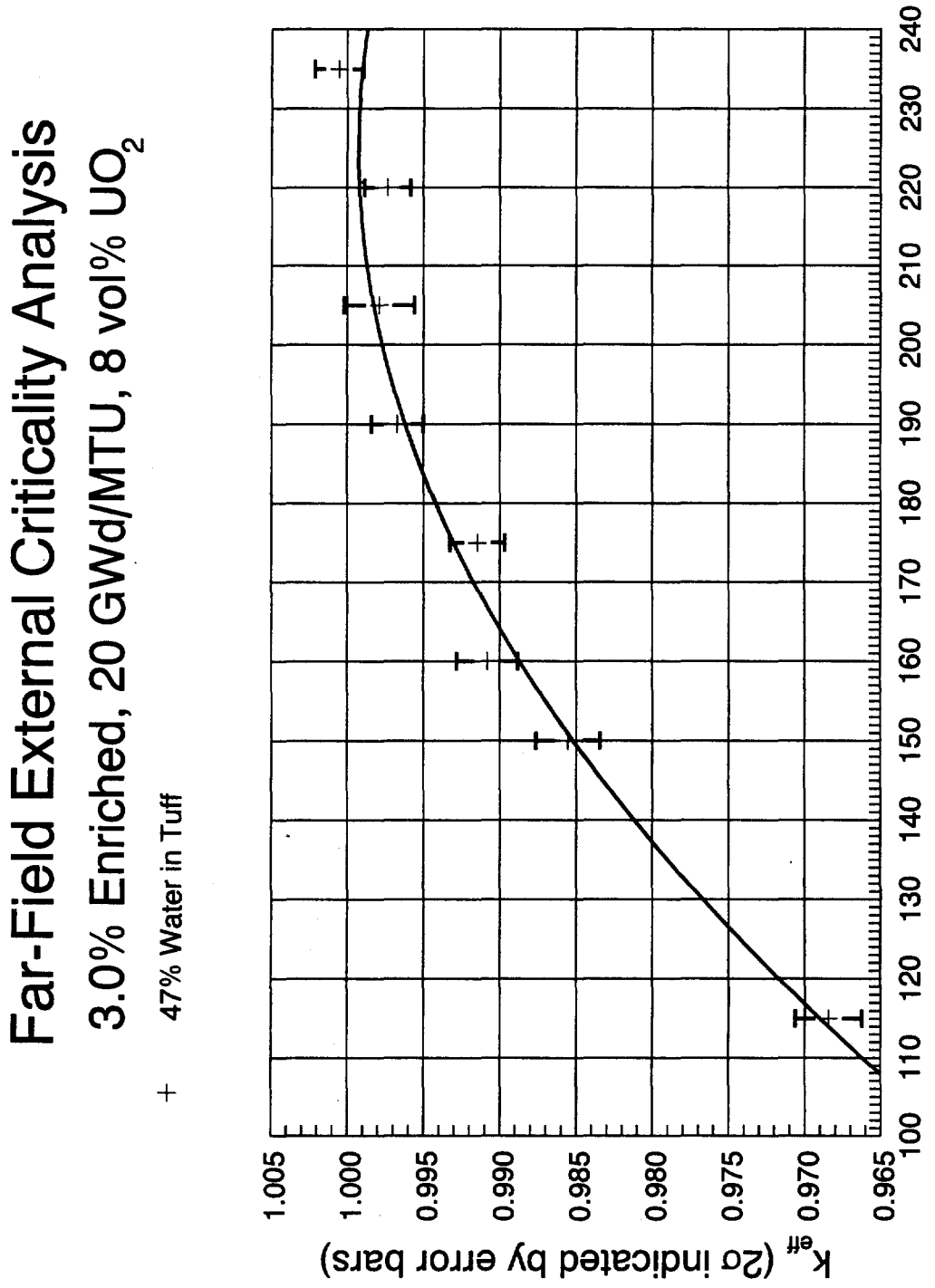

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2
+ 47% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
Sphere Radius (cm)

FIGURE 7.4.3-1

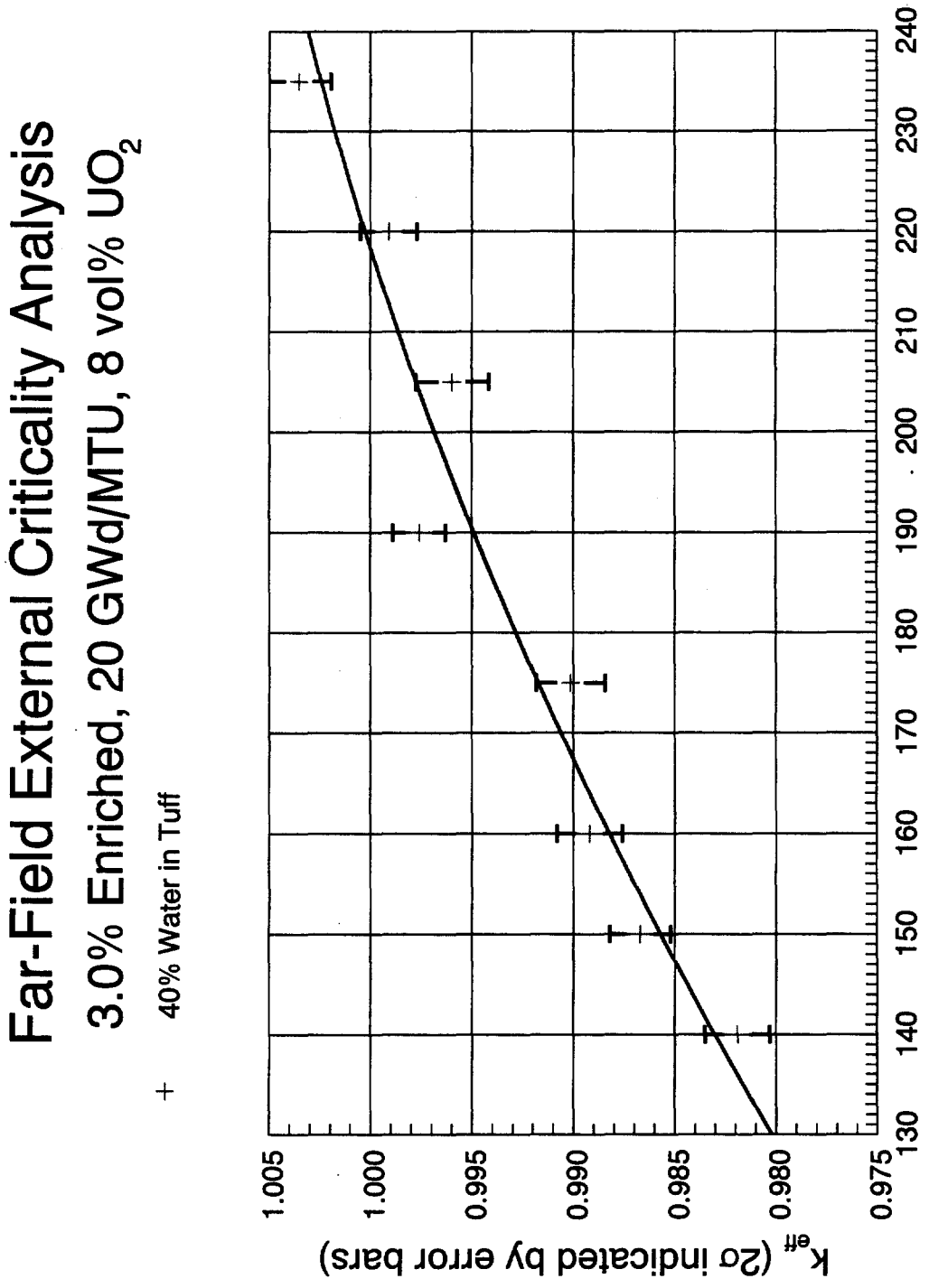

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2
+ 40% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
0.975
130
140
150
160
170
180
190
200
210
220
230
240
Sphere Radius (cm)

FIGURE 7.4.3-2

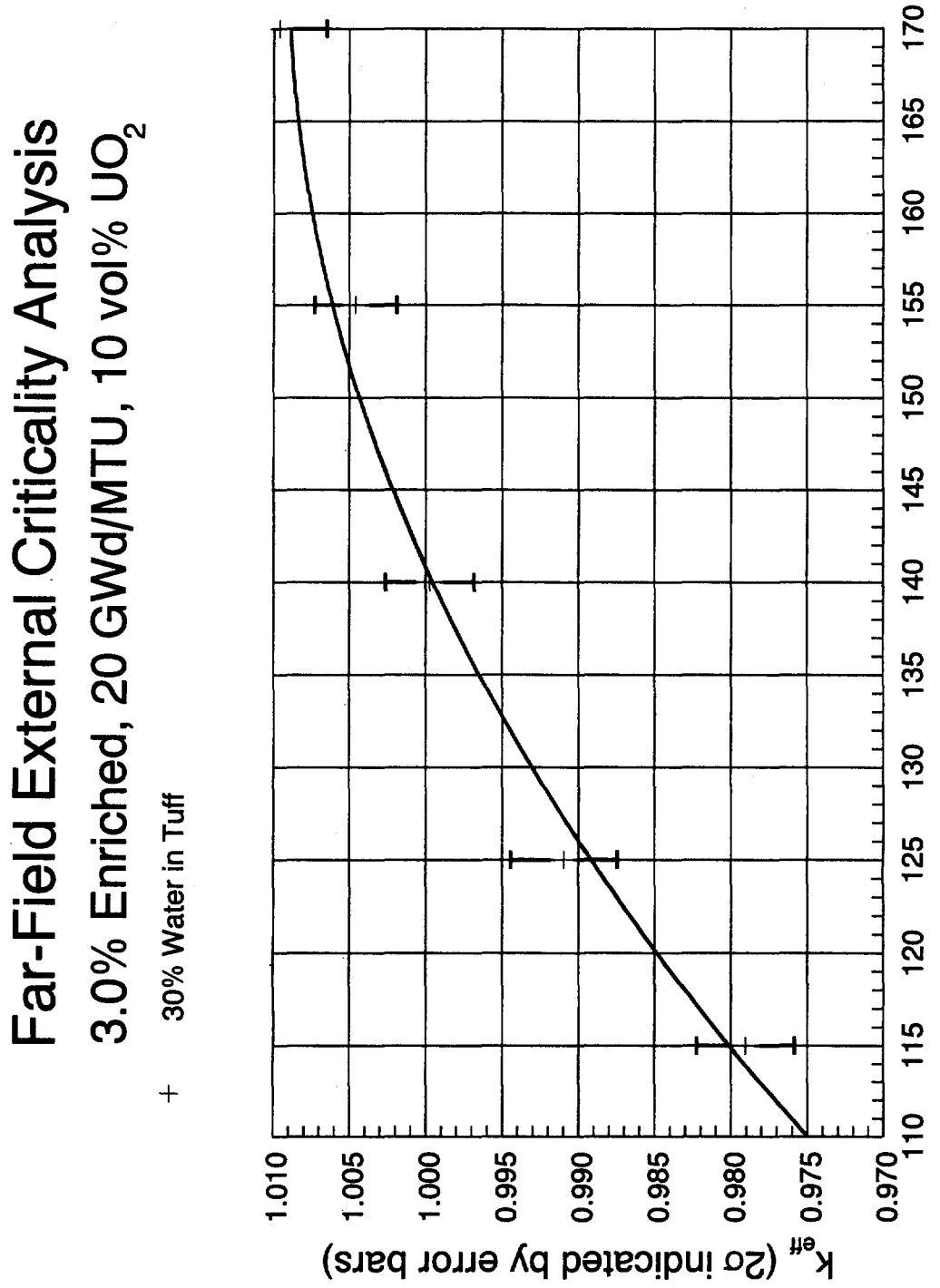

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 10 vol% UO_2
+ 30% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
0.970
110
115
120
125
130
135
140
145
150
155
160
165
170
Sphere Radius (cm)

FIGURE 7.4.3-3

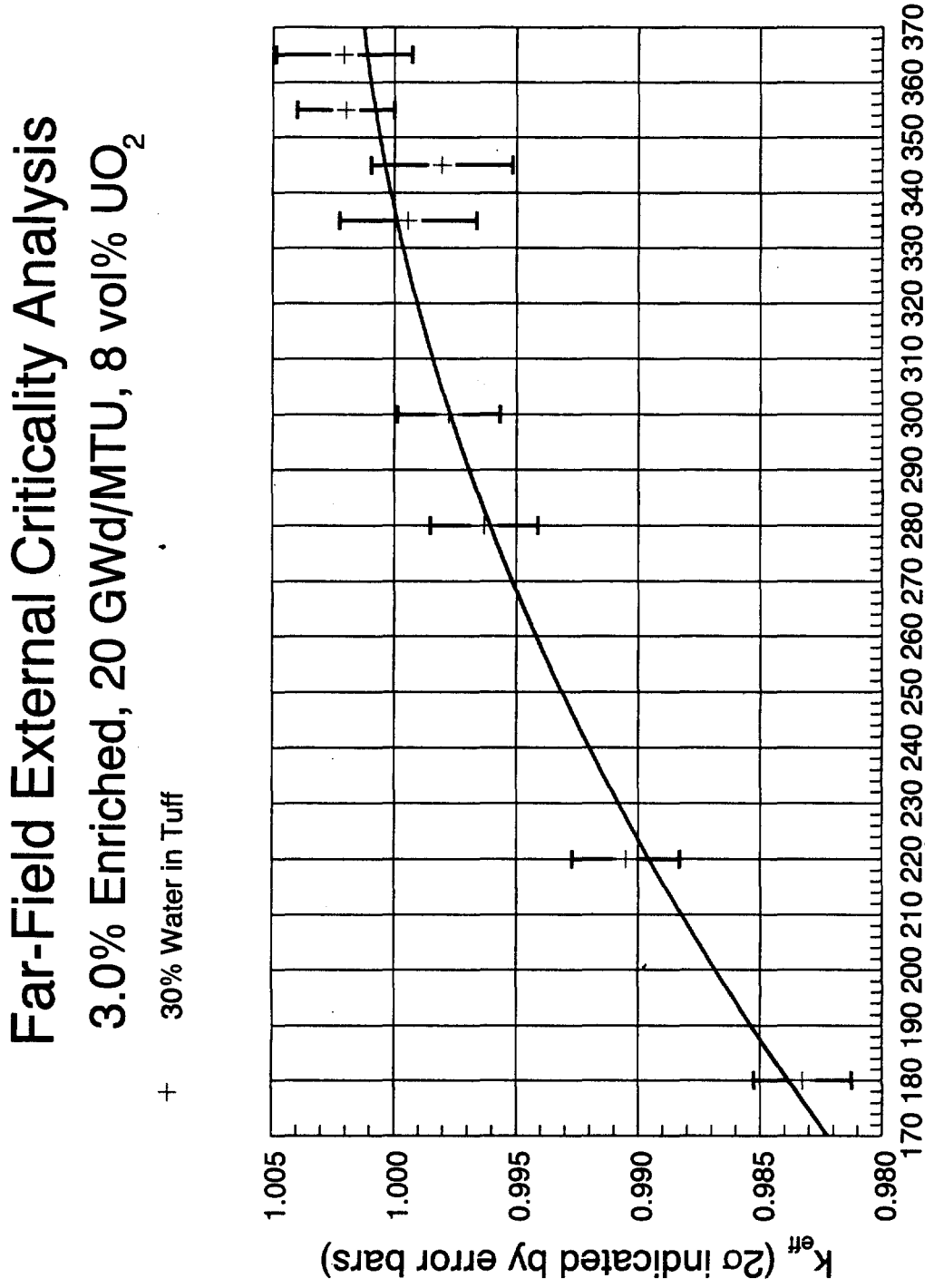

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 8 vol% UO_2
+ 30% Water in Tuff
k_{eff} (2σ indicated by error bars)
1.005
1.000
0.995
0.990
0.985
0.980
170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370
Sphere Radius (cm)

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 UO_2-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 UO_2-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 UO_2-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% UO_2 - NpO_2 92% Tuff-Water 47% Tuff Porosity				
Water %	Att. #	$K_\infty \pm 2\sigma$	Att. #	$K_{eff} \pm 2\sigma$
47	CXXXIV	1.01025 ± .0018	CXLI	.98706 ± .0013
40	CXXXV	1.02854 ± .0018	CXLII	.99684 ± .0014
35	CXXXVI	1.03566 ± .0019	CXLIII	1.00242 ± .0015
30	CXXXVII	1.04272 ± .0019	CXLIV	1.00163 ± .0016
25	CXXXVIII	1.04320 ± .0020	CXLV	.99189 ± .0016
20	CXXXIX	1.03318 ± .0022	CXLVI	.97117 ± .0016
15	CXL	1.00676 ± .0022	CXLVII	.93067 ± .0018

Figures 7.4.1-1 and 7.4.3-1 indicate that 8% UO_2-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.

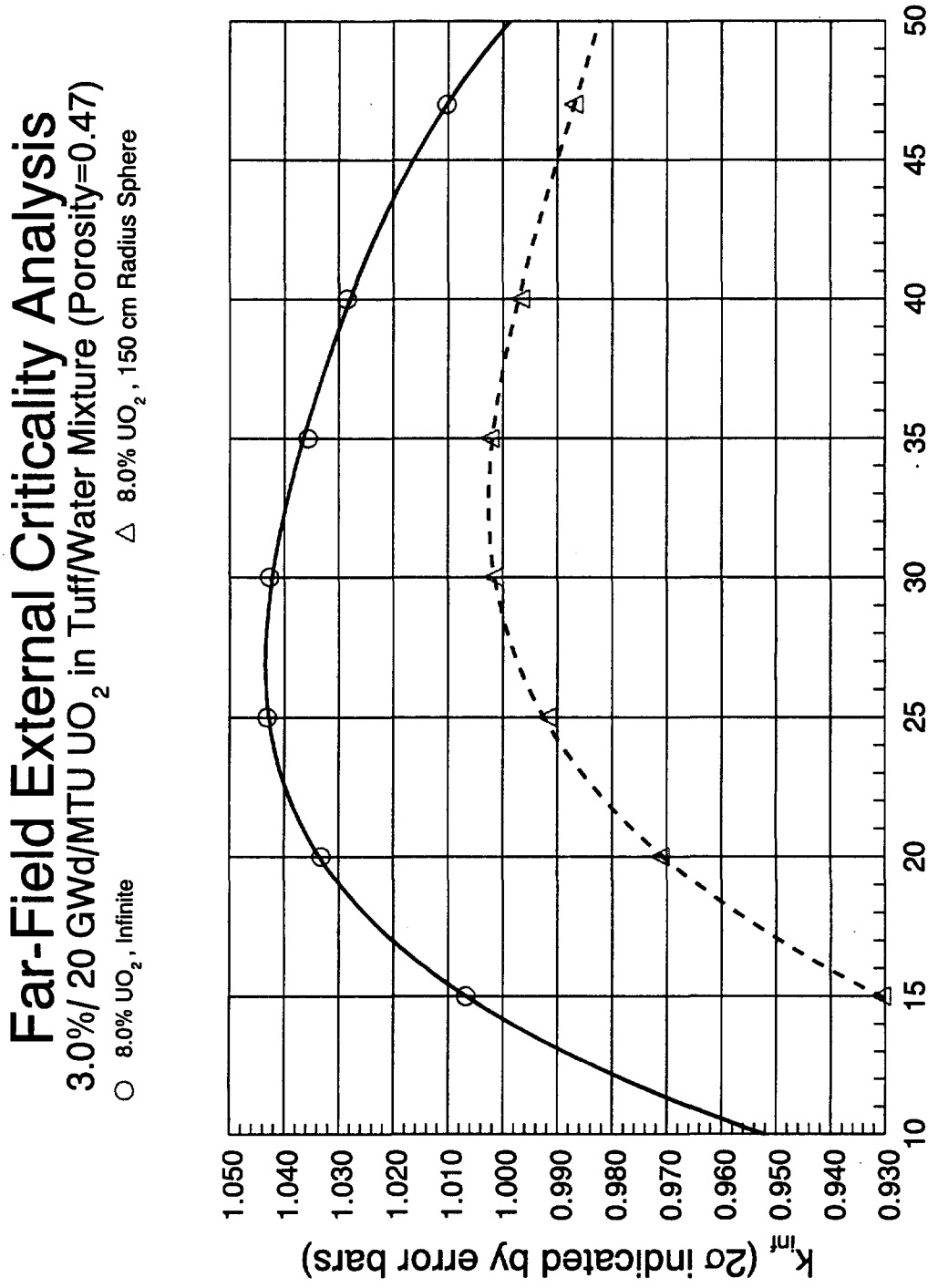

Far-Field External Criticality Analysis
3.0%/ 20 GWd/MTU UO_2 in Tuff/Water Mixture (Porosity=0.47)
○ 8.0% UO_2, Infinite
△ 8.0% UO_2, 150 cm Radius Sphere
k_{inf} (2σ indicated by error bars)
1.050
1.040
1.030
1.020
1.010
1.000
0.990
0.980
0.970
0.960
0.950
0.940
0.930
10
15
20
25
30
35
40
45
50
Volume % Water in Tuff/Water Mixture

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

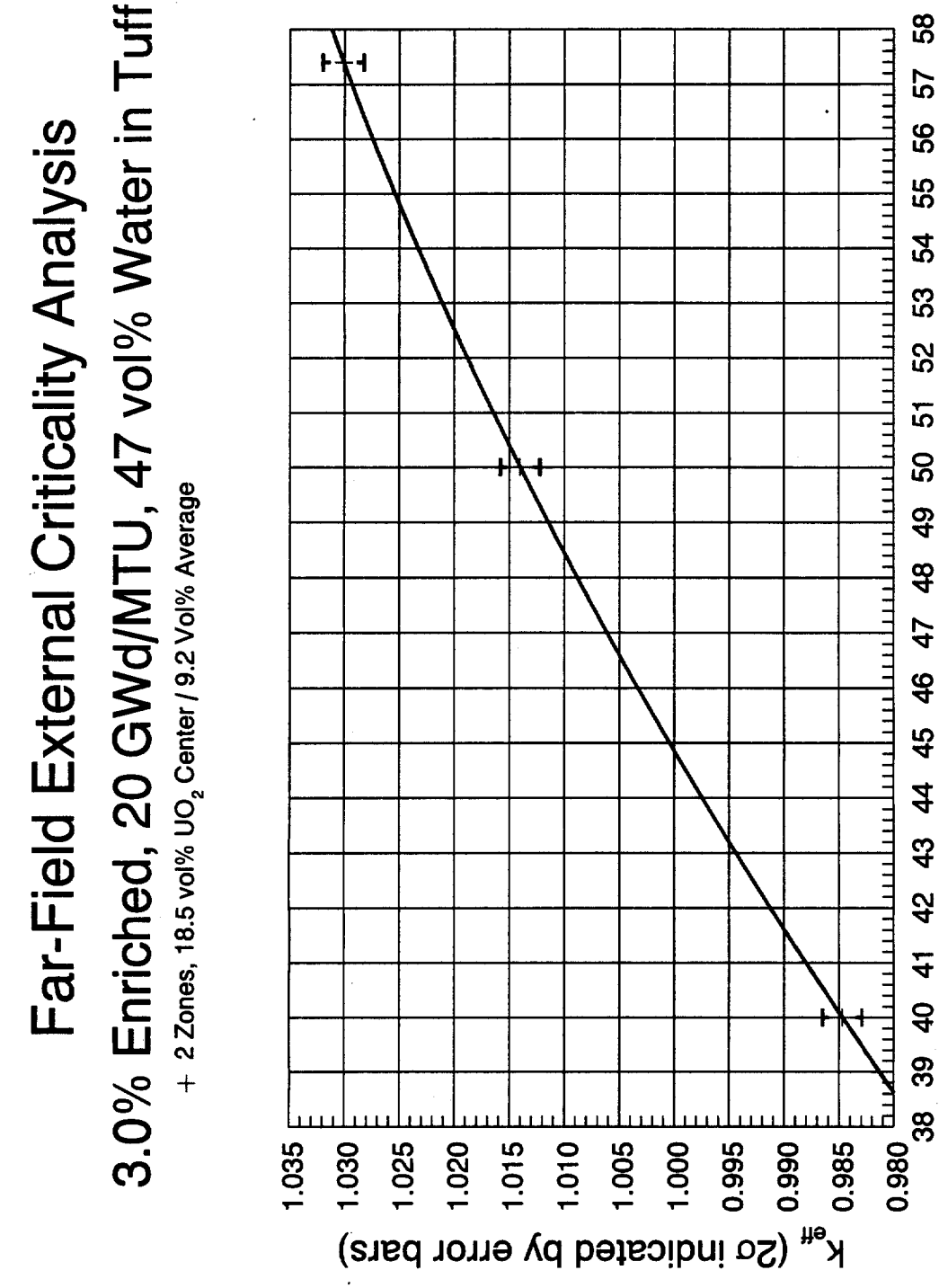

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 47 vol% Water in Tuff
+ 2 Zones, 18.5 vol% UO_2 Center / 9.2 Vol% Average
k_{eff} (2σ indicated by error bars)
1.035
1.030
1.025
1.020
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
Sphere Radius (cm)

FIGURE 7.4.5-1

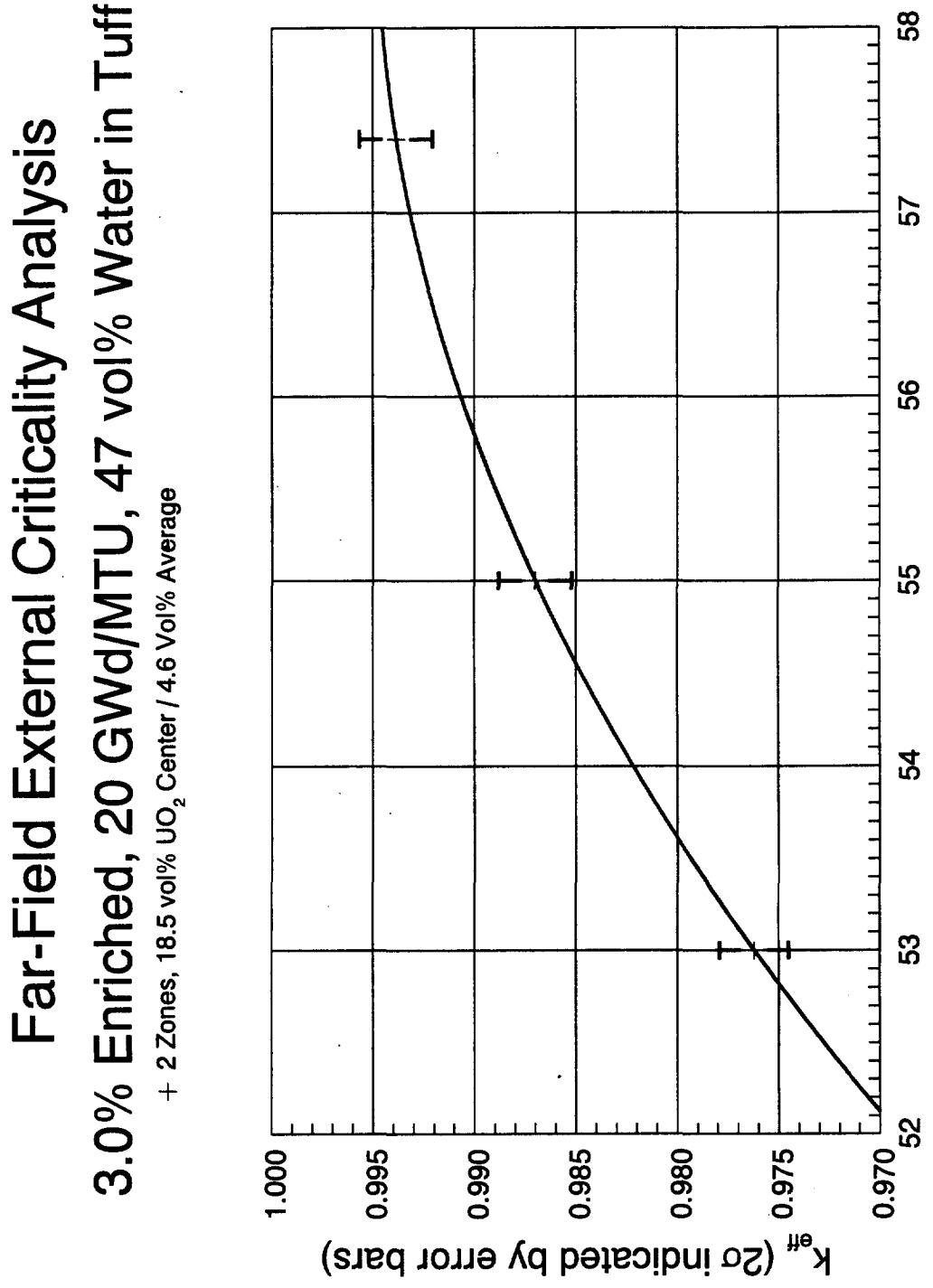

Far-Field External Criticality Analysis
3.0% Enriched, 20 GWd/MTU, 47 vol% Water in Tuff
+ 2 Zones, 18.5 vol% UO2 Center / 4.6 Vol% Average
1.000
0.995
0.990
0.985
0.980
0.975
0.970
52
53
54
55
56
57
58
Sphere Radius (cm)
keff (2σ indicated by error bars)

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 ± .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 (bias and uncertainty) - 2σ} 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 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 ρ=2.028 g/cm^3

8 vol% UO_2 / 43.2 vol% water - R=140 cm, UO_2 mass=10.1, UO_2 ρ=0.877 g/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 7.2 vol% / 0.789 g/cm^3

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 ρ=1.863 g/cm^3

8 vol% UO_2 / 36.8 vol% water - R=140 cm, UO_2 mass=10.1, UO_2 ρ=0.877 g/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 7.1 vol% / 0.778 g/cm^3

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/cm^3

10 vol% UO_2 / 27.0 vol% water - R=117 cm, UO_2 mass=7.4 MT, UO_2 ρ=1.096 g/cm^3

8 vol% UO_2 / 27.6 vol% water - R=170 cm, UO_2 mass=18.0 MT, UO_2 ρ=0.877 g/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 7.0 vol% / 0.767 g/cm^3

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/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 7.2 vol% / 0.789 g/cm^3

$\leq$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=11.1MT, UO_2 ρ=1.534 g/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 7.6 vol% / 0.833 g/cm^3

$\leq$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/cm^3

Minimum UO_2 vol%/density for criticality (k_∞ =.982) - 8.6 vol% / 0.943 g/cm^3

$\leq$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% UO_2 (i3020md.sum), 6/5/96, 1 page
X. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2 (i3020mf.sum), 5/21/96, 1 page
XI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 10% UO_2 (i3020me.sum), 5/21/96, 1 page
XII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 15% UO_2 (i3020ma.sum), 5/21/96, 1 page
XIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 20% UO_2 (i3020mb.sum), 5/21/96, 1 page
XIV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 25% UO_2 (i3020mc.sum), 5/21/96, 1 page
XV. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 5% UO_2 (i3020oa.sum), 5/21/96, 1 page
XVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 8% UO_2 (i3020ob.sum), 5/21/96, 1 page
XVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 10% UO_2 (i3020oc.sum), 5/21/96, 1 page
XVIII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 15% UO_2 (i3020od.sum), 5/21/96, 1 page
XIX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 20% UO_2 (i3020oe.sum), 5/21/96, 1 page
XX. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 40% Water, 25% UO_2 (i3020of.sum), 5/21/96, 1 page
XXI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 5% UO_2 (I1-3.0E-20GWd-30W05U), 5/20/96, 2 pages
XXII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 30% Water, 10% UO_2

(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% UO_2, r=61 (s3020mi.sum), 6/6/96, 2 pages

LXXXVIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=120 (s3530i.sum), 5/24/96, 2 pages

LXXXIX. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=130 (s3530h.sum), 5/24/96, 2 pages

XC. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=134 (s3530g.sum), 5/24/96, 2 pages

XCI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=140 (s3530f.sum), 5/23/96, 2 pages

XCII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=150 (s3530b.sum), 5/24/96, 2 pages

XCIII. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=151 (s3530c.sum), 5/23/96, 2 pages

XCIV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=152 (s3530d.sum), 5/23/96, 2 pages

XCV. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=153 (s3530e.sum), 5/23/96, 2 pages

XCVI. MCNP Case - 3.5% Enrichment, 30 GWd/MTU, 30% Water, 14% UO_2, r=154.9 (s3530a.sum), 5/23/96, 2 pages

XCVII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO_2, r=160 (C1-4.0E-40GWd-30W15U), 5/21/96, 2 pages

XCVIII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO_2, r=187 (C2-4.0E-40GWd-30W15U), 5/20/96, 2 pages

IC. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO_2, 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% UO_2, 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% UO_2, r=280 (C5-4.0E-40GWd-30W15U), 5/21/96, 2 pages

CII. MCNP Case - 4.0% Enrichment, 40 GWd/MTU, 30% Water, 15% UO_2, 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% UO_2, 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% UO_2, 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% UO_2, r=115 (s3020nh.sum), 5/24/96, 2 pages

CVI. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2, r=150 (s3020ni.sum), 5/24/96, 2 pages

CVII. MCNP Case - 3.0% Enrichment, 20 GWd/MTU, 47% Water, 8% UO_2, 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

CXXIX. 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

UO_2, 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 UO_2, 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 UO_2, 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 UO_2, 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 UO_2, 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% UO_2, 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	3.555654E-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	6.533880E-03	8.253808E-03	8.810386E-03	9.018534E-03	1.012049E-02
U238	9.744020E-01	9.723868E-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

	Nominal				
Tuff Density (g/cc)	1.746				
Tuff Porosity	0.306		Renormalized		
Tuff Composition	Weight fractions	Minerals used	Wt. Fractions		Atomic Wts (g/mole)
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	0.006665939341043	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				0.35	12.01115
	1.0073	0.9166	1.000	1	

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
'
```

```
' - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
'
'  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=1280 down=1826.25
  end
end
```

1

sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp actinides page 6

power= 7.25mw, burnup= 1160.mwd, flux= 1.76E+13n/cm**2-sec

0 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

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

sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp actinides page 7
power= 7.25mw, burnup= 1160.mwd, flux= 1.76E+13n/cm**2-sec
0 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
0 flux		1.78E+13	1.77E+13	1.75E+13	1.74E+13	1.74E-02

0

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sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp actinides page 41
power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec
0 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

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sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp actinides page 42
power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec

0 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	3.88E-05	4.23E-05	4.59E-05

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

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sas2h: babcock wilcox 15x15, 3.00wt%, 20gwd/mtu burn high temp actinides page 47

decay, following reactor irradiation identified by: power= 7.25mw, burnup= 9280.mwd, flux= 1.70E+13n/cm**2-sec

0 nuclide concentrations, gram atoms

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	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

cm244	7.51E-03	7.30E-03	7.07E-03	6.84E-03	6.63E-03	6.42E-03	6.22E-03
cm245	1.83E-04	1.83E-04	1.83E-04	1.83E-04	1.83E-04	1.83E-04	1.83E-04
cm246	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05
total	1.91E+03	1.91E+03	1.91E+03	1.91E+03	1.91E+03	1.91E+03	1.91E+03

```
 =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 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=1920 down=1826.25
   end
end
```


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

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

sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp actinides page 41
power= 7.25mw, burnup= 13920.mwd, flux= 1.51E+13n/cm**2-sec
0 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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sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp actinides page 42
power= 7.25mw, burnup= 13920.mwd, flux= 1.51E+13n/cm**2-sec

0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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

bk249	4.71E-10	6.61E-10	9.17E-10	1.26E-09	1.71E-09
bk250	1.12E-13	2.25E-13	3.14E-13	4.34E-13	5.94E-13
bk251	6.50E-19	3.03E-18	4.27E-18	5.95E-18	8.19E-18
cf249	1.08E-10	1.55E-10	2.20E-10	3.08E-10	4.26E-10
cf250	5.76E-11	8.27E-11	1.17E-10	1.64E-10	2.26E-10
cf251	3.23E-11	4.72E-11	6.81E-11	9.68E-11	1.36E-10
cf252	1.17E-11	1.79E-11	2.69E-11	3.98E-11	5.80E-11
cf253	1.01E-14	1.57E-14	2.39E-14	3.57E-14	5.28E-14
cf254	4.20E-18	6.67E-18	1.04E-17	1.59E-17	2.39E-17
cf255	1.93E-22	6.45E-22	1.01E-21	1.56E-21	2.36E-21
totals	1.90E+03	1.89E+03	1.89E+03	1.89E+03	1.89E+03
0 flux		1.60E+13	1.61E+13	1.62E+13	1.63E+13

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sas2h: babcock wilcox 15x15, 3.50wt%, 30gwd/mtu burn high temp actinides page 47
decay, following reactor irradiation identified by: power= 7.25mw, burnup= 13920.mwd, flux= 1.51E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
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	6.00E-02	8.09E-02	8.96E-02	9.50E-02	9.96E-02	1.04E-01	1.08E-01
th230	3.92E-06	4.79E-06	5.66E-06	6.54E-06	7.42E-06	8.31E-06	9.20E-06
th232	7.63E-07	9.66E-07	1.17E-06	1.37E-06	1.57E-06	1.78E-06	1.98E-06
pa231	2.48E-06	2.50E-06	2.52E-06	2.54E-06	2.56E-06	2.58E-06	2.60E-06
u232	1.05E-06	1.25E-06	1.40E-06	1.52E-06	1.62E-06	1.70E-06	1.76E-06
u233	4.90E-06	5.15E-06	5.40E-06	5.66E-06	5.91E-06	6.17E-06	6.42E-06
u234	3.69E-01	3.71E-01	3.72E-01	3.74E-01	3.76E-01	3.78E-01	3.80E-01
u235	2.38E+01	2.38E+01	2.38E+01	2.38E+01	2.38E+01	2.38E+01	2.38E+01
u236	8.23E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00	8.23E+00
u238	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03
np236	1.12E-06	1.12E-06	1.12E-06	1.12E-06	1.12E-06	1.12E-06	1.12E-06
np237	8.27E-01	8.36E-01	8.36E-01	8.37E-01	8.38E-01	8.38E-01	8.39E-01
pu238	2.77E-01	2.93E-01	2.95E-01	2.95E-01	2.93E-01	2.91E-01	2.90E-01
pu239	1.18E+01	1.19E+01	1.19E+01	1.19E+01	1.19E+01	1.19E+01	1.19E+01
pu240	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00
pu241	2.40E+00	2.31E+00	2.22E+00	2.13E+00	2.05E+00	1.96E+00	1.89E+00
pu242	7.08E-01	7.08E-01	7.08E-01	7.08E-01	7.08E-01	7.08E-01	7.08E-01
am241	1.47E-01	2.42E-01	3.32E-01	4.19E-01	5.03E-01	5.83E-01	6.59E-01
am242m	3.14E-03	3.12E-03	3.11E-03	3.10E-03	3.09E-03	3.07E-03	3.06E-03
am243	1.40E-01	1.40E-01	1.40E-01	1.40E-01	1.40E-01	1.40E-01	1.40E-01
cm242	2.32E-02	6.40E-03	1.76E-03	4.88E-04	1.40E-04	4.40E-05	1.79E-05
cm243	5.72E-04	5.61E-04	5.49E-04	5.38E-04	5.28E-04	5.17E-04	5.07E-04
cm244	3.45E-02	3.35E-02	3.24E-02	3.14E-02	3.04E-02	2.95E-02	2.85E-02
cm245	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03
cm246	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04
cm247	1.77E-06	1.77E-06	1.77E-06	1.77E-06	1.77E-06	1.77E-06	1.77E-06
total	1.89E+03	1.89E+03	1.89E+03	1.89E+03	1.89E+03	1.89E+03	1.89E+03

```
=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
```

1

sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp actinides page 6
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

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 actinides page 41

power= 7.25mw, burnup= 18560.mwd, flux= 1.38E+13n/cm**2-sec

0 nuclide concentrations, gram atoms

basis = single reactor assembly

	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 actinides page 42
power= 7.25mw, burnup= 18560.mwd, flux= 1.38E+13n/cm**2-sec

0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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

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     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
0    flux              1.52E+13  1.53E+13  1.55E+13  1.56E+13
0
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     sas2h: babcock wilcox 15x15, 4.00wt%, 40gwd/mtu burn high temp                    actinides        page   49
 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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pb208	3.60E-06	5.65E-06	8.34E-06	1.16E-05	1.55E-05	1.98E-05	2.45E-05
th228	6.27E-06	8.61E-06	1.09E-05	1.30E-05	1.48E-05	1.65E-05	1.79E-05
th230	1.08E-03	1.29E-03	1.49E-03	1.70E-03	1.91E-03	2.12E-03	2.34E-03
th232	3.01E-04	3.60E-04	4.19E-04	4.78E-04	5.37E-04	5.96E-04	6.55E-04
th234	6.26E-06	6.26E-06	6.26E-06	6.26E-06	6.26E-06	6.26E-06	6.26E-06
pa231	9.16E-04	9.22E-04	9.26E-04	9.30E-04	9.34E-04	9.38E-04	9.42E-04
pa233	9.92E-06	9.81E-06	9.81E-06	9.82E-06	9.82E-06	9.83E-06	9.84E-06
u232	5.21E-04	6.05E-04	6.72E-04	7.25E-04	7.68E-04	8.01E-04	8.27E-04
u233	1.49E-03	1.57E-03	1.66E-03	1.75E-03	1.83E-03	1.92E-03	2.00E-03
u234	8.82E+01	8.90E+01	8.99E+01	9.07E+01	9.16E+01	9.24E+01	9.33E+01
u235	4.99E+03	4.99E+03	4.99E+03	4.99E+03	4.99E+03	4.99E+03	4.99E+03
u236	2.43E+03	2.43E+03	2.43E+03	2.43E+03	2.43E+03	2.43E+03	2.43E+03
u237	2.49E+00	2.15E-05	2.06E-05	1.98E-05	1.90E-05	1.83E-05	1.75E-05
u238	4.31E+05	4.31E+05	4.31E+05	4.31E+05	4.31E+05	4.31E+05	4.31E+05
np236	5.48E-04	5.48E-04	5.48E-04	5.48E-04	5.48E-04	5.48E-04	5.48E-04
np237	2.86E+02	2.89E+02	2.89E+02	2.89E+02	2.89E+02	2.89E+02	2.90E+02
np239	1.84E+01	5.84E-05	5.84E-05	5.84E-05	5.84E-05	5.84E-05	5.84E-05
pu236	4.96E-04	4.07E-04	3.34E-04	2.73E-04	2.24E-04	1.84E-04	1.50E-04
pu238	1.26E+02	1.32E+02	1.33E+02	1.33E+02	1.32E+02	1.31E+02	1.30E+02
pu239	3.08E+03	3.10E+03	3.10E+03	3.10E+03	3.10E+03	3.10E+03	3.10E+03
pu240	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.21E+03	1.21E+03	1.21E+03
pu241	7.37E+02	7.08E+02	6.80E+02	6.53E+02	6.27E+02	6.03E+02	5.79E+02
pu242	2.73E+02	2.73E+02	2.73E+02	2.73E+02	2.73E+02	2.73E+02	2.73E+02
am241	5.51E+01	8.41E+01	1.12E+02	1.39E+02	1.64E+02	1.89E+02	2.12E+02
am242m	1.25E+00	1.24E+00	1.24E+00	1.23E+00	1.23E+00	1.22E+00	1.22E+00
am242	5.45E-02	1.61E-05	1.60E-05	1.59E-05	1.59E-05	1.58E-05	1.57E-05
am243	6.79E+01	6.79E+01	6.79E+01	6.79E+01	6.79E+01	6.79E+01	6.79E+01
cm242	9.22E+00	2.54E+00	6.99E-01	1.94E-01	5.54E-02	1.75E-02	7.10E-03
cm243	2.89E-01	2.83E-01	2.78E-01	2.72E-01	2.67E-01	2.61E-01	2.56E-01
cm244	2.23E+01	2.16E+01	2.09E+01	2.03E+01	1.96E+01	1.90E+01	1.84E+01
cm245	9.23E-01	9.23E-01	9.23E-01	9.23E-01	9.23E-01	9.23E-01	9.23E-01
cm246	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01
cm247	2.45E-03	2.45E-03	2.45E-03	2.45E-03	2.45E-03	2.45E-03	2.45E-03
cm248	2.61E-04	2.61E-04	2.61E-04	2.61E-04	2.61E-04	2.61E-04	2.61E-04
cf249	1.19E-06	3.11E-06	4.10E-06	4.60E-06	4.86E-06	4.99E-06	5.05E-06
total	4.45E+05	4.45E+05	4.45E+05	4.45E+05	4.45E+05	4.45E+05	4.45E+05

```
=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
```

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sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp actinides page 6
power= 7.25mw, burnup= 2610.mwd, flux= 1.32E+13n/cm**2-sec

0 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

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sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp actinides page 41
power= 7.25mw, burnup= 20880.mwd, flux= 1.40E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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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sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp actinides page 42
power= 7.25mw, burnup= 20880.mwd, flux= 1.40E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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

cm250	3.07E-15	4.41E-15	6.27E-15	8.80E-15	1.22E-14
cm251	5.73E-25	9.78E-23	1.41E-22	1.99E-22	2.80E-22
bk249	1.41E-08	1.95E-08	2.68E-08	3.64E-08	4.89E-08
bk250	3.17E-12	6.72E-12	9.33E-12	1.28E-11	1.74E-11
bk251	1.52E-17	8.85E-17	1.24E-16	1.73E-16	2.37E-16
cf249	4.17E-09	5.91E-09	8.24E-09	1.13E-08	1.55E-08
cf250	1.99E-09	2.83E-09	3.95E-09	5.44E-09	7.41E-09
cf251	1.37E-09	1.97E-09	2.79E-09	3.89E-09	5.37E-09
cf252	7.30E-10	1.10E-09	1.63E-09	2.37E-09	3.41E-09
cf253	6.90E-13	1.05E-12	1.58E-12	2.34E-12	3.41E-12
cf254	3.20E-16	5.03E-16	7.73E-16	1.17E-15	1.74E-15
cf255	1.35E-20	5.14E-20	8.00E-20	1.22E-19	1.83E-19
totals	1.87E+03	1.87E+03	1.86E+03	1.86E+03	1.86E+03
0 flux		1.57E+13	1.59E+13	1.60E+13	1.62E+13

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sas2h: babcock wilcox 15x15, 4.00wt%, 45gwd/mtu burn high temp actinides page 49
decay, following reactor irradiation identified by: power= 7.25mw, burnup= 20880.mwd, flux= 1.40E+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	8.46E-01	1.03E+00	1.11E+00	1.16E+00	1.21E+00	1.25E+00	1.29E+00
pb208	5.79E-06	8.62E-06	1.23E-05	1.66E-05	2.17E-05	2.74E-05	3.37E-05
th228	8.85E-06	1.17E-05	1.46E-05	1.72E-05	1.96E-05	2.17E-05	2.35E-05
th230	1.05E-03	1.24E-03	1.43E-03	1.62E-03	1.82E-03	2.02E-03	2.22E-03
th232	3.60E-04	4.22E-04	4.83E-04	5.44E-04	6.06E-04	6.67E-04	7.29E-04
th234	6.23E-06	6.23E-06	6.23E-06	6.23E-06	6.23E-06	6.23E-06	6.23E-06
pa231	1.01E-03	1.02E-03	1.02E-03	1.03E-03	1.03E-03	1.03E-03	1.04E-03
pa233	1.14E-05	1.12E-05	1.12E-05	1.12E-05	1.12E-05	1.12E-05	1.12E-05
u232	6.83E-04	7.91E-04	8.78E-04	9.47E-04	1.00E-03	1.04E-03	1.08E-03
u233	1.53E-03	1.62E-03	1.72E-03	1.82E-03	1.92E-03	2.02E-03	2.12E-03
u234	8.16E+01	8.27E+01	8.38E+01	8.50E+01	8.61E+01	8.72E+01	8.83E+01
u235	4.12E+03	4.12E+03	4.12E+03	4.12E+03	4.12E+03	4.12E+03	4.12E+03
u236	2.53E+03	2.53E+03	2.53E+03	2.53E+03	2.53E+03	2.53E+03	2.53E+03
u237	2.64E+00	2.35E-05	2.26E-05	2.17E-05	2.09E-05	2.00E-05	1.92E-05
u238	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05	4.29E+05
np235	1.05E-05	6.15E-06	3.61E-06	2.12E-06	1.24E-06	7.31E-07	4.29E-07
np236	7.40E-04	7.40E-04	7.40E-04	7.40E-04	7.40E-04	7.40E-04	7.40E-04
np237	3.26E+02	3.29E+02	3.29E+02	3.29E+02	3.30E+02	3.30E+02	3.30E+02
np239	1.90E+01	8.19E-05	8.19E-05	8.19E-05	8.19E-05	8.19E-05	8.19E-05
pu236	6.42E-04	5.27E-04	4.32E-04	3.54E-04	2.90E-04	2.37E-04	1.95E-04
pu238	1.65E+02	1.72E+02	1.73E+02	1.73E+02	1.72E+02	1.71E+02	1.70E+02
pu239	3.12E+03	3.14E+03	3.14E+03	3.14E+03	3.14E+03	3.14E+03	3.14E+03
pu240	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.33E+03
pu241	8.08E+02	7.76E+02	7.46E+02	7.16E+02	6.88E+02	6.61E+02	6.35E+02
pu242	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02	3.46E+02
am241	6.40E+01	9.58E+01	1.26E+02	1.56E+02	1.84E+02	2.10E+02	2.36E+02
am242m	1.47E+00	1.46E+00	1.46E+00	1.45E+00	1.44E+00	1.44E+00	1.43E+00
am242	6.51E-02	1.89E-05	1.88E-05	1.87E-05	1.86E-05	1.86E-05	1.85E-05
am243	9.51E+01	9.52E+01	9.52E+01	9.52E+01	9.52E+01	9.51E+01	9.51E+01
cm242	1.14E+01	3.14E+00	8.62E-01	2.39E-01	6.82E-02	2.14E-02	8.57E-03
cm243	3.98E-01	3.90E-01	3.82E-01	3.74E-01	3.67E-01	3.59E-01	3.52E-01
cm244	3.62E+01	3.51E+01	3.40E+01	3.29E+01	3.19E+01	3.09E+01	2.99E+01
cm245	1.63E+00	1.63E+00	1.63E+00	1.63E+00	1.63E+00	1.63E+00	1.62E+00
cm246	2.53E-01	2.53E-01	2.53E-01	2.53E-01	2.53E-01	2.53E-01	2.53E-01
cm247	5.82E-03	5.82E-03	5.82E-03	5.82E-03	5.82E-03	5.82E-03	5.82E-03

cm248	7.31E-04	7.31E-04	7.31E-04	7.32E-04	7.32E-04	7.32E-04	7.32E-04
cf249	3.85E-06	9.72E-06	1.27E-05	1.43E-05	1.51E-05	1.55E-05	1.57E-05
cf250	1.85E-06	1.78E-06	1.70E-06	1.63E-06	1.56E-06	1.49E-06	1.42E-06
cf251	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.35E-06	1.34E-06	1.34E-06
total	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05

```
=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 actinides page 6

power= 7.25mw, burnup= 2610.mwd, flux= 1.26E+13n/cm**2-sec

0 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

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	6.88E-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

1

sas2h: babcock wilcox 15x15, 4.20wt%, 45gwd/mtu burn high temp actinides page 41
power= 7.25mw, burnup= 20880.mwd, flux= 1.34E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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 actinides page 42
power= 7.25mw, burnup= 20880.mwd, flux= 1.34E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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
totals	1.87E+03	1.87E+03	1.86E+03	1.86E+03	1.86E+03
0 flux		1.50E+13	1.52E+13	1.54E+13	1.55E+13

1

sas2h: babcock wilcox 15x15, 4.20wt%, 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

cf250	1.49E-06	1.43E-06	1.37E-06	1.31E-06	1.26E-06	1.20E-06	1.15E-06
cf251	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06	1.09E-06
total	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05	4.42E+05

```
=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
```

1

sas2h: babcock wilcox 15x15, 4.50wt%, 53gwd/mtu burn high temp actinides page 6

power= 7.25mw, burnup= 3074.mwd, flux= 1.18E+13n/cm**2-sec

0 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 actinides page 41
power= 7.25mw, burnup= 24592.mwd, flux= 1.29E+13n/cm**2-sec
0 nuclide concentrations, gram atoms
basis = single reactor assembly

	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 actinides page 42
power= 7.25mw, burnup= 24592.mwd, flux= 1.29E+13n/cm**2-sec
0 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

cm251	1.59E-24	2.75E-22	3.97E-22	5.66E-22	7.96E-22
bk249	4.15E-08	5.73E-08	7.84E-08	1.06E-07	1.43E-07
bk250	9.09E-12	1.92E-11	2.67E-11	3.66E-11	4.98E-11
bk251	4.09E-17	2.39E-16	3.36E-16	4.67E-16	6.42E-16
cf249	1.36E-08	1.92E-08	2.66E-08	3.64E-08	4.93E-08
cf250	6.02E-09	8.52E-09	1.18E-08	1.63E-08	2.21E-08
cf251	4.45E-09	6.34E-09	8.94E-09	1.24E-08	1.71E-08
cf252	2.64E-09	3.96E-09	5.84E-09	8.49E-09	1.22E-08
cf253	2.52E-12	3.82E-12	5.73E-12	8.46E-12	1.23E-11
cf254	1.15E-15	1.80E-15	2.77E-15	4.17E-15	6.18E-15
cf255	4.88E-20	1.86E-19	2.89E-19	4.42E-19	6.63E-19
totals	1.86E+03	1.85E+03	1.85E+03	1.85E+03	1.84E+03
0 flux		1.49E+13	1.51E+13	1.53E+13	1.55E+13

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sas2h: babcock wilcox 15x15, 4.50wt%, 53gwd/mtu burn high temp actinides page 49

decay, following reactor irradiation identified by: power= 7.25mw, burnup= 24592.mwd, flux= 1.29E+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	1.29E+00	1.52E+00	1.63E+00	1.70E+00	1.77E+00	1.83E+00	1.89E+00
pb208	1.17E-05	1.64E-05	2.21E-05	2.89E-05	3.66E-05	4.52E-05	5.46E-05
th228	1.49E-05	1.89E-05	2.28E-05	2.64E-05	2.97E-05	3.26E-05	3.51E-05
th229	9.62E-07	9.69E-07	9.76E-07	9.84E-07	9.92E-07	1.00E-06	1.01E-06
th230	1.17E-03	1.37E-03	1.58E-03	1.78E-03	1.99E-03	2.21E-03	2.43E-03
th232	4.96E-04	5.68E-04	6.39E-04	7.10E-04	7.81E-04	8.52E-04	9.24E-04
th234	6.17E-06	6.16E-06	6.16E-06	6.16E-06	6.16E-06	6.16E-06	6.16E-06
pa231	1.33E-03	1.33E-03	1.34E-03	1.34E-03	1.34E-03	1.35E-03	1.35E-03
pa233	1.42E-05	1.38E-05	1.38E-05	1.38E-05	1.38E-05	1.38E-05	1.38E-05
u232	1.04E-03	1.19E-03	1.31E-03	1.41E-03	1.48E-03	1.54E-03	1.59E-03
u233	1.85E-03	1.97E-03	2.09E-03	2.21E-03	2.33E-03	2.45E-03	2.58E-03
u234	8.62E+01	8.77E+01	8.92E+01	9.08E+01	9.23E+01	9.39E+01	9.54E+01
u235	3.99E+03	3.99E+03	3.99E+03	3.99E+03	3.99E+03	3.99E+03	3.99E+03
u236	2.94E+03	2.94E+03	2.94E+03	2.94E+03	2.94E+03	2.94E+03	2.94E+03
u237	2.92E+00	2.61E-05	2.51E-05	2.41E-05	2.31E-05	2.22E-05	2.13E-05
u238	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05	4.24E+05
np235	1.39E-05	8.15E-06	4.79E-06	2.81E-06	1.65E-06	9.69E-07	5.69E-07
np236	1.10E-03	1.10E-03	1.10E-03	1.10E-03	1.10E-03	1.10E-03	1.10E-03
np237	4.02E+02	4.05E+02	4.05E+02	4.05E+02	4.05E+02	4.06E+02	4.06E+02
np239	1.89E+01	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04
pu236	8.98E-04	7.37E-04	6.04E-04	4.95E-04	4.05E-04	3.32E-04	2.72E-04
pu238	2.30E+02	2.39E+02	2.40E+02	2.39E+02	2.38E+02	2.37E+02	2.35E+02
pu239	3.28E+03	3.30E+03	3.30E+03	3.30E+03	3.30E+03	3.30E+03	3.30E+03
pu240	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.45E+03
pu241	8.97E+02	8.61E+02	8.27E+02	7.95E+02	7.63E+02	7.33E+02	7.04E+02
pu242	4.21E+02	4.21E+02	4.21E+02	4.21E+02	4.21E+02	4.21E+02	4.21E+02
am241	7.83E+01	1.14E+02	1.47E+02	1.80E+02	2.11E+02	2.41E+02	2.69E+02
am242m	1.85E+00	1.84E+00	1.83E+00	1.82E+00	1.82E+00	1.81E+00	1.80E+00
am242	7.73E-02	2.37E-05	2.36E-05	2.35E-05	2.34E-05	2.34E-05	2.33E-05
am243	1.28E+02	1.28E+02	1.28E+02	1.28E+02	1.28E+02	1.28E+02	1.28E+02
cm242	1.39E+01	3.83E+00	1.05E+00	2.92E-01	8.35E-02	2.63E-02	1.06E-02
cm243	5.41E-01	5.30E-01	5.20E-01	5.09E-01	4.99E-01	4.89E-01	4.79E-01
cm244	5.60E+01	5.43E+01	5.26E+01	5.09E+01	4.93E+01	4.78E+01	4.63E+01
cm245	2.78E+00	2.78E+00	2.78E+00	2.78E+00	2.78E+00	2.78E+00	2.78E+00
cm246	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.95E-01
cm247	1.30E-02	1.30E-02	1.30E-02	1.30E-02	1.30E-02	1.30E-02	1.30E-02

cm248	1.94E-03	1.94E-03	1.94E-03	1.94E-03	1.94E-03	1.94E-03	1.94E-03
bk249	3.55E-05	1.84E-05	9.50E-06	4.92E-06	2.54E-06	1.31E-06	6.80E-07
cf249	1.23E-05	2.94E-05	3.82E-05	4.27E-05	4.50E-05	4.62E-05	4.67E-05
cf250	5.51E-06	5.29E-06	5.06E-06	4.84E-06	4.63E-06	4.43E-06	4.24E-06
cf251	4.29E-06	4.28E-06	4.28E-06	4.28E-06	4.28E-06	4.27E-06	4.27E-06
cf252	3.06E-06	2.46E-06	1.98E-06	1.59E-06	1.28E-06	1.03E-06	8.26E-07
total	4.38E+05	4.38E+05	4.38E+05	4.38E+05	4.38E+05	4.38E+05	4.38E+05

Far-Field External Criticality Analysis

Avogadro's 0.602252

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

Number Density Calculations

		3.0% / 20 GWD/mt Full Density
UO2	O	4.8888950E-02
	U-234	5.8680620E-06
	U-235	4.7816080E-04
	U-236	1.1441480E-04
	U-238	2.3818750E-02
	Np-237	2.7286570E-05
H2O	H	6.6861260E-02
	O	3.3430630E-02
Tuff	H	0.0000000E+00
	O	3.2628830E-02
	Na	4.5533820E-04
	Mg	2.6751210E-04
	Al	3.0153870E-03
	Si	1.3193410E-02
	P	0.0000000E+00
	K	6.4299900E-04
	Ca	6.5871220E-04
	Ti	0.0000000E+00
	Mn	0.0000000E+00
	Fe	1.6235590E-04

3.0% / 20 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	8.802093E-07
U-235	7.172412E-05
U-236	1.716222E-05
U-238	3.572813E-03
Np-237	4.092986E-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

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	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

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	1.805254E-02
O	9.026270E-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	8.033424E-02
Total O	4.328111E-02
Total H	1.805254E-02

3.0% / 20 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	2.000000E-01
O	9.777790E-03
U-234	1.173612E-06
U-235	9.563216E-05
U-236	2.288296E-05
U-238	4.763750E-03
Np-237	5.457314E-06
H	1.604670E-02
O	8.023351E-03
H	0.000000E+00
O	2.610306E-02
Na	3.642706E-04
Mg	2.140097E-04
Al	2.412310E-03
Si	1.055473E-02
P	0.000000E+00
K	5.143992E-04
Ca	5.269698E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.298847E-04
Total	7.955638E-02
Total O	4.390421E-02
Total H	1.604670E-02

		3.5% / 30 GWD/mt Full Density
UO2	O	4.8888950E-02
	U-234	8.6916090E-06
	U-235	4.6281670E-04
	U-236	1.5971730E-04
	U-238	2.3769490E-02
	Np-237	4.3765000E-05
H2O	H	6.6861260E-02
	O	3.3430630E-02
Tuff	H	0.0000000E+00
	O	3.2628830E-02
	Na	4.5533820E-04
	Mg	2.6751210E-04
	Al	3.0153870E-03
	Si	1.3193410E-02
	P	0.0000000E+00
	K	6.4299900E-04
	Ca	6.5871220E-04
	Ti	0.0000000E+00
	Mn	0.0000000E+00
	Fe	1.6235590E-04

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	1.303741E-06
U-235	6.942251E-05
U-236	2.395760E-05
U-238	3.565424E-03
Np-237	6.564750E-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

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.600000E-01
O	7.822232E-03
U-234	1.390657E-06
U-235	7.405067E-05
U-236	2.555477E-05
U-238	3.803118E-03
Np-237	7.002400E-06
H	1.684904E-02
O	8.424519E-03
H	0.000000E+00
O	2.740822E-02
Na	3.824841E-04
Mg	2.247102E-04
Al	2.532925E-03
Si	1.108246E-02
P	0.000000E+00
K	5.401192E-04
Ca	5.533182E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.363790E-04
Total	7.986752E-02
Total O	4.365497E-02
Total H	1.684904E-02

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.400000E-01
O	6.844453E-03
U-234	1.216825E-06
U-235	6.479434E-05
U-236	2.236042E-05
U-238	3.327729E-03
Np-237	6.127100E-06
H	1.725021E-02
O	8.625103E-03
H	0.000000E+00
O	2.806079E-02
Na	3.915909E-04
Mg	2.300604E-04
Al	2.593233E-03
Si	1.134633E-02
P	0.000000E+00
K	5.529791E-04
Ca	5.664925E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.396261E-04
Total	8.002310E-02
Total O	4.353035E-02
Total H	1.725021E-02

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	8.691609E-07
U-235	4.628167E-05
U-236	1.597173E-05
U-238	2.376949E-03
Np-237	4.376500E-06
H	1.805254E-02
O	9.026270E-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	8.033424E-02
Total O	4.328111E-02
Total H	1.805254E-02

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	1.845371E-02
O	9.226854E-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	8.048982E-02
Total O	4.315649E-02
Total H	1.845371E-02

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	2.500000E-01
O	1.222224E-02
U-234	2.172902E-06
U-235	1.157042E-04
U-236	3.992933E-05
U-238	5.942373E-03
Np-237	1.094125E-05
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

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	2.005838E-02
O	1.002919E-02
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
Total	8.111211E-02
Total O	4.265802E-02
Total H	2.005838E-02

3.5% / 30 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	8.800000E-02
O	4.302228E-03
U-234	7.648616E-07
U-235	4.072787E-05
U-236	1.405512E-05
U-238	2.091715E-03
Np-237	3.851320E-06
H	1.829324E-02
O	9.146620E-03
H	0.000000E+00
O	2.975749E-02
Na	4.152684E-04
Mg	2.439710E-04
Al	2.750033E-03
Si	1.203239E-02
P	0.000000E+00
K	5.864151E-04
Ca	6.007455E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.480686E-04
Total	8.042759E-02
Total O	4.320634E-02
Total H	1.829324E-02

.47 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.700000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	8.802093E-07
U-235	7.172412E-05
U-236	1.716222E-05
U-238	3.572813E-03
Np-237	4.092986E-06
H	2.671107E-02
O	1.335554E-02
H	0.000000E+00
O	2.118053E-02
Na	2.955762E-04
Mg	1.736516E-04
Al	1.957395E-03
Si	8.564310E-03
P	0.000000E+00
K	4.173934E-04
Ca	4.275934E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.053910E-04
Total	8.418847E-02
Total O	4.186941E-02
Total H	2.671107E-02

3.5% / 30 GWD/mt	
water vol frac	2.000000E-01
UO2 vol frac	1.200000E-01
O	5.866674E-03
U-234	1.042993E-06
U-235	5.553800E-05
U-236	1.916608E-05
U-238	2.852339E-03
Np-237	5.251800E-06
H	1.176758E-02
O	5.883791E-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	7.135298E-02
Total O	4.046384E-02
Total H	1.176758E-02

.47 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.700000E-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	3.142479E-02
O	1.571240E-02
H	0.000000E+00
O	2.491827E-02
Na	3.477367E-04
Mg	2.042960E-04
Al	2.302817E-03
Si	1.007566E-02
P	0.000000E+00
K	4.910511E-04
Ca	5.030511E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.239894E-04
Total	8.610406E-02
Total O	4.063067E-02
Total H	3.142479E-02

3.5% / 30 GWD/mt	
water vol frac	2.000000E-01
UO2 vol frac	1.400000E-01
O	6.844453E-03
U-234	1.216825E-06
U-235	6.479434E-05
U-236	2.236042E-05
U-238	3.327729E-03
Np-237	6.127100E-06
H	1.150014E-02
O	5.750068E-03
H	0.000000E+00
O	2.806079E-02
Na	3.915909E-04
Mg	2.300604E-04
Al	2.593233E-03
Si	1.134633E-02
P	0.000000E+00
K	5.529791E-04
Ca	5.664925E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.396261E-04
Total	7.139799E-02
Total O	4.065532E-02
Total H	1.150014E-02

.47 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.700000E-01
UO2 vol frac	2.000000E-01
O	9.777790E-03
U-234	1.173612E-06
U-235	9.563216E-05
U-236	2.288296E-05
U-238	4.763750E-03
Np-237	5.457314E-06
H	2.513983E-02
O	1.256992E-02
H	0.000000E+00
O	1.993462E-02
Na	2.781893E-04
Mg	1.634368E-04
Al	1.842254E-03
Si	8.060527E-03
P	0.000000E+00
K	3.928409E-04
Ca	4.024409E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	9.919150E-05
Total	8.354993E-02
Total O	4.228232E-02
Total H	2.513983E-02

3.5% / 30 GWD/mt	
water vol frac	2.000000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	8.691609E-07
U-235	4.628167E-05
U-236	1.597173E-05
U-238	2.376949E-03
Np-237	4.376500E-06
H	1.203503E-02
O	6.017513E-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	7.130797E-02
Total O	4.027236E-02
Total H	1.203503E-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	1.838664E-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

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

log model

3.0% / 20 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	3.600000E-02
O	1.760002E-03
U-234	2.112502E-07
U-235	1.721379E-05
U-236	4.118933E-06
U-238	8.574750E-04
Np-237	9.823165E-07
H	1.933628E-02
O	9.668138E-03
H	0.000000E+00
O	1.572710E-02
Na	2.194730E-04
Mg	1.289408E-04
Al	1.453417E-03
Si	6.359224E-03
P	0.000000E+00
K	3.099255E-04
Ca	3.174993E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	7.825554E-05
C	2.706816E-02
Total	8.330641E-02
Total O	2.715524E-02
Total H	1.933628E-02

log model

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	1.845371E-02
O	9.226854E-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	8.285121E-02
Total O	2.814723E-02
Total H	1.845371E-02

3.0% / 20 GWD/mt	
water vol frac	3.000000E-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	1.905546E-02
O	9.527730E-03
H	0.000000E+00
O	1.549869E-02
Na	2.162856E-04
Mg	1.270682E-04
Al	1.432309E-03
Si	6.266870E-03
P	0.000000E+00
K	3.054245E-04
Ca	3.128883E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	7.711905E-05
C	2.667505E-02
Total	8.316157E-02
Total O	2.747087E-02
Total H	1.905546E-02

3.0% / 20 GWD/mt	
water vol frac	1.000000E-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	6.151236E-03
O	3.075618E-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	6.439750E-02
Total O	2.199600E-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 Cas 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
3.0% / 20 GWD/mt	
water vol fra	1.920000E-01
UO2 vol frac	5.500000E-02
O	2.688892E-03
U-234	3.227434E-07
U-235	2.629884E-05
U-236	6.292814E-06
U-238	1.310031E-03
Np-237	1.500761E-06
H	1.283736E-02
O	6.418681E-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	7.431393E-02
Total O	4.173640E-02
Total H	1.283736E-02

Additional Cas	Soddyite/water in Tuff
3.0% / 20 GWD/mt	
water vol frac	1.470000E-01
UO2 vol frac	1.650000E-01
O	8.066677E-03
U-234	9.682302E-07
U-235	7.889653E-05
U-236	1.887844E-05
U-238	3.930094E-03
Np-237	4.502284E-06
H	9.828605E-03
O	4.914303E-03
H	0.000000E+00
O	2.470469E-02
Na	3.447561E-04
Mg	2.025449E-04
Al	2.283079E-03
Si	9.989296E-03
P	0.000000E+00
K	4.868421E-04
Ca	4.987392E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.229266E-04
C	0.000000E+00
Total	6.547579E-02
Total O	3.768566E-02
Total H	9.828605E-03

Additional Cas	Soddyite/water in Tuff
3.0% / 20 GWD/mt	
water vol frac	2.190000E-01
UO2 vol frac	1.290000E-01
O	6.306675E-03
U-234	7.569800E-07
U-235	6.168274E-05
U-236	1.475951E-05
U-238	3.072619E-03
Np-237	3.519968E-06
H	1.464262E-02
O	7.321308E-03
H	0.000000E+00
O	2.470469E-02
Na	3.447561E-04
Mg	2.025449E-04
Al	2.283079E-03
Si	9.989296E-03
P	0.000000E+00
K	4.868421E-04
Ca	4.987392E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.229266E-04
C	0.000000E+00
Total	7.005681E-02
Total O	3.833267E-02
Total H	1.464262E-02

.30 Porosity

Additional Case	Soddyite/water in Tuff
3.0% / 20 GWD/mt	
water vol frac	2.900000E-01
UO2 vol frac	9.200000E-02
O	4.497783E-03
U-234	5.398617E-07
U-235	4.399079E-05
U-236	1.052616E-05
U-238	2.191325E-03
Np-237	2.510364E-06
H	1.938977E-02
O	9.694883E-03
H	0.000000E+00
O	2.470469E-02
Na	3.447561E-04
Mg	2.025449E-04
Al	2.283079E-03
Si	9.989296E-03
P	0.000000E+00
K	4.868421E-04
Ca	4.987392E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.229266E-04
C	0.000000E+00
Total	7.446419E-02
Total O	3.889735E-02
Total H	1.938977E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	2.000000E-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	1.337225E-02
O	6.686126E-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
Total	7.108292E-02
Total O	3.931496E-02
Total H	1.337225E-02

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-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	2.540728E-02
O	1.270364E-02
H	0.000000E+00
O	2.679889E-02
Na	3.739809E-04
Mg	2.197145E-04
Al	2.476615E-03
Si	1.083609E-02
P	0.000000E+00
K	5.281116E-04
Ca	5.410172E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.333471E-04
Total	8.368536E-02
Total O	4.194698E-02
Total H	2.540728E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	2.000000E-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	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

.40 Porosity

/mt	3.0% / 20 GWD/mt	
4.000000E-01	water vol frac	4.000000E-01
8.000000E-02	UO2 vol frac	1.000000E-01
3.911116E-03	O	4.888895E-03
4.694450E-07	U-234	5.868062E-07
3.825286E-05	U-235	4.781608E-05
9.153184E-06	U-236	1.144148E-05
1.905500E-03	U-238	2.381875E-03
2.182926E-06	Np-237	2.728657E-06
2.460494E-02	H	2.407005E-02
1.230247E-02	O	1.203503E-02
0.000000E+00	H	0.000000E+00
2.595261E-02	O	2.538843E-02
3.621710E-04	Na	3.542977E-04
2.127762E-04	Mg	2.081506E-04
2.398406E-03	Al	2.346267E-03
1.049389E-02	Si	1.026577E-02
0.000000E+00	P	0.000000E+00
5.114344E-04	K	5.003162E-04
5.239325E-04	Ca	5.125426E-04
0.000000E+00	Ti	0.000000E+00
0.000000E+00	Mn	0.000000E+00
1.291361E-04	Fe	1.263288E-04
8.335845E-02	Total	8.314052E-02
4.216620E-02	Total O	4.231235E-02
2.460494E-02	Total H	2.407005E-02

.30 Porosity

/mt	3.0% / 20 GWD/mt	
2.000000E-01	water vol frac	2.000000E-01
8.000000E-02	UO2 vol frac	1.000000E-01
3.911116E-03	O	4.888895E-03
4.694450E-07	U-234	5.868062E-07
3.825286E-05	U-235	4.781608E-05
9.153184E-06	U-236	1.144148E-05
1.905500E-03	U-238	2.381875E-03
2.182926E-06	Np-237	2.728657E-06
1.230247E-02	H	1.203503E-02
6.151236E-03	O	6.017513E-03
0.000000E+00	H	0.000000E+00
3.001852E-02	O	2.936595E-02
4.189111E-04	Na	4.098044E-04
2.461111E-04	Mg	2.407609E-04
2.774156E-03	Al	2.713848E-03
1.213794E-02	Si	1.187407E-02
0.000000E+00	P	0.000000E+00
5.915591E-04	K	5.786991E-04
6.060152E-04	Ca	5.928410E-04
0.000000E+00	Ti	0.000000E+00
0.000000E+00	Mn	0.000000E+00
1.493674E-04	Fe	1.461203E-04
7.126296E-02	Total	7.130797E-02
4.008088E-02	Total O	4.027236E-02
1.230247E-02	Total H	1.203503E-02

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	8.802093E-07
U-235	7.172412E-05
U-236	1.716222E-05
U-238	3.572813E-03
Np-237	4.092986E-06
H	2.273283E-02
O	1.136641E-02
H	0.000000E+00
O	2.397796E-02
Na	3.346145E-04
Mg	1.965867E-04
Al	2.215918E-03
Si	9.695445E-03
P	0.000000E+00
K	4.725209E-04
Ca	4.840680E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.193105E-04
Total	8.259568E-02
Total O	4.267772E-02
Total H	2.273283E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	2.000000E-01
UO2 vol frac	1.160000E-01
O	5.671118E-03
U-234	6.806952E-07
U-235	5.546665E-05
U-236	1.327212E-05
U-238	2.762975E-03
Np-237	3.165242E-06
H	1.182107E-02
O	5.910535E-03
H	0.000000E+00
O	2.884389E-02
Na	4.025190E-04
Mg	2.364807E-04
Al	2.665602E-03
Si	1.166297E-02
P	0.000000E+00
K	5.684111E-04
Ca	5.823016E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.435226E-04
Total	7.134398E-02
Total O	4.042554E-02
Total H	1.182107E-02

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-01
UO2 vol frac	2.000000E-01
O	9.777790E-03
U-234	1.173612E-06
U-235	9.563216E-05
U-236	2.288296E-05
U-238	4.763750E-03
Np-237	5.457314E-06
H	2.139560E-02
O	1.069780E-02
H	0.000000E+00
O	2.256749E-02
Na	3.149313E-04
Mg	1.850228E-04
Al	2.085570E-03
Si	9.125125E-03
P	0.000000E+00
K	4.447255E-04
Ca	4.555935E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.122923E-04
Total	8.205084E-02
Total O	4.304308E-02
Total H	2.139560E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	2.000000E-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	1.176758E-02
O	5.883791E-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	7.135298E-02
Total O	4.046384E-02
Total H	1.176758E-02

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-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	2.005838E-02
O	1.002919E-02
H	0.000000E+00
O	2.115702E-02
Na	2.952481E-04
Mg	1.734589E-04
Al	1.955222E-03
Si	8.554805E-03
P	0.000000E+00
K	4.169302E-04
Ca	4.271189E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.052740E-04
Total	8.150600E-02
Total O	4.340845E-02
Total H	2.005838E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	2.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	8.802093E-07
U-235	7.172412E-05
U-236	1.716222E-05
U-238	3.572813E-03
Np-237	4.092986E-06
H	1.136641E-02
O	5.683207E-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	7.142050E-02
Total O	4.075106E-02
Total H	1.136641E-02

.40 Porosity

3.0% / 20 GWD/mt	
water vol frac	4.000000E-01
UO2 vol frac	1.700000E-01
O	8.311122E-03
U-234	9.975705E-07
U-235	8.128734E-05
U-236	1.945052E-05
U-238	4.049188E-03
Np-237	4.638717E-06
H	2.219794E-02
O	1.109897E-02
H	0.000000E+00
O	2.341377E-02
Na	3.267412E-04
Mg	1.919611E-04
Al	2.163779E-03
Si	9.467317E-03
P	0.000000E+00
K	4.614027E-04
Ca	4.726782E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.165032E-04
Total	8.237774E-02
Total O	4.282386E-02
Total H	2.219794E-02

.30 Porosity

3.0% / 20 GWD/mt	
water vol frac	1.800000E-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	1.107222E-02
O	5.536112E-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	6.941759E-02
Total O	3.946575E-02
Total H	1.107222E-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	Full Density
UO2	O	4.8888950E-02
	U-234	1.2468890E-05
	U-235	4.5157230E-04
	U-236	2.0176000E-04
	U-238	2.3719690E-02
	Np-237	5.8984170E-05
H2O	H	6.6861260E-02
	O	3.3430630E-02
Tuff	H	0.0000000E+00
	O	3.2628830E-02
	Na	4.5533820E-04
	Mg	2.6751210E-04
	Al	3.0153870E-03
	Si	1.3193410E-02
	P	0.0000000E+00
	K	6.4299900E-04
	Ca	6.5871220E-04
	Ti	0.0000000E+00
	Mn	0.0000000E+00
	Fe	1.6235590E-04

4.0% /40 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.400000E-01
O	6.844453E-03
U-234	1.745645E-06
U-235	6.322012E-05
U-236	2.824640E-05
U-238	3.320757E-03
Np-237	8.257784E-06
H	1.725021E-02
O	8.625103E-03
H	0.000000E+00
O	2.806079E-02
Na	3.915909E-04
Mg	2.300604E-04
Al	2.593233E-03
Si	1.134633E-02
P	0.000000E+00
K	5.529791E-04
Ca	5.664925E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.396261E-04
Total	8.002310E-02
Total O	4.353035E-02
Total H	1.725021E-02

4.0% /40 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.200000E-01
O	5.866674E-03
U-234	1.496267E-06
U-235	5.418868E-05
U-236	2.421120E-05
U-238	2.846363E-03
Np-237	7.078100E-06
H	1.765137E-02
O	8.825686E-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	8.017867E-02
Total O	4.340573E-02
Total H	1.765137E-02

4.0% /40 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.600000E-01
O	7.822232E-03
U-234	1.995022E-06
U-235	7.225157E-05
U-236	3.228160E-05
U-238	3.795150E-03
Np-237	9.437467E-06
H	1.684904E-02
O	8.424519E-03
H	0.000000E+00
O	2.740822E-02
Na	3.824841E-04
Mg	2.247102E-04
Al	2.532925E-03
Si	1.108246E-02
P	0.000000E+00
K	5.401192E-04
Ca	5.533182E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.363790E-04
Total	7.986752E-02
Total O	4.365497E-02
Total H	1.684904E-02

4.0% /40 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	1.246889E-06
U-235	4.515723E-05
U-236	2.017600E-05
U-238	2.371969E-03
Np-237	5.898417E-06
H	1.805254E-02
O	9.026270E-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	8.033424E-02
Total O	4.328111E-02
Total H	1.805254E-02

	4.2% /45 GWD/mt	Full Density
UO2	O	4.8888950E-02
	U-234	1.4634310E-05
	U-235	4.3780630E-04
	U-236	2.2045330E-04
	U-238	2.3705580E-02
	Np-237	6.5997150E-05
H2O	H	6.6861260E-02
	O	3.3430630E-02
Tuff	H	0.0000000E+00
	O	3.2628830E-02
	Na	4.5533820E-04
	Mg	2.6751210E-04
	Al	3.0153870E-03
	Si	1.3193410E-02
	P	0.0000000E+00
	K	6.4299900E-04
	Ca	6.5871220E-04
	Ti	0.0000000E+00
	Mn	0.0000000E+00
	Fe	1.6235590E-04

4.2% /45 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.000000E-01
O	4.888895E-03
U-234	1.463431E-06
U-235	4.378063E-05
U-236	2.204533E-05
U-238	2.370558E-03
Np-237	6.599715E-06
H	1.805254E-02
O	9.026270E-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	8.033424E-02
Total O	4.328111E-02
Total H	1.805254E-02

4.2% /45 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.200000E-01
O	5.866674E-03
U-234	1.756117E-06
U-235	5.253676E-05
U-236	2.645440E-05
U-238	2.844670E-03
Np-237	7.919658E-06
H	1.765137E-02
O	8.825686E-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	8.017867E-02
Total O	4.340573E-02
Total H	1.765137E-02

4.2% /45 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	1.500000E-01
O	7.333343E-03
U-234	2.195147E-06
U-235	6.567095E-05
U-236	3.306800E-05
U-238	3.555837E-03
Np-237	9.899573E-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

4.2% /45 GWD/mt	
water vol frac	3.000000E-01
UO2 vol frac	2.000000E-01
O	9.777790E-03
U-234	2.926862E-06
U-235	8.756126E-05
U-236	4.409066E-05
U-238	4.741116E-03
Np-237	1.319943E-05
H	1.604670E-02
O	8.023351E-03
H	0.000000E+00
O	2.610306E-02
Na	3.642706E-04
Mg	2.140097E-04
Al	2.412310E-03
Si	1.055473E-02
P	0.000000E+00
K	5.143992E-04
Ca	5.269698E-04
Ti	0.000000E+00
Mn	0.000000E+00
Fe	1.298847E-04
Total	7.955637E-02
Total O	4.390421E-02
Total H	1.604670E-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
 ******************************************************************************                probid =   04/26/96 14:14:39
 INP=i3020md OUTP=i3020md0

     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=i3020mf0

    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     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 ksrc 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 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    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 OUTP=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     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=i3020mb0

    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     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
 ******************************************************************************                    probid =   04/26/96 13:56:54
 INP=i3020mc OUTP=i3020mc0

    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-        m1       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.                                          print table 90
1keff results for: Far-Field Criticality Study - 3.0% /20 GWD/mt - 47% H2O/ 25% UO2 (i3020mc)   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
 ******************************************************************************                    probid =   05/03/96 09:39:29
 inp=i3020oa outp=i3020oa0

     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-        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 .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
 ******************************************************************************                probid =   05/03/96 10:28:15
 inp=i3020ob outp=i3020ob0

    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-       m1       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
 ******************************************************************************                    probid =   05/03/96 13:48:52
 inp=i3020od outp=i3020od0

     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     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 |
 |                                                                                                                            |
 ------------------------------------------------------------------------------------------------------------------------------
```

```
1mcnp     version 4a     ld=10/01/93                    05/03/96 14:59:14
 ******************************************************************************                    probid =   05/03/96 14:59:14
 inp=i3020oe outp=i3020oe0

    1-       Far-Field Criticality Study - 3.0% /20 GWD/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     1  8.20508-2   -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 GWD/MT decayed to Uranium isotopes
   19-       m1        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 4.555955-4  26000.55c 1.122923-4
   22-                 92234.50c 1.173612-6  92235.50c 9.563216-5  92236.50c 2.288296-5
   23-                 92238.50c 4.763750-3  95237.50c 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 - 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 = 1.08932 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=i3020of0

    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     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.IO

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  30% Water  5% U-Np O2
    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-
   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  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 O2        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=3.0E10I OUTP=30E10.IO

    1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  30% Water 10% U-Np O2
    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-
   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  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 3.0E 20GWD  30% Water 10% U-Np O2       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=3.0EI OUTP=3.0E.IO

    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-
   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  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  93237.50C 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
 ***********************************************************************                probid =   04/20/96 22:09:09
 INP=3.0E20I OUTP=30E20.IO

    1-        FarField Criticality - Sphere of Transmuted 3.0E 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  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  93237.50C 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 3.0E 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
 ***********************************************************************                probid =   05/14/96 10:05:12
 INP=3E30W25I OUTP=3E3025.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  30% Water  25% U-Np O2
    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-
   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    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 O2       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 O2
     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  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 O2       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=3.0E08I OUTP=3E08.IO

    1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water  8% U-Np O2
    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-
   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  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 3.0E 20GWD  20% Water 10% U-Np O2        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.IO

    1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water 10% U-Np O2
    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-
   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  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 4.027236-2       $ 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 O2        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
 ******************************************************************************                probid =   04/23/96 11:14:58
 INP=3.0E12I OUTP=3E12.IO

    1-       FarField Criticality - Sphere of Transmuted 3.0E 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  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 3.0E 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
 ******************************************************************************                probid =   04/22/96 15:23:31
 INP=3.0E15I OUTP=3E15.IO

     1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water 15% U-Np O2
     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  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  93237.50C 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 O2       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 = 4.23E-05 seconds with an estimated standard deviation of 9.98E-08

```
1mcnp     version 4a    ld=10/01/93                          04/23/96 16:48:09
 ******************************************************************************                    probid =   04/23/96 16:48:09
 INP=i30loga OUTP=i30logaO

    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-       m1        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
 ******************************************************************************                    probid =   04/24/96 07:17:23
 inp=i30logc outp=i30logc0

    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     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  93237.50c 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=i30logbO

    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
 ***********************************************************************                probid =   05/26/96 00:08:17
 INP=3E20W08I OUTP=320W08.O

    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  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
 ***********************************************************************                probid =   05/26/96 00:47:15
 INP=3E20W10I OUTP=320W10.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water  10% U-Np O2
    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-
   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    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 4.027236-2       $ 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 O2       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 3.0E 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-
   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    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 3.0E 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
 ***********************************************************************                probid =   05/25/96 20:14:43
 INP=3E18W08I OUTP=318W08.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 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  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 3.0E 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 = 8.15E-05 seconds with an estimated standard deviation of 1.66E-07

```
1mcnp     version 4a    ld=10/01/93                          05/25/96 22:03:42
 ******************************************************************************                probid =   05/25/96 22:03:42
 INP=3E18W10I OUTP=318W10.0

    1-       FarField Criticality - Sphere of Transmuted 3.0E 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  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 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 3.0E 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
 ******************************************************************************                probid =   05/25/96 23:34:27
 INP=3E18W12I OUTP=318W12.O

    1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  18% Water  12% U-Np O2
    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-
   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    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 3.0E 20GWD  18% Water  12% U-Np O2      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 O2
    2-       C    k-inf Optimization Minimum Water
    3-       C
    4-       C    SPHERE
    5-       1    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-
   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    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 O2        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
 ***********************************************************************                probid =   05/25/96 17:06:59
 INP=3E16W10I OUTP=316W10.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  16% Water  10% U-Np O2
    2-       C    k-inf Optimization Minimum Water
    3-       C
    4-       C    SPHERE
    5-       1    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-
   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    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 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 O2       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.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  16% Water  12% U-Np O2
    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-
   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    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 O2       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=i3530f0

    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     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
 ******************************************************************************                probid =   04/16/96 16:30:08
 inp=i3530d outp=i3530d0

    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 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-        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 1.216825-6  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.                                                    print table 90
1keff results for: Far-Field Criticality Study - 3.5% /30 GWD/mt - 30% H2O/ 15% UO2 (i3530a)    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
 ******************************************************************************                    probid =   04/16/96 15:23:12
 inp=i3530b outp=i3530b0

    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
 ******************************************************************************                    probid =   04/30/96 12:52:39
 inp=i3530j outp=i3530j0

    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     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
 ******************************************************************************                    probid =   04/17/96 15:56:27
 inp=i3530i outp=i3530i0

    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
 ******************************************************************************                probid =   04/17/96 15:03:47
 inp=i3530g outp=i3530g0

    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
 ******************************************************************************                probid =   04/17/96 15:26:39
 inp=i3530h outp=i3530h0

    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=i4040f0

    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 07:15:0
 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     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  .99291 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
 ******************************************************************************                probid =   04/17/96 17:11:03
 INP=i4040b OUTP=i4040b0

     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     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
 ******************************************************************************                probid =   04/17/96 16:37:13
 INP=i4040a OUTP=i4040a0

    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
 ******************************************************************************                probid =   04/17/96 17:32:17
 INP=i4040c OUTP=i4040c0

    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     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     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
 ***********************************************************************                probid =   08/21/96 15:48:08
 INP=i4245b OUTP=i4245b0

    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
 ******************************************************************************                probid =   08/21/96 16:23:15
 INP=i4245c OUTP=i4245c0

    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     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     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  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 = 7.34E-05 seconds with an estimated standard deviation of 3.99E-07

```
1mcnp     version 4a    ld=10/01/93                    04/26/96 18:52:57
 ***********************************************************************          probid =   04/26/96 18:52:57
 INP=s3020md OUTP=s3020md0

    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 = 6.96E-05 seconds with an estimated standard deviation of 3.58E-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     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 (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 = 6.38E-05 seconds with an estimated standard deviation of 2.57E-07

```
1mcnp     version 4a    ld=10/01/93                    04/26/96 16:36:42
 ******************************************************************************                probid =   04/26/96 16:36:42
 INP=s3020ma OUTP=s3020ma0

    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 = 6.05E-05 seconds with an estimated standard deviation of 2.69E-07

```
1mcnp     version 4a    ld=10/01/93                          05/03/96 16:29:24
 ******************************************************************************                    probid =   05/03/96 16:29:24
 INP=s3020oa OUTP=s3020oa0

    1-       Far-Field Criticality Study - 3.0% /20 GWD/mt - 40% H2O/ 17% UO2 (s3020oa)
    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 (s3020oa)          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 = 8.01E-05 seconds with an estimated standard deviation of 1.94E-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     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  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 = 7.53E-05 seconds with an estimated standard deviation of 1.85E-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 = 7.18E-05 seconds with an estimated standard deviation of 1.74E-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     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  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 OUTP=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     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  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 = 6.55E-05 seconds with an estimated standard deviation of 1.56E-07

```
1mcnp     version 4a    ld=10/01/93                          05/04/96 06:06:23
 ***********************************************************************                probid =   05/04/96 06:06:23
 INP=s3020of OUTP=s3020of0

    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     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  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-        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 (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 = 6.36E-05 seconds with an estimated standard deviation of 1.45E-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.O

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  30% Water 15% U-Np O2
    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  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 O2        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 O2
    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 O2        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=s3020a0

    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 = 6.49E-05 seconds with an estimated standard deviation of 2.47E-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 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 0 113.15      $ 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 O2        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=3.0EC OUTP=3.0E.CO

    1-       FarField Criticality - Sphere of Transmuted 3.0E 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 3.0E 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
 ******************************************************************************                probid =   04/18/96 12:22:24
 INP=3.0EC OUTP=3.0E.CO

    1-       FarField Criticality - Sphere of Transmuted 3.0E 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 0 123.15      $ 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 3.0E 20GWD  30% Water 15% U-Np O2        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
 ***********************************************************************                probid =   05/02/96 07:39:43
 inp=s30e12h outp=s30e12h0

     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  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 =   05/02/96 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=s30e12g0

    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  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   -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
 ***********************************************************************                probid =   05/01/96 08:43:08
 inp=s30e12e outp=s30e12e0

     1-        FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water 11.6% U-Np O2
     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 O2      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
 ******************************************************************************                    probid =   04/24/96 12:55:39
 inp=s30e12b outp=s30e12b0

    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


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```

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 O2
    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  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 O2      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

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```

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


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```

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
 ******************************************************************************                    probid =   04/24/96 15:28:49
 inp=s30e12d outp=s30e12d0

    1-       FarField Criticality - Sphere of Transmuted 3.0E 20GWD  20% Water 11.6% U-Np O2
    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 O2      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


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```

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

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 |
 |  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 = 7.80E-05 seconds with an estimated standard deviation of 2.94E-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     1  8.354993-2   -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 .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 = 6.72E-05 seconds with an estimated standard deviation of 3.42E-07

```
1mcnp     version 4a    ld=10/01/93                          05/01/96 16:24:18
 ******************************************************************************                probid =   05/01/96 16:24:18
 inp=s3530i outp=s3530i0

    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     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  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 = 6.60E-05 seconds with an estimated standard deviation of 2.63E-07

```
1mcnp     version 4a    ld=10/01/93                          05/01/96 15:25:40
 ******************************************************************************                probid =   05/01/96 15:25:40
 inp=s3530h outp=s3530h0

    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 = 6.40E-05 seconds with an estimated standard deviation of 2.65E-07

```
1mcnp     version 4a    ld=10/01/93                          05/01/96 14:19:52
 ***********************************************************************                probid =   05/01/96 14:19:52
 inp=s3530g outp=s3530g0

    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
 ***********************************************************************                probid =   05/01/96 11:32:55
 inp=s3530f outp=s3530f0

    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 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 = 6.23E-05 seconds with an estimated standard deviation of 2.52E-07

```
1mcnp     version 4a    ld=10/01/93                    04/17/96 08:54:32
 ******************************************************************************                probid =   04/17/96 08:54:32
 inp=s3530b outp=s3530b0

     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 = 6.05E-05 seconds with an estimated standard deviation of 3.64E-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     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  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 = 6.12E-05 seconds with an estimated standard deviation of 3.11E-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     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  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 = 6.03E-05 seconds with an estimated standard deviation of 3.09E-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     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 = 6.04E-05 seconds with an estimated standard deviation of 2.73E-07

```
1mcnp     version 4a    ld=10/01/93                          05/03/96 10:49:38
 ***********************************************************************                probid =   05/03/96 10:49:38
 INP=4.0EC OUTP=4EC.0

    1-       FarField Criticality - Sphere of Transmuted 4.0E 40GWD  30% Water 15% U-Np O2
    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 -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 O2        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.O

    1-        FarField Criticality - Sphere of Transmuted 4.0E 40GWD  30% Water 15% U-Np O2
    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  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 O2        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
```