MOL.19971231.0251

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.) QA: L

Page: I . Of: 113

2. DESIGN ANALYSIS TITLE			
Criticality Evaluation of Degraded Internal Configurations for the PWR AUCF WP Designs			
3. DOCUMENT IDENTIFIER (Including Rev. No.) BBA000000-01717-0200-00056 REV 00			4. TOTAL PAGES 113
5. TOTAL ATTACHMENTS 11 hardcopy, 3 tape, & 2 disk	6. ATTACHMENT NUMBERS - NO. OF PAGES IN EACH See remarks section below		
	Printed Name	Signature	Date
7. Originator	John R. Massari	John Massari	9/4/97
8. Checker	E. Fuentes	E. Fuentes	9/4/97
9. Lead Design Engineer	Peter Gottlieb	P. Gottlieb	9/4/97
10. Department Manager	Hugh Benton	Hugh A. Benton	9/4/97

11. REMARKS

List of attachments with page count: I-2, II-4, III-14, IV-5, V-1, VI-2, VII-6, VIII-7, IX-3, X-4, XI-20

Initial Issue

Editorial Corrections made to pages III-1, III-8 to -11, and III-14 JM 9/18/97
JAC 9/18/97 for HAB

MOL.19971231.0251

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.) QA: L

Page: 1 . Of: 113

2. DESIGN ANALYSIS TITLE			
Criticality Evaluation of Degraded Internal Configurations for the PWR AUCF WP Designs			
3. DOCUMENT IDENTIFIER (Including Rev. No.) BBA000000-01717-0200-00056 REV 00			4. TOTAL PAGES 113
5. TOTAL ATTACHMENTS 11 hardcopy, 3 tape, & 2 disk	6. ATTACHMENT NUMBERS - NO. OF PAGES IN EACH See remarks section below		
	Printed Name	Signature	Date
7. Originator	John R. Massari	[signature]	9/4/97
8. Checker	E. Fuentes	[signature]	9/4/97
9. Lead Design Engineer	Peter Gottlieb	P. Gottlieb	9/4/97
10. Department Manager	Hugh Benton	Hugh A. Benton	9/4/97

11. REMARKS

List of attachments with page count: I-2, II-4, III-14, IV-5, V-1, VI-2, VII-6, VIII-7, IX-3, X-4, XI-20

Initial Issue

Editorial Corrections made to pages III-1, III-8 to -11, and III-14 JM 9/18/97 JAE 9/18/97 for HAB

QAP-3-9 (Effective 06/02/97) 0492 (Rev. 03/10/97)

Design Analysis Revision Record

Complete only applicable items.

(1.)

2. DESIGN ANALYSIS TITLE

Criticality Evaluation of Degraded Internal Configurations for the PWR AUCF WP Designs

3. DOCUMENT IDENTIFIER (Including Rev. No.)

BBA000000-01717-0200-00056 REV 00

4. Revision No.	5. Description of Revision
00	Initial Issue

1. Purpose

The purpose of this analysis is to provide input on the criticality potential of various degraded configurations to an analysis on the probability of a criticality event in a Pressurized Water Reactor (PWR) Advanced Uncanistered Fuel (AUCF) Waste Package (WP). The objective of this evaluation is to develop multivariate regressions which represent k_{eff} for the various degraded configurations as a function of fuel assembly parameters (i.e., burnup, enrichment, age), and configuration parameters (i.e., amount and distribution of remaining basket corrosion products, amount of borated stainless steel plate remaining). Potential design options for reducing the k_{eff} of the degraded configurations are also discussed. For guidance in determining the range of parameters which can occur, this analysis begins with a refinement of the WP degradation scenarios developed in previous degraded mode criticality evaluations (Refs. 5.16 and 5.37), as applied to the current reference WP designs (Ref. 5.5).

2. Quality Assurance

The Quality Assurance (QA) program applies to this analysis. The work reported in this document is part of the preliminary WP design analysis that will eventually support the License Application Design phase. This activity, when appropriately confirmed, can impact the proper functioning of the Mined Geologic Disposal System (MGDS) waste package; the waste package has been identified as an MGDS Q-List item important to safety and waste isolation (pp. 4, 15, Ref. 5.1). The waste package is on the Q-List by direct inclusion by the Department of Energy (DOE), without conducting a QAP-2-3 evaluation. The Waste Package Development Department responsible manager has evaluated this activity in accordance with QAP-2-0, *Conduct of Activities.* The *Perform Probabilistic Waste Package Design Analyses* activity evaluation (Ref. 5.2) has determined that work associated with determining the probability of criticality for degraded configurations is subject to *Quality Assurance Requirements and Description* (QARD; Ref. 5.3) requirements. As specified in NLP-3-18, *Documentation of QA Controls on Drawings, Specifications, Design Analyses, and Technical Documents,* this activity is subject to QA controls.

All design parameters and assumptions which are identified in this document are for preliminary design and shall be treated as unqualified data unless otherwise indicated; these design parameters and assumptions will require subsequent qualification (or superseding inputs) as the WP 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 (to be verified). In addition, the inputs associated with this analysis are not required to be procedurally controlled as TBV. However, use of any data from this analysis for input into documents supporting procurement, fabrication, or construction is required to be controlled as TBV in accordance with the appropriate procedures.

3. Method

The method used for this analysis involves the following steps:

A. Identify scenarios for degradation of the WP basket structure, and the PWR spent nuclear fuel (SNF) waste form. This task involves reviewing the available structural and corrosion information for the WP basket and fuel assembly materials to identify the sequence of basket component degradation, estimate the maximum lifetime of the component, and identify the corrosion products which may remain and have some impact on criticality. Based on this information, configurations to be evaluated in the remainder of the analysis are determined. This step is performed in Section 7.1.

B. Select fuel assembly parameters for evaluation by reviewing the historic and projected population of PWR fuel, and grouping the fuel according to the 10-year k_∞ as estimated by a multivariate regression developed by Oak Ridge National Laboratory (ORNL; Ref. 5.4). This ORNL regression was used in the initial determination of WP design configurations (Ref. 5.5) to bin the PWR fuel population into the various conceptual PWR WP types using k_∞ as a basis. For this analysis, k_∞ groups are defined which correspond to the binning method used in the design configuration analysis (e.g., k_∞<1.13 as the limit for the absorber plate WP), to allow an evaluation of the adequacy of that binning method. For each of these k_∞ groups, bounding burnup/enrichment pairs are identified, and their isotopics as a function of time since discharge are determined using the SAS2H and ORIGEN-S sequences of the SCALE 4.3 code package. This step is performed in Section 7.2.

C. Perform MCNP4A calculations of k_{eff} for the degraded internal WP configurations identified in step 1 above to identify the worst case configuration. The calculations start with the isotopics for the bounding k_∞ group for each PWR WP design and work backwards through less stressing fuels until k_{eff} no longer exceeds the defined limit for criticality concern at any time during the postclosure phase. For the purpose of this analysis, that limit will be defined as k_{eff} < 0.91 (see assumption 4.3.16). This step is performed in Sections 7.3 through 7.5.

D. Evaluate the data developed in step C and develop multivariate regressions which relate the k_{eff} for a particular class of configurations (e.g., intact fuel with fully degraded basket and oxide settled to bottom of WP) to various parameters for that class (e.g., time, burnup, enrichment, assemblies covered by oxide, etc...). This will simplify application of the data in future probabilistic analyses. This step is performed in Section 7.6.

E. Identify design options for reducing the peak postclosure k_{eff} of each PWR WP design for all fuels which will be contained in that package and for all degraded configurations. This step is performed in Section 7.7

Further detail on the specific methods employed for each step is available in Section 7 of this analysis.

4. Design Inputs

All design inputs are for preliminary design; these design inputs will require subsequent qualification (or superseding inputs) before this analysis can be used to support procurement, fabrication, or construction activities, unless otherwise noted.

4.1 Design Parameters

4.1.1 Spent Fuel Assembly Parameters

The fuel assembly upon which this calculation is based is the B&W 15 x 15 fuel assembly. The mechanical parameters for this assembly type are shown in Table 4.1-1. Note that inches are converted to centimeters exactly (2.54 cm/in.); this is not an indication of tolerance, but is done for consistency between calculations using English or metric units. The theoretical density of UO_2 is 10.96 g/cm^3 (Ref. 5.14, Table M8.2.1). This information represents actual B&W fuel assembly dimensions and is considered qualified data.

Table 4.1-1. Mechanical Parameters of B&W 15x15 Fuel Assembly

Parameter	Value	Units	Metric	Units	Radius (cm)	Ref.
Fuel Rods	208	/assbly	208	/assbly	-	5.7, p. 2.1.2.2-6
Fuel Rods on a Lattice Side	15	/side	15	/side	-	5.7, p. 2.1.2.2-6
Guide Tubes	16	/assbly	16	/assbly	-	5.7, p. 2.1.2.2-6
Instrumentation Tubes	1	/assbly	1	/assbly	-	5.7, p. 2.1.2.2-6
Total Guide + Instrument Tubes	17	/assbly	17	/assbly	-	-
Clad/Tube Material	Zirc-4		Zirc-4		-	5.7, p. 2.1.2.2-6
Fuel Pellet OD	0.3686	inches	0.936244	cm	0.468122	5.7, p. 2.1.2.2-6
Fuel Stack Height	141.8	inches	360.172	cm	-	5.7, p. 2.1.2.2-6
Fuel Assembly Height	165.625	inches	420.7	cm	-	5.9, p. 2A-8
Mass of U	1023	lb	464	kg	-	5.9, p. 2A-8
Mass of UO_2	1160.64	lb	526.38	kg	-	5.7, p. 2.1.2.2-6
Percent of Theoretical Density	95	%	95	%	-	5.7, p. 2.1.2.2-6
Fuel Clad OD	0.430	inches	1.0922	cm	0.5461	5.7, p. 2.1.2.2-6
Clad Thickness	0.0265	inches	0.06731	cm	-	5.7, p. 2.1.2.2-6
Fuel Clad ID*	0.377	inches	0.95758	cm	0.47879	-
Fuel Rod Pitch	0.568	inches	1.44272	cm	-	5.7, p. 2.1.2.2-6
Guide Tube OD	0.530	inches	1.3462	cm	0.6731	5.7, p. 2.1.2.2-6
Guide Tube Thickness	0.016	inches	0.04064	cm	-	5.7, p. 2.1.2.2-6
Guide Tube ID*	0.498	inches	1.26492	cm	0.63246	-
Instrumentation Tube OD	0.493	inches	1.25222	cm	0.62611	5.7, p. 2.1.2.2-6
Fuel Assembly Envelope	8.536	inches	21.68144	cm	-	5.7, p. 2.1.2.2-6
Displaced Volume per Fuel Assembly	4927	inches^3	0.081	m^3	-	5.10, p. II-3.6-98

* The inner diameters (IDs) above are calculated by subtracting 2 X thickness from the outer diameter (OD).

4.1.2 Intact Waste Package Geometry Parameters

The intact waste package geometry parameters used in this analysis are listed in Table 4.1-2 below. Figure 4.1-1 depicts the 21 Pressurized Water Reactor (PWR) Advanced Uncanistered Fuel (AUCF) absorber plate WP, its internals, and the material specifications (Ref. 5.17). This is considered unqualified TBV information, as other WPD QAP-3-9 analyses being performed in parallel may result in design changes not reflected in this analysis.

Table 4.1-2. Intact WP Dimensions

Component	Dimension	Reference
Outer barrier length (skirt edge to skirt edge)	533.5 cm	5.15, p. I-18
Outer barrier skirt length (both ends)	22.5 cm	5.15, p. I-18
Outer barrier lid thickness	11.0 cm	5.15, p. I-18
Outer barrier inner radii	73.1 cm	5.16,.p. 8
Outer barrier outer radii	83.1 cm	5.16, p. 8
Gap between inner and outer lids	3.0 cm	5.15, p. I-18 & 19
Inner barrier length (overall)	463.5 cm	5.15, p. I-19
Inner barrier lid thickness	2.5 cm	5.15, p. I-19
Inner barrier inner radii	71.095 cm[1]	5.16, p. 8
Inner barrier outer radii	73.095 cm	5.16, p. 8
Fuel cell tube thickness	0.5 cm	5.15, p. I-21
Fuel cell tube height	457.5 cm	5.15, p. I-21
Fuel cell tube outside width	23.64 cm	5.15, p. I-21
Total displaced volume of single fuel cell tube	0.02117 m^3	5.15, p. VI-1
Criticality control plate thickness	0.7 cm	5.15, p. I-29 to 31
Criticality control plate height	113.38 cm	5.15, p. I-20
Total displaced volume of all criticality control plates	0.243 m^3	5.15, p. VI-1
Total displaced volume of guides and supports	0.259 m^3	5.15, p. VI-1

1- Excel spreadsheet calculations of oxide volume fractions used the more recent inner barrier inner radii of 70.485 cm from Reference 5.15, p. I-19.

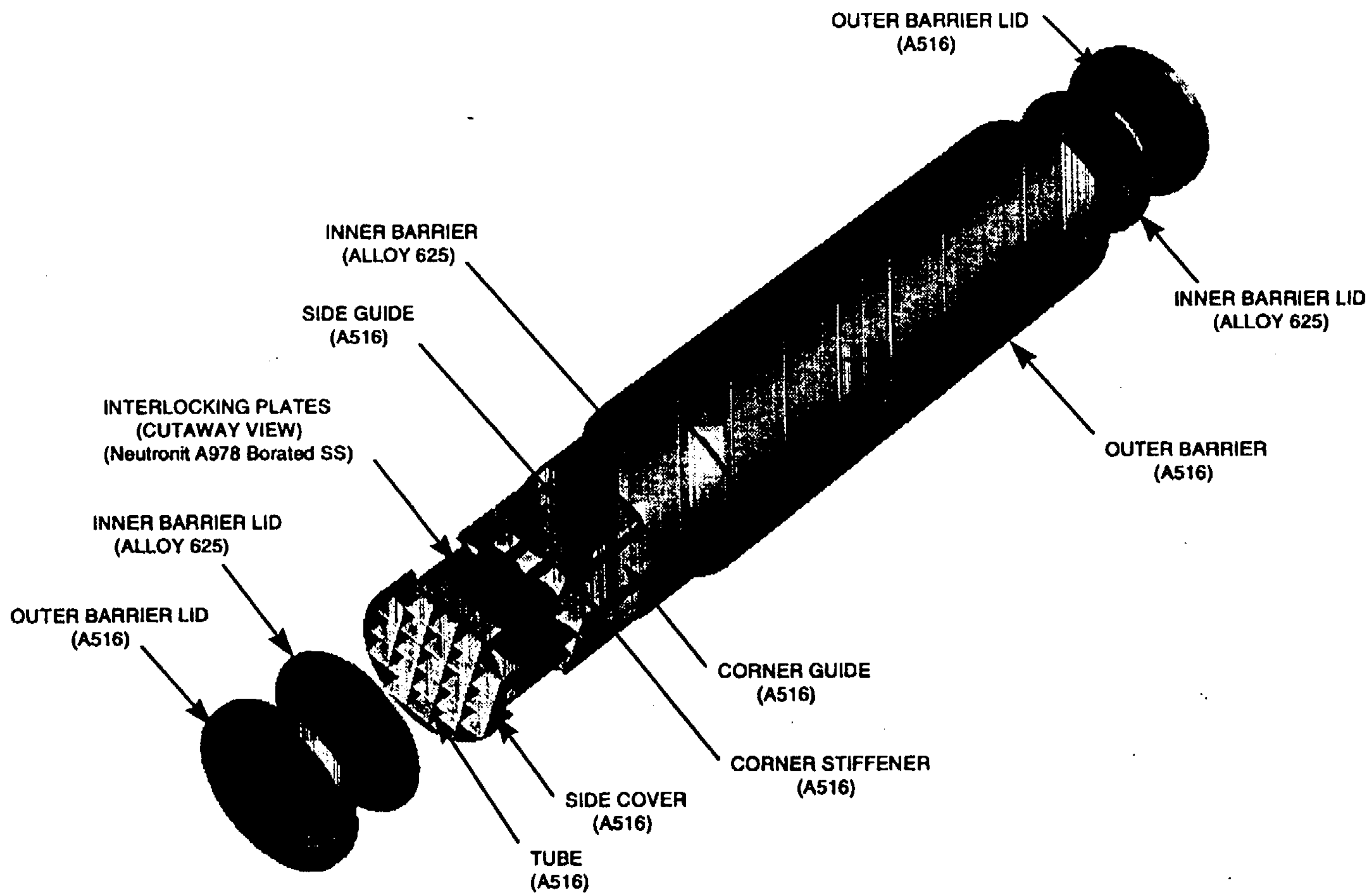


Figure 4.1-1. Advanced Uncanistered Fuel Waste Package with Internals Shown

4.1.3 Material Properties

The atomic weights of isotopes are listed in Table 4.1-3 below (Ref. 5.18, pp. 941-978, unless otherwise noted). This information is obtained from qualified QAP-3-9 analyses, or is considered established fact, and is therefore considered qualified.

Table 4.1-3. Atomic Weights in g/mole (Ref. 5.18)

Isotope	MCNP ID#	Atomic Weight
B-10	5010.50C	10.0129388
B-11	5011.56C	11.0093053
Nat. O	not used	15.9994*
O-16	8016.50C	15.994915
Nat. Fe	26000.55C	55.847*
Mo-95	42095.50C	94.905839
Tc-99	43099.50C	98.90627501**
Ru-101	44101.50C	100.905576
Rh-103	45103.50C	102.905511
Ag-109	47109.50C	108.904756
Nd-143	60143.50C	142.909779
Nd-145	60145.50C	144.912538
Sm-147	62147.50C	146.914867
Sm-149	62149.50C	148.91718
Sm-150	62150.50C	149.917276
Sm-151	62151.50C	150.919919
Sm-152	62152.50C	151.919756
Eu-151	63151.55C	150.919838
Eu-153	63153.55C	152.921242
Gd-155	64155.50C	154.922664
U-233	92233.50C	233.039522
U-234	92234.50C	234.040904
U-235	92235.50C	235.043915
U-236	92236.50C	236.045637
U-238	92238.50C	238.05077
Np-237	93237.55C	237.048056
Pu-238	94238.50C	238.049511
Pu-239	94239.55C	239.052146
Pu-240	94240.50C	240.053882
Pu-241	94241.50C	241.056737
Pu-242	94242.50C	242.058725
Am-241	95241.50C	241.056714
Am-242m	95242.50C	242.059502
Am-243	95243.50C	243.061367

* From Reference 5.20, pp. 16 &17

** From Reference 5.19

Avogadro's Number $[N_A] = 0.602252\ (\text{g-mol})^{-1} \times 10^{24}$ (Ref. 5.18, p. 933).

Densities of non-fuel materials used in this analysis is as follows:

A 516 Grade 55 Carbon Steel	7832	kg/m^3	Reference 5.19, p. I-1
SS316B6A w/ 20% B removed	7745	kg/m^3	Reference 5.19, p. I-12
B_4C with natural B	1780	kg/m^3	Reference 5.19, p. I-15
Iron Oxide (Fe_2O_3)	5240	kg/m^3	Reference 5.22, p. B-104
Zircaloy-4	6560	kg/m^3	Reference 5.19, p. I-16
Inconel Alloy 625	8442	kg/m^3	Reference 5.23, p. 1
Water	1000	kg/m^3	Reference 5.19, p. I-19

Chemical compositions of alloys used in this analysis are given in Table 4.1-4 below.

Table 4.1-4. Chemical Compositions of Non-Fuel Materials

Element \ Material	A 516 Gr. 55 Carbon Steel (Ref. 5.19, p. I-1)	Inconel Alloy 625 (Ref. 5.23, p. 3)	B_4C (Ref. 5.19, p. I-15)	Zircaloy-4 (Ref. 5.19, p. I-16)	SS316B6A w/ 20% B removed (Ref. 5.19, p. I-12)
Fe	98.535%	5.000%	-	0.200%	60.6390%
^{10}B / ^{11}B	-	-	14.143%/ 64.427%	-	0.2311%/ 1.0530%
Cr	-	21.500%	-	0.100%	19.0610%
Ni	-	58.000%	-	-	13.5433%
Mn	0.900%	0.500%	-	-	2.0064%
Mo	-	9.000%	-	-	2.5080%
N	-	-	-	-	0.1003%
S	0.035%	0.015%	-	-	0.0301%
Si	0.275%	0.500%	-	-	0.7524%
P	0.035%	0.015%	-	-	0.0451%
C	0.220%	0.100%	21.430%	-	0.0301%
O	-	-	-	0.120%	-
Co	-	0.930%	-	-	-
Ti	-	0.400%	-	-	-
Al	-	0.400%	-	-	-
50% Nb + 50% Ta	-	3.600%	-	-	-
Zr	-	-	-	98.180%	-
Sn	-	-	-	1.400%	-

4.1.4 Stainless Steel Corrosion Data

Several researchers have investigated the general corrosion rates of 304 and 316 series stainless steels in J-13 well water environments which roughly bound the range of conditions indicated in assumption 4.3.8. A summary of this corrosion data for temperatures in the 28 - 100°C range is given in Table 4.1-5. These temperatures cover the range expected for the WP internals (Ref. 5.33) for times later than 3,000 years in a repository with a thermal loading of 83 MTU/acre (see assumption 4.3.10), which is when the majority of WPs will begin to fail (see assumption 4.3.9) and release the He fill gas which previously maintained an inert environment within the WP. While the specified criticality control material is Neutronit A978 (with a composition similar to the conceptual borated 316 stainless steel, SS316B6A, in Ref. 5.19), much of the stainless steel corrosion data collected in repository relevant environments is for 304 stainless steels, because this was the material specified for the old borehole emplaced WP design. This data has been included in Table 4.1-5 because 304 stainless steels have performed similarly to 316 stainless steel in repository relevant tests which included both materials, and they are generally recognized as being less corrosion resistant than 316 stainless steels in harsher environments.

Based on the short term (relative to the time frames being considered) corrosion information in Table 4.1-5, the corrosion rate for 304/316 stainless steels in the typical J-13 well water environment ranges between 0.02 - 0.57 μm/yr in tests lasting from less than 100 hours to tests lasting more than 11,000 hours. The middle of this range on a log scale is ≈0.1 μm/yr, and many of the longer corrosion test show corrosion rates that are comparable or less than this by the end of the test, so this value will be used as the typical corrosion rate for 304/316 stainless steel for this analysis. At a pH slightly below that of the bottom range given in assumption 4.3.8, or Cl^- concentrations (a significant influence on SS corrosion per Ref. 5.34, p. 148) ≈2,500x that of J-13, the corrosion rates of 304/316 stainless steels were 1 to 2 orders of magnitude higher than in the typical environment. At a pH near the top of assumption 4.3.8, and Cl^- concentration ≈150x J-13, the corrosion rates were only slightly to one order of magnitude higher than the typical range. Therefore, a rate of 1 μm/yr (one order of magnitude higher than typical) will be used as the upper bound for the 304/316 stainless steel corrosion rate. The lower bound of the stainless steel corrosion rate will be taken to be that of the lower range of the J-13 tests, 0.02 μm/yr, to account for the possibility of further passivation of the stainless steel than that which occured during the relatively short duration tests shown in Table 4.1-5. Figure 4.1-2 illustrates the effects of passivation on the corrosion rate of 304L stainless steel in J-13 well water at temperatures of 90 to 100°C.

Most of the tests in Table 4.1-5 were performed for unborated stainless steel. The one comparison of borated versus unborated 304L stainless steel in a low pH environment found that the borated material (with 1.23 wt% B) had a corrosion rate that was 4x that of the unborated material. Reference 5.31 (pp. 3-22 to 3-27) also indicates that borated stainless steels with boron contents between 1-2% show decreased resistance to general, pitting, crevice, and intergranular corrosion in harsh (boiling acidic and/or high Cl^-) environments as boron content increases. However, a six month test in more benign spent fuel pool conditions of 68°C and pH of 5.3 (2,000 ppm boric acid) showed no difference in corrosion

Table 4.1-5. 304 and 316 SS General Corrosion Data

SS Material	Environment	pH	Cl- (ppm)	Test Type	Test Duration (hours)	Test Temp(s) (°C)	Corrosion Rate (μm/yr)	Reference
304L	J-13	7.6^2	6.9^2	weight loss	10-11k	50-100	0.07-0.13	5.25, p. 24
304L	J-13	7.6^2	6.9^2	weight loss	3.5-5k	50-100	0.03-0.23	5.28, p. 24
304L	J-13	7.6^2	6.9^2	weight loss	8.8k	28	0.14-0.45	5.25, p. 26
304L	J-13 w/ crushed tuff	7.6^2	6.9^2	weight loss	1k	100	0.25	5.27, p. 79
304L	Simulated J-13 w/ Alloy 825 galv. couple	7^2	6.4^2	electrochem.	0-1k	90	0.08-0.37	5.26, p. 108
304L	Simulated J-13 w/ Alloy 825 galv. couple	7^2	6.4^2	electrochem	1-2k	90	0.04-0.07	5.26, p. 108
304L	Simulated J-13	7^2	6.4^2	electrochem.	0-2k	90	0.02-0.14	5.27, p. 35
304L	Simulated J-13	7^2	6.4^2	weight loss	2k	90	0.57	5.26, p. 117
316L	J-13	7.6^2	6.9^2	weight loss	10-11k	50-100	0.04-0.15	5.25, p. 24
316L	J-13	7.6^2	6.9^2	weight loss	3.5-5k	50-100	0.10-0.28	5.28, p. 24
316L	J-13 w/ crushed tuff	7.6^2	6.9^2	weight loss	1k	100	0.51	5.27, p. 79
304L	Sim. J-13 Sol. 20 (vapor/liq./alternating)	10^2	1000^2	weight loss	2.9k	90	0.03/0.29/0.43	5.27, p. 54
304L	Sim. J-13 Sol. 20 (vapor/liq./alternating)	10^2	1000^2	electrochem.	0-2.5k	90	0.04-0.18	5.27, p. 56
304L	Sim. J-13 Sol. 20	10^2	1000^2	electrochem.	0-1k	90	0.46-1.3	5.27, p. 114
304L	Sim. J-13 Sol. 20	10^2	1000^2	electrochem.	1-2k	90	0.04-0.25	5.27, p. 114
304L	Sim. J-13 Sol. 20	10^2	1000^2	weight loss	2k	90	1.57	5.27, p. 114
304	Ocean Surface	8^3	$19k^3$	weight loss	9.3k	17.6	14.6	5.24, p. 40
316	Seawater, Kure Beach, NC	8^3	$19k^3$	weight loss	11.5k	0-40	6.11	5.29, p. 21
316	Seawater, Panama Canal	8^3	$19k^3$	weight loss	8.8k/70k/140k	0-40	14.99/6.4/1.25	5.29, p. 21
304L	See Note 1 below	3.8	0.4	weight loss	96	90	10	5.30, p. 14
B-304L	See Note 1 below	3.8	0.4	weight loss	96	90	41	5.30, p. 14

Note 1: 0.01M formic acid, 0.01M sodium formate, 0.02M sodium oxalate, 0.01M nitric acid, 0.01M sodium chloride, 0.01M hydrogen peroxide in dist. water.
Note 2: J-13 and Simulated J-13 composition based on Reference 5.27, Table 2.3. Simulated J-13 Solution 20 composition from Reference 5.27, Table B.3.
Note 3: Seawater composition based on Reference 5.24, Table 28.

resistance for stainless steel with boron concentrations of 1% to 1.75% (Ref. 5.31, p. 3-22). Therefore, to more conservatively model the corrosion of Neutronit A978 with the available data, a factor of 4 will be applied to the lower bound, typical, and upper bound corrosion rates defined for unborated 304/316 stainless steels. Data presented in this section is based on preliminary corrosion testing and is therefore considered unqualified TBV data.

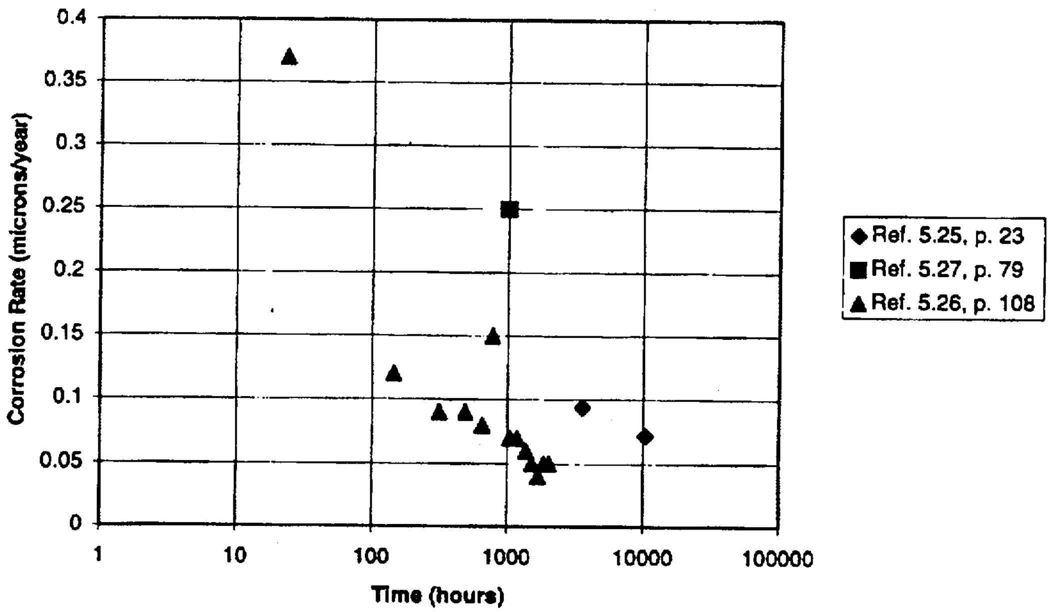


Figure 4.1-2. Corrosion Rate of 304L Stainless Steel as a Function of Time in 90-100°C J-13 Well Water

4.2 Criteria

The *Engineered Barrier Design Requirements Document* (EBDRD; Ref. 5.8) contains several criteria which relate to criticality control. The "TBD" items identified in these criteria will not be carried to the conclusions of this analysis based on the rationale that the conclusions are for preliminary design, and will not be used as input in design documents supporting construction, fabrication, or procurement. A review of the EBDRD and CDA identified the following relevant requirements:

4.2.1 Criticality Control

The EBDRD requirements 3.2.2.6 and 3.7.1.3.A both indicate that a WP criticality shall not be possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. These requirements also indicate that the design must provide for criticality safety under normal and accident conditions, and, that the calculated effective multiplication factor (k_{eff}) 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. The latter requirement contains a "TBD" at the end.

CDA Assumption EBDRD 3.7.1.3.A (Ref. 5.21, p. 4-32) clarifies that the above requirement is applicable to only the preclosure phase of the MGDS, in accordance with the current DOE position on postclosure criticality. This assumption also indicates that for postclosure, the probability and consequences of a criticality provide reasonable assurance that the performance objective of 10CFR60.112 is met. While the Nuclear Regulatory Commission (NRC) has not yet endorsed any specific change for postclosure, they have indicated that they agree that one is necessary.

Finally, EBDRD 3.3.1.G indicates that "The Engineered Barrier Segment design shall meet all relevant requirements imposed by 10CFR60." The NRC has recently revised several parts of 10CFR60 which relate to the identification and analysis of design basis events (Ref. 5.13) including the criticality control requirement, which was moved to 60.131(h). These changes are not reflected in the current versions of the EBDRD or the CDA. The change to the criticality requirement simply replaces the phrase "criticality safety under normal and accident conditions" with "criticality safety assuming design basis events."

This analysis contributes to satisfying the proposed postclosure requirement by supporting probabilistic analyses of internal PWR AUCF WP criticality. The probabilistic analysis, along with an estimate of internal criticality consequences to be performed in a separate analysis, will be considered in the Total System Performance Assessment (TSPA) - Viability Assessment (VA) to demonstrate compliance with the performance objective of §60.112 (or, as appropriate, other applicable performance objectives in effect or proposed by the NRC at the time the TSPA-VA analysis is performed). Evaluations of potential design options also consider the 5% administrative margin in the current requirement.

4.3 Assumptions

All assumptions are for preliminary design; these assumptions will require verification before this analysis can be used to support procurement, fabrication, or construction activities.

4.3.1 Principal Isotope (PI) burnup credit is assumed to be an acceptable method to account for reduced reactivity of SNF in criticality evaluations. The basis for this assumption is CDA Key 009 (Ref. 5.44). This assumption is used throughout Section 7.

4.3.2 It is assumed that B&W Mark B 15 x 15 fuel type is bounding for all PWR assembly designs. The basis for this assumption is a previous evaluation performed for the BR-100 transportation cask, which established the B&W Mark B assembly as one of the more reactive PWR fuel designs under intact fuel assembly and fixed basket geometry conditions (Ref. 5.10, p. II.6-6). This assumption is used throughout Section 7.

4.3.3 For spent nuclear fuel (SNF), the list of "Principal Isotopes" previously established (Ref. 5.46, p. 4-4) for long-term criticality control was used. The 29 principal isotopes are shown in Table 4.3-1. This assumption is used throughout Sections 7.

Table 4.3-1. Principal Long-Term Burnup Credit Isotopes

-	Mo-95	Tc-99	Ru-101	Rh-103
Ag-109	Nd-143	Nd-145	Sm-147	Sm-149
Sm-150	Sm-151	Sm-152	Eu-151	Eu-153
Gd-155	U-233	U-234	U-235	U-236
U-238	Np-237	Pu-238	Pu-239	Pu-240
Pu-241	Pu-242	Am-241	Am-242m	Am-243

4.3.4 Reserved.

4.3.5 It is assumed that the WP is fully flooded for this analysis. The basis for this assumption is that it is conservative, and moderation is a required condition for criticality in commercial SNF with an enrichment of less than 5 wt% (Ref. 5.46). Furthermore, scenarios leading to a fully flooded WP have been proposed in previous QAP 3-9 analyses (Ref. 5.37, p. 17). The probability of achieving and maintaining this condition for a long period of time will be evaluated in the probabilistic analysis which this document supports. This assumption is used throughout Section 7.

4.3.6 It is assumed that the k_{eff} of commercial SNF is conservatively determined using a single fuel region assembly in the MCNP model and using isotopics developed with the SAS2H fuel depletion model used in Reference 5.43. The following core operating conditions from Reference 5.43 were used for the SAS2H runs: a maximum B&W 177 fuel assembly core moderator outlet temperature of 607.6 K, maximum pellet average temperature of 975 K, maximum beginning of cycle hot full power boron concentration of 1,050 ppm and average boron concentration of 552.6 ppm, cladding temperature 42 K higher than moderator outlet temperature, and an average 7.25 MW/assembly. The basis for using a single node fuel region in the MCNP model is that a single axial node has been found to provide conservative results compared to a multi-node for fuel assembly burnups less than ≈30 GWd/MTU (much of the fuel of concern for this analysis has burnup less than this) in other analyses using different code systems (Ref. 5.47) or depletion models (Ref. 5.48, App. B). The basis for using the Reference 5.43 SAS2H model is that it was developed under the M&O QAP-3-9 procedure and attempts to conservatively model assembly isotopics (from the standpoint of maximizing reactivity) by minimizing moderator density and using a minimum assembly specific power to achieve a longer burntime. However, it does not take into account the effects of burnable poison rods, control rods, or axial power shaping rods which may be in the assembly at some time during reactor operation, and which also have the potential increasing the reactivity of the spent fuel assembly. Bounding methods for modeling commercial PWR fuel isotopics using the SAS2H/MCNP code system are currently being developed by the WPD Criticality Analysis Methodology Group for use during the License Application phase of design. This assumption is used throughout Section 7.

4.3.7 The long-term (300-20,000 years after emplacement) design-basis ambient (naturally existing) flow conditions are provided by CDA Assumption TDSS 026 (Ref. 5.21, p. 10-22) and are grouped into three categories: Fully Mediated (steady in time and uniform in space), Steady Focused (steady in time and focused in space), and Episodic Focused (episodic in time and focused in space). The assumed flow rates of water onto the WP, and the frequency of occurrence for each category are as follows:

Category	Flow Rate	Frequency
Fully Mediated	0.5 m^3/year	Nominal
Steady Focused	20 m^3 /year	Once per 40 years
Episodic Focused	20 m^3 /year, occurring over one week	Once per 40 years

Furthermore, the Rationale section of TDSS 026 also indicates that the above mentioned ambient flow assumptions do not consider the spatial variation of average flux across the repository footprint, which is estimated to be between near zero to a factor of five times the average infiltration flux. An average value of 2.5 times the average flux will be used for this analysis. This assumption is used in Section 7.1.

4.3.8 The composition of seeping water that enters the excavated volume of the repository per CDA Assumption TDSS 025 (Ref. 5.21, p.10-20) is assumed to be:

Typical:	pH 7.4 (J-13)
Variability:	pH 4.5 to 10.5
	Concentration factor of 0.1 to 10 times the nominal J-13

These variabilities of the water chemistry are applicable to the water influx at the edge of the excavated volume. The basis for this assumption is given in TDSS 025. For this analysis, the above composition is also taken to be the composition of the water entering the WP.

4.3.9 It is assumed, per the WP barrier design goal in CDA Assumption Key 074 (Ref. 5.21, p. 3-64), that no more than 10 waste packages will breach within 3,000 years after repository closure when exposed to the near-field environment based on assumptions 4.3.7 and 4.3.8 as modified by the engineered barrier system. Breaching of the waste package is defined as an opening through the wall of the waste package through which advective or diffusive transport of gas or radionuclides can occur. The basis for this assumption is given in Key 074. This assumption is used in Section 7.1.

4.3.10 It is assumed that the repository thermal loading will be within the range of 80-100 MTU/acre (corrosion times based on WP temperatures in an 83 MTU/acre thermal loading are used). The basis for this assumption is provided in CDA Assumption Key 019 (Ref. 5.21, p. 3-64). This assumption is used in Section 7.1.

4.3.11 The following equation obtained from Reference 5.4, page 7, is assumed to provide representative , but slightly conservative values for PWR SNF assembly k_∞ values:

$$k_\infty = 1.06 - 0.01 \cdot b - 0.002 \cdot c + 0.114 \cdot a + 0.00007081 \cdot b^2 + 0.00007565 \cdot c^2 - 0.007 \cdot a^2 - 0.0002671 \cdot b \cdot a - 0.0001145 \cdot b \cdot c + 0.0002318 \cdot c \cdot a + 0.000009366 \cdot b \cdot c \cdot a$$

where, a = initial U235 enrichment in weight percent,
b = assembly burnup in GWd/MTU, and
c = assembly cooling time (i.e., age) in years (< 20 years).

The usage and development of this equation is presented in detail in Reference 5.4. The basis for using this equation is that it was used in defining the WP design configurations in Reference 5.5, and is used in this analysis only to identify the range of burnups and enrichments of fuels currently intended for a specific WP design. This assumption is used in Sections 7.2 and 7.7.

4.3.12 It is assumed for the purposes of estimating the amount of iron oxide removal that 100% of the water flowing onto the WP enters the interior, and that iron saturated internal water is exchanged with unsaturated water from the outside with a 10% efficiency. The basis for the former assumption is that it is very conservative because some fraction of water dripping onto the WP is likely to run off rather than enter, especially when the WP is only initially breached by small pits. The latter assumption is based on the high range of the exchange efficiency used in Reference 5.37 assumption 4.3.4, and the fact that water that is both entering and leaving the WP at the top is not likely to significantly mix with the water in the lower portion of the WP, which is where most of the iron oxide will be. This assumption is used in Section 7.1.

4.3.13 The specific MGDS commercial SNF assembly population data (burnup and enrichment) to consider for this analysis were identified in Reference 5.42 and have been developed based upon the best information available to the MGDS program. The specific electronic data file used from Reference 5.42 is the uncompressed C1_WSM.ZIP, with only the information on the historic and projected PWR population used for this analysis. However, since a 10 year age will be assumed for all PWR assemblies in the binning process performed here, and the assembly receipt time information in the data file is not being used, any of the files for scenarios C1 through C8 could be used because the burnup and enrichment information does not change. The basis for this assumption is that it is consistent with Ref. 5.5 and several other recent MGDS throughput analyses. The basis for assuming the 10 year fuel age for all assemblies is that it is conservative with respect to the k_∞ calculated using the equation in assumption 4.3.11, and is consistent with CDA Assumption Key 004 (Ref. 5.21, p. 3-15) which indicates that fuel younger than 10 years will not be accepted at the MGDS. This assumption is used in Section 7.2.

4.3.14 It is assumed that the 304/316 stainless steel general corrosion data can be used to represent the bulk corrosion of Neutronit A978 borated stainless steel in repository environments, when increased by a factor of 4. The basis for this assumption is that Neutronit A978 is similar in composition to 316 stainless steel, and corrosion data in repository relevant environments is only available for 304/316 stainless steels. Furthermore, a borated 304 stainless steel was found to have a corrosion rage 4 times that of unborated stainless steel in a short term corrosion test in a harsh environment (see Section 4.1.4). This assumption is used in Section 7.1.

4.3.15 While Reference 5.5 (p. 6) indicates that Disposal Control Rod Assemblies (DCRA) will be zircaloy clad with B_4C as the neutron absorber material, no other design details have been developed at this time. Therefore, it is assumed that the DCRA rods are clad with Zircaloy-4 and have a cladding thickness that is equivalent to that of a thick fuel rod cladding, 0.0762 cm (based on 0.030 in. for the thickest PWR fuel cladding from Exxon; Ref. 5.7, p. 2.1.2.2-2). The basis for this assumption is that the DCRA rod cladding should be fabricated from material that is at least as thick and corrosion resistant as the fuel rod cladding, to ensure that the DCRA lasts longer than the fuel rod. Furthermore, it is assumed that there is a 0.0762 cm gap between the OD of the DCRA rod and the ID of the guide tube. The basis for this assumption is engineering judgement to allow adequate clearance for insertion of the DCRA rod into the guide tube. Finally, it is assumed that there is a gap of 0.0165 cm between the ID of the DCRA rod cladding and the OD of the B_4C pellets. The basis for this assumption is engineering judgement to make the gap thickness similar to that of a long-life control rod (Ref. 5.7, p. 2.1.2.2-7). Based on the above DCRA rod thickness and gap assumptions, and the 0.63246 cm inner radius of the guide tube (see Table 4.1-1) minus 0.1016 mm (0.004 in.) for tolerance, the following DCRA rod dimmensions are obtained:

DCRA cladding outer radius	0.5461 cm
DCRA cladding inner radius	0.4699 cm
B_4C pellet outer radius	0.4534 cm

This assumption is used in Sections 7.4 and 7.7.

4.3.16 It is assumed, for the purpose of estimating the amount of additional carbon steel necessary for long-term criticality control of the the absorber plate WP under the worst configuration, that the bias and uncertainty in the method of calculation used for this analysis is 4%. The basis for this assumption is that previous analyses (Ref. 5.54) of fresh medium and high enriched fuel using MCNP and the ENDF B/V cross section library had a bias of ≈2%. Furthermore, analyses of fresh PWR fuel using the SAS2H/KENO code system and the ENDF B/IV cross section library had a bias of ≈2.5%. As benchmarking of a model for PWR fuel has not yet been completed, the 4% bias is used with the expectation that it will be conservative. Bounding methods for modeling commercial PWR fuel isotopics using the SAS2H/MCNP code system and ENDF B/VI cross section library are currently being developed by the WPD Criticality Analysis Methodology Group for use during the License Application phase of design.

4.3.17 It is assumed for the purpose of evaluating the absorber rod WP that its basket contains the same amount of iron as that of the absorber plate WP, and thus the amounts of iron oxide produced will be the same. The basis for this assumption is engineering judgement until detailed design information for the absorber rod WP can be developed. This assumption is used in Section 7.4.

4.4 Codes and Standards

None used.

5. References

5.1 *Q-List*, YMP/90-55Q, REV 4, Yucca Mountain Site Characterization Project.

5.2 *Perform Probabilistic Waste Package Design Analyses*, QAP-2-0 Activity Evaluation No. WP-25, Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O), August 3, 1997.

5.3 *Quality Assurance Requirements and Description*, DOE/RW-0333P, REV 7, Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM).

5.4 *Reactivity and Isotopic Composition of Spent PWR Fuel as a Function of Initial Enrichment, Burnup, and Cooling Time*, ORNL/CSD/TM-244, Oak Ridge National Laboratory, October 1987.

5.5 *Determination of WP Design Configurations*, Document Identifier Number (DI#): BBAA00000-01717-0200-00017 REV 00, CRWMS M&O.

5.6 *Mined Geologic Disposal System Advanced Conceptual Design Report*, DI#: B00000000-01717-5705-00027 REV 00, CRWMS M&O.

5.7 *Preliminary Waste Form Characteristics Report Version 1.0*, UCRL-ID-108314 Rev 1, Lawrence Livermore National Laboratory, December 1994.

5.8 *Engineered Barrier Design Requirements Document*, YMP/CM-0024, REV 0, ICN 1, Yucca Mountain Site Characterization Project.

5.9 *Characteristics of Potential Repository Wastes*, DOE/RW-0184-R1, Volume 1, US DOE OCRWM, July 1992.

5.10 *Final Design Package - Babcock & Wilcox BR-100 - 100 Ton Rail/Barge Spent Fuel Shipping Cask*, Document No. 51-1203400-01, B&W Fuel Company, November 1991.

5.11 Software Qualification Report for the SCALE Modular Code System Version 4.3, DI#: 30011-2002 REV 01, CRWMS M&O.

5.12 Software Qualification Report for MCNP4A, DI#: 30006-2003 REV 02, CRWMS M&O.

5.13 *10 CFR Part 60; Disposal of High-Level Radioactive Wastes in Geologic Repositories; Design Basis Events; Final Rule*, U.S. Nuclear Regulatory Commission, Federal Register, Volume 61, Number 234, pp. 64257-64270, December 4, 1996.

5.14 *SCALE 4.3*, RSIC Computer Code Collection, CCC-545, Oak Ridge National Laboratory, October 1995.

5.15 *Waste Package Design Basis Events*, DI#: BBA000000-01717-0200-00037 REV 00, CRWMS M&O.

5.16 *Probabilistic Criticality Consequence Evaluation*, DI#: BBA000000-01717-0200-00021 REV 00, CRWMS M&O.

5.17 *Waste Package Materials Selection Analysis*, DI#: BBA000000-01717-0200-00020 REV 00, CRWMS M&O.

5.18 Benedict, Manson, et al., *Nuclear Chemical Engineering*, Second Edition, McGraw-Hill Book Company, New York, 1981.

5.19 *Material Compositions and Number Densities for Neutronics Calculations*, DI#: BBA000000-01717-0200-00002 REV 00, CRWMS M&O.

5.20 *Nuclides and Isotopes*, 14th Edition, general electric Company, 1989.

5.21 *Controlled Design Assumptions Document*, DI#: B00000000-01717-4600-00032 REV 04, ICN 01, CRWMS M&O.

5.22 *CRC Handbook of Chemistry and Physics*, 66th Edition, CRC Press, 1985.

5.23 *Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNSN06625) Plate, Sheet, and Strip*, ASTM B443-93$^{\epsilon 1}$, American Society for Testing and Materials, Philadelphia, PA.

5.24 *Survey of Degradation Modes of Four Nickel-Chromium-Molybdenum Alloys*, UCRL-ID-108330, Lawrence Livermore National Laboratory, March 1991.

5.25 *Progress Report on the Results of Testing Advanced Conceptual Design Metal Barrier Materials Under Relevant Environmental Conditions For A Tuff Repository*, UCID-21044, Lawrence Livermore National Laboratory, December 1987.

5.26 *Pitting, Galvanic, and Long-term Corrosion Studies on Candidate Container Alloys for the Tuff Repository*, NUREG/CR-5709, U.S. Nuclear Regulatory Commission, January 1992.

5.27 *Immersion Studies on Candidate Container Alloys for the Tuff Repository*, NUREG/CR-5598, U.S. Nuclear Regulatory Commission, May 1991.

5.28 *Electrochemical Determination of the Corrosion Behavior of Candidate Alloys Proposed for Containment of High Level Nuclear Waste in Tuff*, UCID-20174, Lawrence Livermore National Laboratory, June 1984.

5.29 *Survey of Degradation Modes of Candidate Materials for High-Level Radioactive-Waste Disposal Containers, Volume 2 - Oxidation and Corrosion*, UCID-21362 Vol. 2, Lawrence Livermore National Laboratory, August 1988.

5.30 Van Konynenburg, R. A., Curtis, P. G., "Scoping Corrosion tests on Candidate Waste Package Basket Materials for the Yucca Mountain Project", *High Level Radioactive Waste Management - Proceedings of the Seventh Annual International Conference*, American Nuclear Society, pp. 464-467, April 29 - May 3, 1996.

5.31 *Borated Stainless Steel Application in Spent-Fuel Storage Racks*, EPRI TR-100784, Electric Power Research Institute (EPRI), June 1992.

5.32 Stephens, J. J., Sorenson, K. B., McConnell, P., *Elevated Temperature Tensile Properties of Borated 304 Stainless Steel: Effect of Boride Dispersion on Strength and Ductility*, white paper, Sandia National Laboratories, performed under DOE contract DE-AC04-76DP00789.

5.33 *Total System Performance Assessment - 1995, An Evaluation of the Potential Yucca Mountain Repository*, DI #: B00000000-01717-2200-00136 REV 01, CRWMS M&O.

5.34 Sedriks, A. John, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., 1996.

5.35 Product Handbook, Inco Alloys International, Huntington, WV, Publication No. IAI-38, 1988.

5.36 *Emplaced Waste Package Structural Capability Through Time Report*, DI #: BBAA00000-01717-5705-00001 REV 00, CRWMS M&O.

5.37 *Second Waste Package Probabilistic Criticality Analysis: Generation and Evaluation of Internal Criticality Configurations*, DI#: BBA000000-01717-2200-00005 REV 00, CRWMS M&O.

5.38 Brown, R. L., Richards, J. C., *Principles of Powder Mechanics - Essays on the Packing and Flow of Powders and Bulk Solids*, Pergamon Press, 1970.

5.39 *Radiation Effects on Tube Denting in the Steam Generators of Pressurized Water Reactors*, UCRL-52892, Lawrence Livermore National Laboratory, February 1980.

5.40 *Criticality Abstraction/Testing Workshop Results*, DI#: B00000000-01717-2200-00187 REV 00, CRWMS M&O.

5.41 Goldberg, S., Glaubig, R. A., "Boron Adsorption on Aluminum and Iron Oxide Minerals", *Soil Sciences Society of America Journal*, Volume 49, pp. 1374-1379, 1985.

5.42 *Input Files and Models Used in the Waste Quantity, Mix and Throughput Study*, Interoffice Correspondence (IOC) #: VA.SAI.MF.03/97.007, CRWMS M&O, March 21, 1997.

5.43 *SAS2H Generated Isotopic Concentrations for B&W 15x15 PWR Assembly,* DI#: BBA000000-01717-0200-00012 REV 01, CRWMS M&O.

5.44 *Engineered Barrier System Performance Requirements Systems Study Report,* DI#: BB0000000-01717-5705-00001 REV 02, CRWMS M&O.

5.45 Lamarsh, John. R., *Introduction to Nuclear Engineering - 2nd Edition,* Addison-Wesley Publishing Company, 1983.

5.46 Knief, R. A., *Nuclear Criticality Safety - Theory and Practice*, American Nuclear Society, La Grange Park, IL, 1993.

5.47. Parish, T. A., Chien, H. C., *Bounding Axial Profile Analysis for the Topical Report Database*, Texas A&M University, May 1997.

5.48 *Disposal Criticality Analysis Methodology Technical Report*, DI#: B00000000-01717-5705-00020 REV 00, CRWMS M&O.

5.51 *Criticality Safety for Handling, Storing, and Transporting LWR Fuel at Fuels and Materials Facilities*, Regulatory Guide 3.58, NRC, October 1986.

5.52 *TMI-2 Criticality Studies: Lower-Vessel Rubble and Analytical Benchmarking*, ORNL/CSD/TM-222, Oak Ridge National Laboratory, December 1985.

5.53 *Design Basis Cladding Analysis*, DI#: BBA000000-01717-0200-00054 REV 00, CRWMS M&O.

5.54 *Neutronic Evaluation of the Codisposal Canister in the Five-Pack DHLW Waste Package*, DI#: BBA000000-01717-0200-00052 REV 00, CRWMS M&O.

5.55 *User Manual for the CDB-Q*, DI#: A00000000-01717-2002-20003 REV 01, CRWMS M&O.

5.56 *User Manual for the CDB-F*, DI#: A00000000-01717-2002-20004 REV 01, CRWMS M&O.

5.57 *Electronic Media for BBA000000-01717-0200-00056 REV 00*, Colorado Trakker tape, RPC Batch Number MOY-970821-11, CRWMS M&O.

6. Use of Computer Software

6.1 Software Approved for QA Work

The calculation of k_{eff} of degraded internal WP configurations was performed with the MCNP4A computer code (CSCI: 30006; Ref. 5.12). MCNP4A calculates k_{eff} for a variety of geometric configurations with neutron cross sections for elements and isotopes described in the Evaluated Nuclear Data File version B-V (ENDF-B/V). MCNP4A is appropriate for the fuel geometries and materials required for these analyses. The calculations using the MCNP4A software were executed on a Hewlett-Packard 9000 Series 735 workstation. The software qualification of the MCNP4A software, including problems related to calculation of k_{eff} for fissile systems, is summarized in the Software Qualification Report for the Monte Carlo N-Particle code (Ref. 5.12). The MCNP4A evaluations performed for this design are fully within the range of the validation for the MCNP4A software used. Access to and use of the MCNP4A software for this analysis was granted by Software Configuration Management and performed in accordance with the QAP-SI series procedures. Inputs and outputs for the MCNP4A software are included as attachments as described in the following design analysis.

The calculation of the PWR spent fuel isotopics was performed with the SAS2H code sequence, which is a part of the SCALE 4.3 code system (CSCI: 30011 V4.3; Ref. 5.11). SAS2H is designed for spent fuel depletion calculations to determine spent fuel isotopic content, decay heat rates, and radiation source terms. Thus, SAS2H is appropriate for the generation of spent fuel isotopics for the calculations of this analysis. The calculations using the SAS2H software were executed on a Hewlett-Packard 9000 Series 735 workstation. The software qualification of the SAS2H software, including benchmark problems related to generation of isotope contents, is summarized in the Software Qualification Report for the SCALE Modular Code system (Ref. 5.11). The SAS2H evaluations performed for this design are fully within the range of the validation for the SAS2H software used. The associated 44-group cross section library was used for these calculations. Access to and use of the SAS2H software for this analysis was granted by Software Configuration Management and performed in accordance with the QAP-SI series procedures. Inputs and outputs for the SAS2H software are included as attachments as described in the following design analysis.

Information on the quantity of fuel with various cladding and spacer materials was obtained from two qualified programs from the Characteristics Data Base (CDB). These were the LWR Fuel Assemblies PC Database (CDB-F; CSCI: 20004 V 1.1) and the LWR Quantities PC Database (CDB-Q; CSCI: 20003 V 1.3). The CDB was installed on an IBM-compatible PC in accordance with the User Manual for the CDB-Q (Ref. 5.55), and for the CDB-F (Ref. 5.56) and was obtained in accordance with the QAP-SI series procedures. This software was appropriate for the application made in this analysis, was used only within its range of validation, and was obtained from the Software Configuration Management in accordance with appropriate procedures.

6.2 Software Routines

Microsoft Excel version 7.0, loaded on a 166MHz Pentium PC. This spreadsheet software package was used as computational support software for calculations performed throughout Section 7. The location of the electronic copy of the BURNRICH.XLW spreadsheet containing all inputs and outputs is given in Section 9, and Attachment III provides a hard copy. All calculations performed in BURNRICH.XLW are described in Section 7 and/or Attachment III.

MathCad version 6.0+, loaded on a 166MHz Pentium PC. This software package was used as computational support software for calculations performed in Section 7.1. The location of the electronic copy of the BORIDE.MCD worksheet containing all inputs and outputs is given in Section 9, and a hard copy is provided in Attachment IV. All calculations performed in BORIDE.MCD are described in Section 7.

Binning of the waste stream data from assumption 4.3.13 was accomplished using a simple C program, BURNRICH.C, which calculates the k_∞ for each PWR assembly in the database using the equation in assumption 4.3.11, and bins them based on k_∞, burnup, and initial enrichment. The BURNRICH.C code is simply an automation of a simple calculation and data manipulation task, which can easily be (and has been) checked by hand, and is therefore classified as computational support software which is not qualified under the M&O QAP-SI series procedures. The input file is discussed in assumption 4.3.13 and the resulting output file is BURNRICH.OUT See Section 9 for the location of the output. The source code is provided in Attachment I. The BURNRICH.C code was compiled and executed on a 166MHz Pentium PC compatible with a DOS 6.2 operating system using Microsoft Visual C++ version 1.0.

Calculation of number densities for the principal isotopes were calculated from the SAS2H/ORIGEN-S summary files using a short BASIC code, AMIGO.BAS, which also automatically placed them into the appropriate spot in an MCNP input file template. The AMIGO.BAS code is simply an automation of a simple number density calculation and data manipulation task, which can easily be (and has been) checked by hand, and is therefore classified as computational support software which is not qualified under the M&O QAP-SI series procedures. The input consists of a SAS2H output summary file containing the gram concentrations per assembly for each of the principal isotopes, and one or more MCNP template files. The SAS2H summary file is produced from the SAS2H output file using the unix "awk" command on the HP9000 computer, and a short script, "getPI", which tells awk which lines of the output file to place in the summary file (see Attachment V). The template files are simply standard MCNP input with the mnemonics "FUELTOT" and "FUELNUM" in place of the cell card total number density and that material card for the fuel region. The AMIGO.BAS output is simply one or more MCNP input files. See Section 9 for the location of the awk script "getPI", the SAS2H summary files (*.sum), the MCNP template files, and the resulting MCNP input files. The source code is provided in Attachment II. The AMIGO.BAS code was executed on a 166MHz Pentium PC compatible with a DOS 6.2 operating system using MS-DOS QBasic version 1.1

7. Design Analysis

This design analysis is presented in seven sections. Section 7.1 describes the progression of WP degradation and the range of configurations to be evaluated. Section 7.2 discusses the development of the PWR assembly isotopics to be used for this analysis. Section 7.3 discusses the evaluation of k_{eff} for partially degraded baskets. Section 7.4 discusses the evaluation of k_{eff} for fully degraded baskets with intact fuel assemblies. Section 7.5 discusses the evaluation of k_{eff} for fully degraded baskets with degraded assemblies. Section 7.6 develops k_{eff} regressions for the various degraded configurations evaluated in Sections 7.3 to 7.5. Finally, Section 7.7 discusses options for reducing k_{eff} for degraded configurations.

7.1 WP Degradation Scenarios

The purpose of this section is to summarize the range of PWR WP internal degraded configurations to be evaluated. In general, the degradation scenario evaluated here begins with breach of the WP, and proceeds through the following four phases: 1) degradation of the carbon steel (least corrosion resistant) basket components, 2) collapse of the basket structure following partial degradation of the borated stainless steel, 3) full basket degradation leaving only intact fuel and oxide corrosion products, and 4) degraded fuel and oxide corrosion products. The engineering analysis which supports this categorization, and the parameter ranges which characterize each phase is given in the following sub-sections.

The design basis WP system configuration for 100% coverage of the projected PWR waste stream is given in Reference 5.5, Table 8-1 (p. 30), and includes five different types of PWR WPs. These types are: a 21 PWR no absorber WP, a 21 PWR absorber plate WP, a 21 PWR absorber rod WP, a 12 PWR no absorber WP, and a long 12 PWR absorber plate WP for South Texas fuel. The basis for the conceptual binning of the PWR waste stream into the plate, rod, and no absorber baskets was as follows: fuel with $k_\infty < 1.0$ was placed in a no absorber WP, fuel with $1.00 \leq k_\infty < 1.13$ was placed in an absorber plate WP, and fuel with $k_\infty \geq 1.13$ was placed in an absorber rod WP. The 1.13 k_∞ limit for the absorber plate was chosen because it corresponded to a k_{eff} of 0.95 in early intact designs of the 21 PWR WP (Ref. 5.6, Vol. III, p. 5-5) using the old PWR criticality design basis fuel (bounded ≈98% of the PWR fuel). Since both the 21 and 12 PWR no absorber WPs are intended for assemblies which have a $k_\infty < 1.0$, they are not expected to be a criticality concern, and will not be evaluated in this analysis unless results for the more stressing WPs indicate otherwise. Therefore, this analysis will focus primarily on the 21 PWR absorber plate WP, with the expectation that this will also bound the 12 PWR absorber plate WP since previous analyses (Ref. 5.6, Vol. III, p. 6.3-157) have shown that it has a k_{eff} which is typically 3-4% lower than that of the 21 PWR WP in intact and collapsed conditions, with and without boron (while the South Texas WP was not evaluated, it is also expected to be lower). Analysis of the absorber rod WP, with a 16 rod zircaloy clad B_4C disposal control rod assembly (DCRA, Ref. 5.5, p. 6) in each fuel assembly, will also be performed for the worst degraded configuration identified in the analysis of the absorber plate WP.

7.1.1 Basket Degradation and Collapse

This section discusses the four primary basket components responsible for maintaining the initial configuration of the WP, and the anticipated changes in the WP configuration which will occur as a result of their degradation following WP breach. These are the side and corner guides, the neutron absorber plates, fuel cell tubes, and the fuel assemblies themselves. Prior to WP breach, the interior of the WP still contains its initial charge of He gas (Ref. 5.17, p. 129), and no degradation of the internal components would be expected. The inert environment is lost on first pit penetration of both WP barriers, which TSPA-95 (Ref. 5.33, Sect. 5) predicted would occur for a majority of WPs (typically 80% or more) within 2,000 to 10,000 years after emplacement under most of the 83 MTU/acre scenarios. However, those scenarios which considered that the remaining carbon steel could provide cathodic protection for the inner barrier showed much longer times to first pit penetration (in the 10,000 to 100,000 year time frame). The WP design goal for VA is that no more than 10 WPs fail before 3,000 years (see assumption 4.3.9).

The AUCF WP side and corner guides are fabricated from 10 mm thick carbon steel plates. Reference 5.36 indicates that the side guide will fail by bending at a thickness of 2.9 mm if there is no other material loading the basket (which would only be the case after the upper portion of the WP barriers have collapsed, allowing backfill and/or rockfall rubble to enter). Reference 5.36 estimated that this failure would occur within 60 to 340 years following WP breach for the 83 MTU/acre case without backfill using the TSPA-95 carbon steel corrosion model. Failure of the side guides will cause the bottom row of fuel assemblies to shift downward to touch the inside of the inner barrier. As the criticality control plate assemblies also rest on the top of the side guides, the entire basket structure should also shift downward. Since the corner guides are under less loading, their failure should occur shortly after failure of the side guides. Failure of the corner guides will result in the assemblies on the end of the second row from the bottom to shift downward to touch the inside of the inner barrier. The assemblies above them should remain in place until sufficient degradation of the neutron absorber plates which support them has occurred.

The fuel cell tubes are also fabricated from carbon steel and have a wall thickness of 5 mm. The tubes are expected to fully degrade before the failure of the side guides (because they are thinner) or the criticality control plates. In structural analysis of the criticality control plates, it was determined that the plates could maintain the basket and SNF assembly configuration without structural support from the tubes (Ref. 5.36). Failure of the tubes will, therefore, not cause collapse of the basket, so no specific structural analyses were performed for the tubes.

The AUCF WP neutron absorber plates are fabricated from 7 mm thick borated Neutronit A978 stainless steel plates. Reference 5.36 found that the horizontal absorber plates will bend once 2.5 mm of thinning has occurred, and the vertical plates will buckle after 5.36 mm of material is removed. Using the stainless steel general corrosion rates discussed in Section 4.1.4 (see assumption 4.3.14), and the factor of 4 increase for the borated stainless steel corrosion rate also discussed in Section 4.1.4, yields a preliminary estimate that it will take ≈3,100 years following breach of the WP for general corrosion of both sides of the neutron absorber plates at the nominal rate (with a high/low range of 310 to 15,600 years) to remove the 2.5 mm of material that would be required for bending to occur. It was estimated to take ≈6,700 years (with a range of 670 to 33,000 years) to remove the

5.36 mm of material that would be required for buckling of the vertical plates. Considering that localized corrosion (pitting, crevice, etc.) is the predominant mechanism for corrosion of stainless steels resulting in faster localized perforation of the material, and that the egg-crate basket structure provides a large number of crevices, the above structural failure times calculated using general corrosion rates should be considered an upper bound. Regardless of the actual failure time, bending will likely occur first at the ends of horizontal long criticality plates, causing the assemblies in the two side columns to drop down. Final collapse of the basket will occur due to bending of the horizontal plates supporting the assemblies (which would be expected to occur at a time later than the bending of the ends because the plates are supported on two sides). Final collapse will leave the center three columns of fuel assemblies resting on the bottom of the inner barrier.

The corrosion products from the degradation of the carbon and stainless steel basket components occupy almost twice the volume of the original components, and are fairly insoluble, and thus need to be considered in degraded criticality analyses because they remain within the WP. Using the volumes of the tubes and the guides/supports (Ref. 5.15, Att. VI), the density of A516 carbon steel, and the weight fraction of iron in carbon steel, the total mass of iron in the WP from these components is 5,430 kg (3,431 kg from the tubes and 1,999 kg from the guides/supports). The borated stainless steel will supply another 1,138 kg of iron when it is fully degraded. The most thermodynamically stable iron oxide for the water temperature and pH range of concern is hematite, Fe_2O_3. While the hydrated oxide form, FeOOH, is also possible, it will essentially be equivalent to the water/Fe_2O_3 mixtures already considered for this analysis. By dividing by the atomic weight of iron, adding three moles of oxygen for every two of iron, and multiplying by the molecular weight of Fe_2O_3, it is found that a total of 7,762 kg of iron oxide will be produced from degradation of the carbon steel components (4,905 kg from tubes and 2,857 kg from guides/supports), and 1,626 kg from degradation of the borated stainless steel, for a total of 9,389 kg of Fe_2O_3 in the WP. These calculations are performed in the VOLMASS sheet of the attached Excel 7.0 worksheet, BURNRICH.XLW (see Section 9.0 and Attachment III).

A possible mechanism for removing this iron oxide from the WP is by dissolution in the incoming water. The solubility of iron in J-13 well water for various pH and oxidizing/reducing conditions was investigated in Attachment IV of Reference 5.37. Under oxidizing conditions, the solubility of iron was 3.45×10^{-10} molar for neutral J-13, and 2.47×10^{-4} molar for acidic J-13. Attachment VI of Reference 5.37 demonstrated that even the small amount of heat produced by the low burnup fuel (20 GWd/MTU evaluated) that is of concern for postclosure criticality is sufficient to drive a small amount of natural circulation and maintain an oxygenated environment in a flooded WP. Therefore, the solubilities for oxidizing conditions will be used for this analysis. The amount of oxide removal by flushing of a flooded WP breached only on the upper surface can be estimated using the average flow rate of 1.48 m^3/yr onto a WP (which can be calculated from the flow rates and frequencies of occurrence given in assumption 4.3.7), conservatively assuming that all of the water enters the package, and using the high exchange efficiency (representing the process of exchanging iron saturated water from inside the WP with fresh water from outside) of 10% (see assumption 4.3.12). This yields a 0% to 3% iron removal over a 100,000 year period, with a maximum of 7.5% removal if the average 2.5 times increase in flow to account for spatial variabilities in the infiltration flux is considered. These calculations are performed in the VOLMASS sheet of the attached Excel 7.0 worksheet, BURNRICH.XLW (see Section 9.0 and Attachment III).

Finally, there are several possible variations for the distribution of the oxide corrosion products within the WP. At the extremes are uniform distribution of the oxide in the WP void space, and settling of the oxide to the bottom of the WP, or to the bottom of a fuel assembly before all of the stainless steel plate has corroded. Using the theoretical density of Fe_2O_3 (see Section 4.1.3), and the total volume contained within the inner barrier minus that occupied by the fuel assemblies (see Sections 4.1.1 and 4.1.2), indicates that a uniform distribution will have the WP void space filled with homogenous mixture of a maximum 33 vol% Fe_2O_3 (all of the basket oxides) with the remainder as water to simulate a flooded WP. The potential removal of 7.5% of the iron by exchange flow represents a loss of ≈3 vol% of iron oxide. If the oxide is settles to the bottom of a fuel cell, or later the WP, the physical geometry of packed solids will result in a density that is less than theoretical. For example, the percent solid content noted in for a tight packing of sand (Ref. 5.38, p. 17) is 58%. The porosity (the complement of the solids content) of tightly packed carbon steel tubesheet corrosion products that led to the denting of steam generator tubes at two Westinghouse plants was found to be between 7 and 25% (Ref. 5.39, p. 10). Since the oxides in the tubesheet were compressed to the point of denting the tube, and no such restriction of the oxides in the WP is expected, the tight packing of sand will be taken to be representative of that of iron oxide scale that has settled. At 58% dense packing, if all of the oxides settle to the bottom, they will completely cover the bottom three rows of assemblies, and cover 59% of the fourth row (53% or 8 rows of a B&W assembly has been used for this analysis). These calculations are performed in the VOLMASS sheet of the attached Excel 7.0 worksheet, BURNRICH.XLW (see Section 9.0 and Attachment III).

Both the uniform and completely settled extremes are expected to be conservative compared to a more likely semi-uniform distribution of oxide flakes and particles among and around the fuel assemblies. This statement is based on the fact that 70% of the Fe_2O_3 comes from degradation of the carbon steel tubes and borated stainless steel plates, and will already be intimately mixed with the assemblies. If only the oxide from the carbon steel tubes and borated stainless is considered, it will take up 40% of the assembly void space at theoretical density. At a 58% dense packing it will take up 70% of the void space, which is equivalent to covering 10 rows of fuel rods when settled to the bottom of the assembly. If only the oxide from the carbon steel is considered, it will occupy 30% of the assembly void space at theoretical density, or cover 8 rows of rods when settled with a 58% dense packing. These calculations are performed in the VOLMASS sheet of the attached Excel 7.0 worksheet, BURNRICH.XLW (see Section 9.0 and Attachment III).

Reference 5.36 also evaluated possible mechanisms for denting or crushing zircaloy clad Westinghouse 17x17 fuel assemblies such that they no longer provide an optimum geometry for criticality. It was concluded that denting of the fuel rods is not likely to occur because there is sufficient void space for expansion of the corroding basket materials, thus preventing them from causing any load on the fuel assemblies. Preliminary structural analyses were also performed which determined that the bottom-most fuel assemblies would be capable of supporting the static load from the entire degraded basket structure, and all fuel assemblies above them, without being crushed. Based on this information, the assumption of intact fuel assemblies for criticality analyses is appropriate and conservative until significant corrosion of the fuel rods and spacer grids has occurred, or other dynamic loads are applied. Further discussion on fuel assembly degradation is provided in Section 7.1.3.

Based on the above discussion, Figure 7.1.1-1 summarizes the initial and degraded waste package internal configurations. The configurations which will be evaluated in this analysis are represented by the final two pictures in Figure 7.1.1-1. The intermediate configurations still retain the majority of the borated stainless steel, and the fully collapsed basket configuration has been previously shown to be more reactive than the intact basket configuration, with or without the boron (Ref. 5.6, Vol. III, p. 6.3-139). Furthermore, reduced moderator density has already been shown to be less reactive (Ref. 5.6, Vol. III, p. 6.3-139) and thus will not be considered in this analysis. Similarly, all configurations are assumed to be in a WP filled with water (see assumption 4.3.5) unless otherwise noted (the effects of water level will be evaluated). The probability of obtaining and maintaining a flooded condition in a WP will be the subject of a future analysis. Finally, it should be noted that while Figure 7.1.1-1 (and the subsequent MCNP models in Sections 7.3 through 7.5) shows the WP oriented such that the basket grid is perpendicular/parallel to the direction of gravity, the results are not expected to be affected by other orientations. In the uniform oxide cases, orientation with respect to gravity does not affect the distribution of the oxide, and in the settled cases, it will not alter the fraction of assemblies covered by oxide (as represented by rows of rods or assemblies covered).

The specific configurations evaluated in this analysis for intact assemblies will be as follows:

1) Collapsed Basket with Partial Thickness Borated Stainless Steel (B-SS) Remaining

   a) Uniformly distributed oxide occupying 30-40 vol% of the assembly void space (30% = carbon steel tube degradation only, 40% = carbon steel tube and all B-SS degradation), depending on the amount of B-SS plate remaining, with the remainder as water, and
   b) Settled oxide covering the bottom 8 to 10 rows of an assembly (8 rows = carbon steel tube degradation only, 10 rows = carbon steel tube and all B-SS degradation), depending on the amount of B-SS plate remaining. The oxide occupies 58% of the covered void, with the remainder being water.

2) Completely Degraded/Oxidized Basket

   a) Uniformly distributed oxide occupying 30, 33, or 40 vol% of the WP void space (33% base vol%, with 30 vol% evaluated to consider 3 vol% loss due to flushing, and 40 vol% evaluated to consider concentration of most oxides in fuel region), and
   b) Settled oxide covering the bottom 3, 3.5, 4, and 4.5 rows of assemblies (3.5 is base case). The oxide occupies 58% of the covered void, with the remainder being water.

The amount of boron potentially remaining in the WP following the degradation of the borated stainless steel will be discussed in Section 7.1.2.

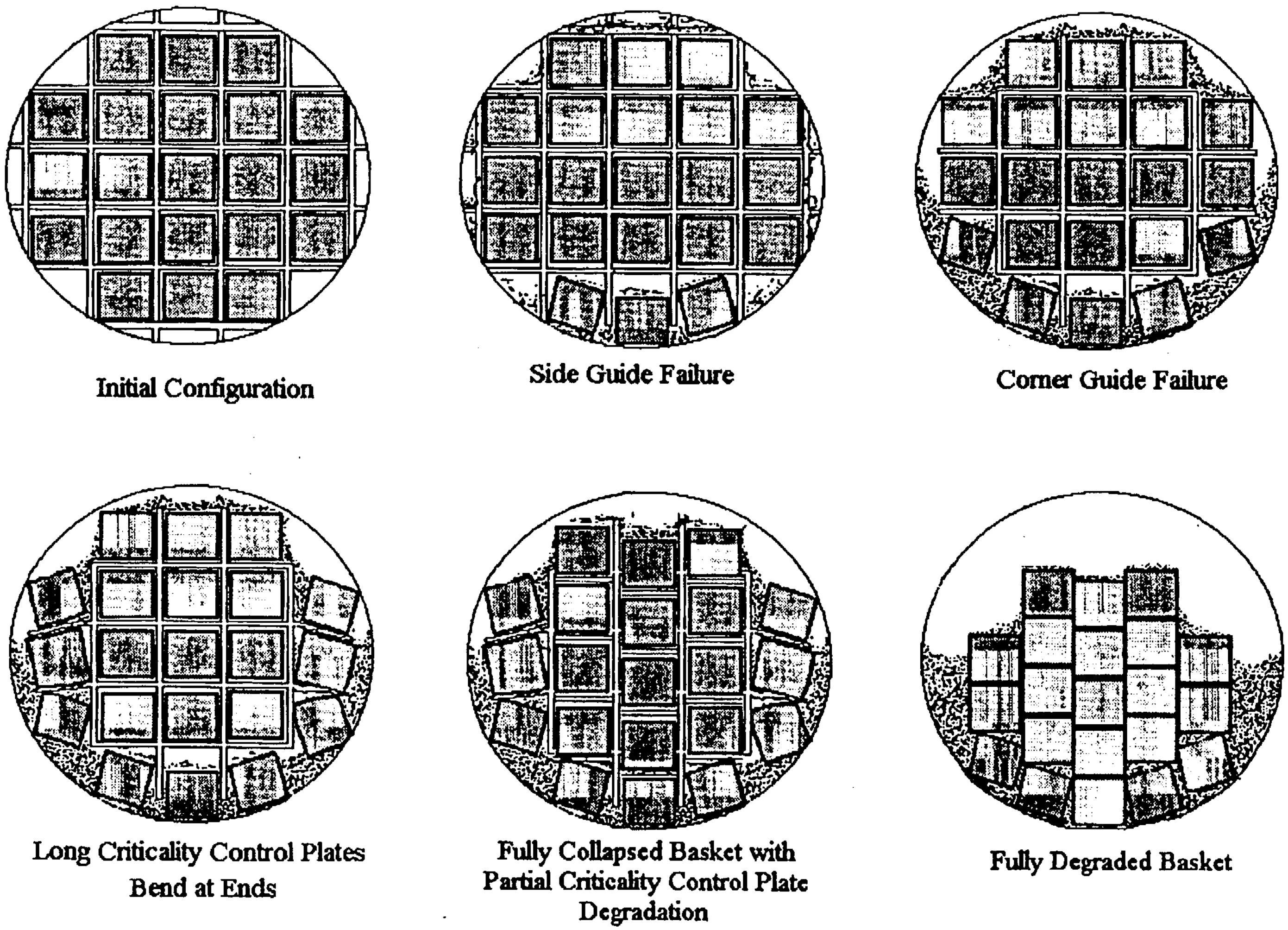


Figure 7.1.1-1. Illustration of Degraded 21 PWR WP Internal Configurations with Intact Fuel

7.1.2 Neutron Absorber Loss

As discussed above in Section 7.1.1, the degradation and collapse of the basket will leave behind a significant amount of insoluble iron oxide corrosion products. In addition, the boron in borated stainless steel is in the form of insoluble, elongated metal boride particles (M_2B), with over half of the metal part being chromium, nearly half iron, and a small amount nickel and possibly molybdenum (Ref. 5.40, Att. VII, p. 23). Preliminary electrochemical measurements indicate that the Neutronit A978 austenitic stainless steel matrix is noble with respect to the metal boride. Therefore, the release of the borides from the stainless steel matrix will be controlled by the corrosion of the matrix. Since general corrosion rate measurements for stainless steels typically represent weight loss due to localized corrosion (Ref. 5.34, p. 360), rather than uniform thinning, they are not generally useful for measuring times to penetration or structural failure of stainless steel components. However, in this case it is appropriate to use general corrosion rates as only the total mass of matrix material lost is of concern. Based on the 304/316 stainless steel general corrosion rates, and the factor of 4 increase for borated stainless steel, discussed in Section 4.1.4, it is estimated that it will take 8,750 years following WP breach to fully degrade the 7 mm thick borated stainless steel plates from both sides (with a range of 875 to 43,750 years).

Even if the boride particles have a very small corrosion rate, they will still degrade relatively quickly to highly soluble orthoboric acid or borates once they have been released from the matrix (Ref. 5.40, Att. VII, p. 23) due to their small size. Reference 5.32 (Table 2) examined the surface area of boride particles in 304B5B and 304B7B stainless steel. The boride particles in the 304B5B were found to have an average surface area of 24.13 μm^2 and a maximum surface area of 456 μm^2. The boride particles in the 304B7B were found to have an average surface area of 32.82 μm^2 and a maximum surface area of 597 μm^2. The average and maximum surface areas for boride particles in a B6B stainless steel can then be estimated by interpolating between the B5B and B7B areas to be 28.48 μm^2 and 526.5 μm^2, respectively. Using a corrosion rate of 0.01 $\mu m/yr$ (just below the low end of the stainless steel bulk corrosion rate), and treating the boride particles as spheres, indicates that only 110 years for the average particle size and 475 years for the maximum particle size are required to degrade ≈98% of the particle. These calculations are performed in the Mathcad+ 6.0 worksheet, BORIDE.MCD (see Section 9.0 and Attachment IV).

However, previous studies have found that adsorption of boron onto Fe_2O_3 occurs at the rate of approximately one mole of boron to 3,000 - 12,000 moles of Fe_2O_3 (2 - 0.5 mmols/kg) in the pH range of 5 to 10 (Ref. 5.41, p. 1377). At the peak adsorption rate, the 9,389 kg of Fe_2O_3 produced by degradation of all carbon and stainless steel basket components will adsorb 203 g of boron. This amounts to 0.67% of the original boron in the borated stainless steel. The effects of this potential mechanism for boron retention on degraded WP k_{eff} will also be evaluated in this analysis. These calculations are performed in the VOLMASS sheet of the attached Excel 7.0 worksheet, BURNRICH.XLW (see Section 9.0 and Attachment III).

7.1.3 Fuel Assembly Degradation

As discussed above in Section 7.1.1, structural calculations have shown that a zircaloy clad Westinghouse 17x17 assembly on the bottom of the WP would be capable of supporting the entire static load of the basket corrosion products and all assemblies above it. Reference 5.53 (Sect. 7.8) has performed further structural analysis to demonstrate that other vendor's assemblies are at least as robust as the Westinghouse 17x17 assembly, and that the top assembly can support the load of 2.5 m of tuff rubble. Significant losses of assembly structural integrity due to corrosion would not be expected due to the high corrosion resistance of zircaloy. Reference 5.53 (p. 40), indicates that at the below-boiling temperatures that would be expected in the time frames considered for WP breach, studies have found no localized corrosion in aqueous environments across a pH range of 1 to 12, and in the presence of a variety of ions including lithium, sodium, potassium, ammonium, nitrate, sulfate, chloride, and fluoride. At general corrosion rates, the zircaloy components of the fuel assembly would be expected to last much longer than any other internal components of the WP. However assembly degradation is still credible, as not all assemblies have cladding and/or spacer grids that are fabricated from highly corrosion resistant zircaloy, and, due to the potential for rockfall, some assemblies may be exposed to dynamic loads.

Based on information in Reference 5.53 (p. 26) there are 1846 PWR assemblies with stainless steel cladding, which represents approximately 1.85% of the total PWR population. Almost all of this cladding is fabricated from Type 304 stainless steel, with thicknesses ranging from 419 to 724 μm. Based on the 304 stainless steel corrosion rates discussed in Section 4.1.3, general corrosion would require 4,190 to 7,240 years (with a range of 419 to 36,200 years) to completely corrode this cladding. This failure time is longer than that required for basket collapse, but shorter than that required for complete degradation of the neutron absorber plates. In addition, information in the CDB (see Section 6.1) indicates that there have been 22,536 PWR (≈22.6%) assemblies discharged with in-core spacer grids fabricated from Inconel 718, which is less corrosion resistant than zircaloy but more corrosion resistant than stainless steel. This will lead to collapse of the fuel assembly structure and consolidation of the fuel rods for these assemblies at some time following full degradation of the WP basket structure. Finally, while the zircaloy fuel rods are relatively robust under static loads, they are not capable of withstanding significant dynamic loads. For example, 100 kg rock falling 2 m will have sufficient energy to break some of the rods on the top row of fuel assemblies (Ref. 5.23, p. 47).

Based on the above information, the following geometries involving full degradation of the basket structure and various degrees of rod consolidation will be evaluated for the limiting fuels:

1) Various amounts of assembly crushing (i.e., reduced fuel rod pitch) in the vertical direction, and both the vertical and horizontal directions for the fully degraded basket, and

2) Fuel rods piled at the bottom of the fully degraded basket WP (simulates complete spacer grid degradation),

7.2 Development of PWR Assembly Isotopics

The purpose of this section is to define the different fuel isotopic sets which will be used in the criticality analysis of degraded WP configurations. The 21 PWR absorber plate WP is currently planned to be used for fuel assemblies with k_∞ between 1.0 and 1.13 (Ref. 5.5, p. 30). For this analysis it is conservatively assumed that all incoming assemblies have an age of 10 years (see assumption 4.3.13). Based on the database of historical and projected waste streams (see Ref. 5.42 and assumption 4.3.13), and a non-linear regression developed by Oak Ridge National Laboratory (see assumption 4.3.11) to estimate k_∞ as a function of assembly burnup, enrichment, and age, it is projected that there are 99,608 PWR assemblies within this range. Figure 7.2-1 below shows how this population of assemblies will be distributed over the above k_∞ range at an age of 10 years. Figure 7.2-2 shows the distribution of assemblies for $k_\infty \geq 1.13$, which would be loaded into the 21 PWR absorber rod WP under the current loading scheme (Ref. 5.5, p. 30). This binning was accomplished using a simple C program (BURNRICH.C with output BURNRICH.OUT; see Section 9.0), which calculates the k_∞ for each PWR assembly in the database using the equation in assumption 4.3.11.

Based on Figure 7.2-1, k_∞ values of 1.13, 1.10, 1.08, 1.06, and 1.04 will bound 100%, 96.78%, 91.92%, 82.99%, and 62.23% of the population of PWR assemblies intended for the 21 PWR absorber plate WP, respectively. The code also bins assemblies by burnup and initial enrichment within each k_∞ group. Figures 7.2-3 to 7.2-7 show the distribution of assembly burnup in the k_∞ groups just below the bounding k_∞ values discussed above. For each of the bounding k_∞ values discussed above, lower bound, median, and upper bound burnups have been selected from these distributions (for the 1.04 and 1.06 k_∞ values, only the median and upper bound burnups were evaluated as results from evaluations of higher k_∞ values indicated that these would bound the low burnups). For each k_∞ /burnup (hereafter refered to as "k_∞ bins" such as 1.13h, 1.13m, 1.13l, etc.), an initial enrichment was selected such that the ORNL regression (assumption 4.3.11) would give a k_∞ approximately equal to that of the k_∞ bin. The match is approximate so that the resulting burnup/enrichment pairs remained within the bounds of the burnup/enrichment distribution for that bin, as given in the BURNRICH.OUT file. The burnup/enrichment pairs for each k_∞ bin are given in Table 7.2-1. For the absorber rod WP, two burnup/enrichment pairs representing the high end of the k_∞ range shown in Figure 7.2-2 were selected (designated as "cr" bins) in the same manner as the other bins, and are also given in Table 7.2-1. Figures 7.2-1 to 7.2-7 were generated from the BURNRICH.OUT file using the graphing capability of Excel 7.0.

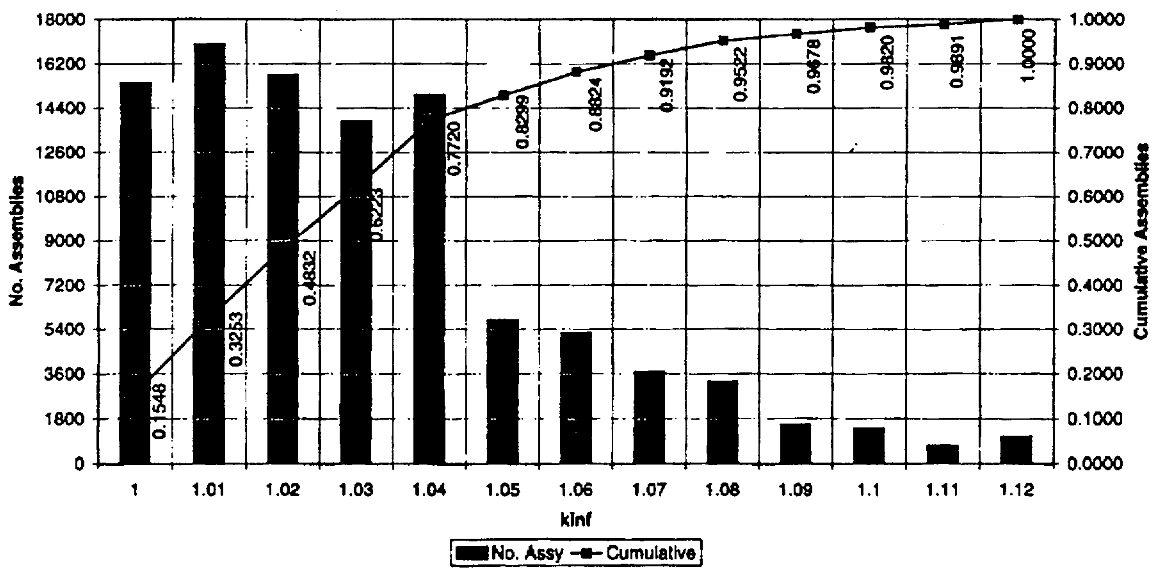


Figure 7.2-1. Distribution of assembly k_∞ for fuel in a 21 PWR absorber plate WP (k_∞ shown represents lower end of the bin)

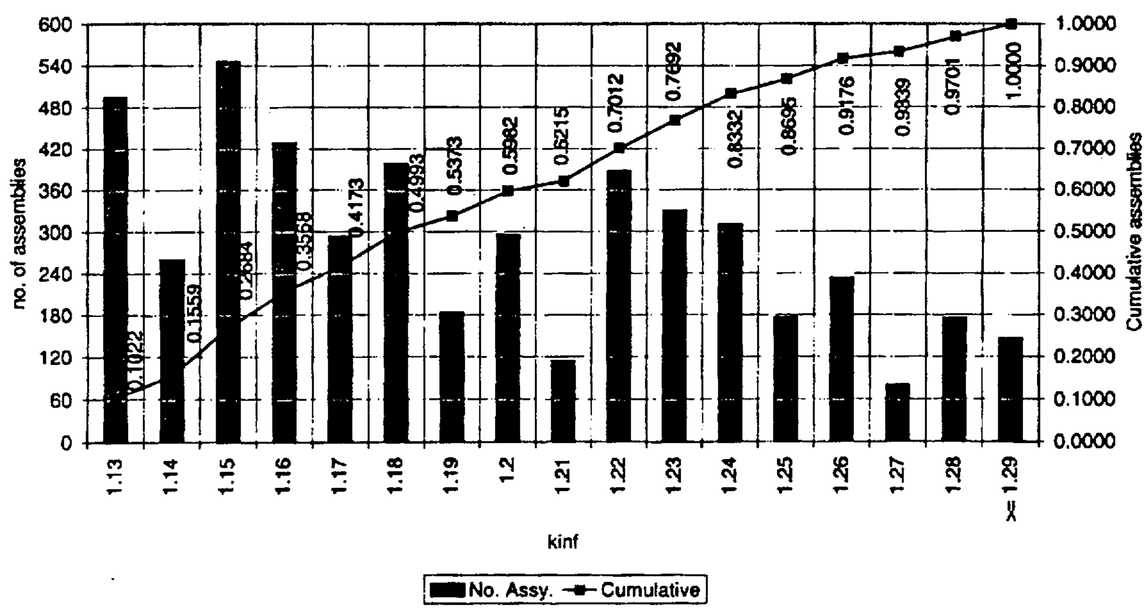


Figure 7.2-2. Distribution of assembly k_∞ for fuel in a 21 PWR absorber rod WP (k_∞ shown represents lower end of the bin)

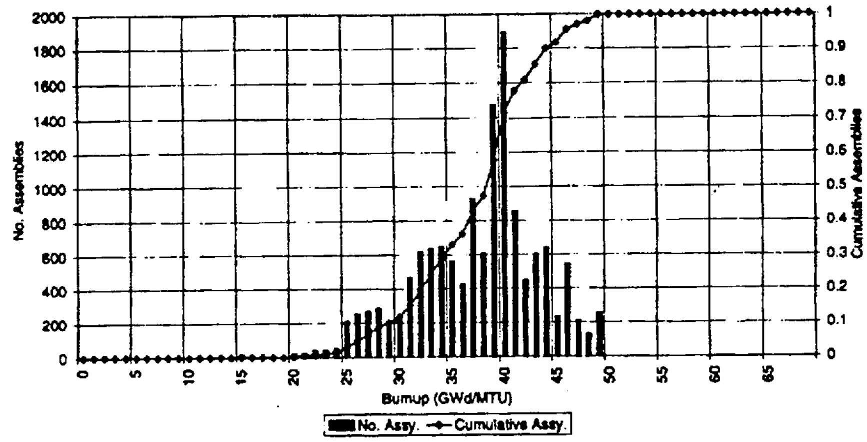


Figure 7.2-3. Distribution of burnup for assemblies with 10 year k_{∞} between 1.03 and 1.04

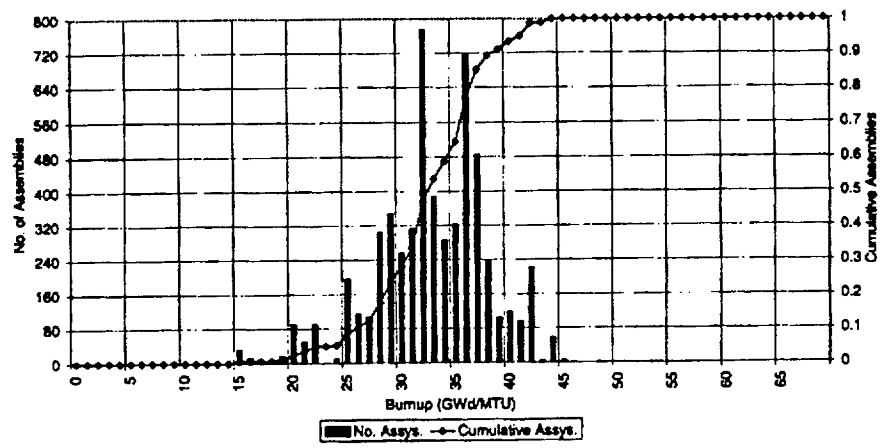


Figure 7.2-4. Distribution of burnup for assemblies with 10 year k_{∞} between 1.05 and 1.06

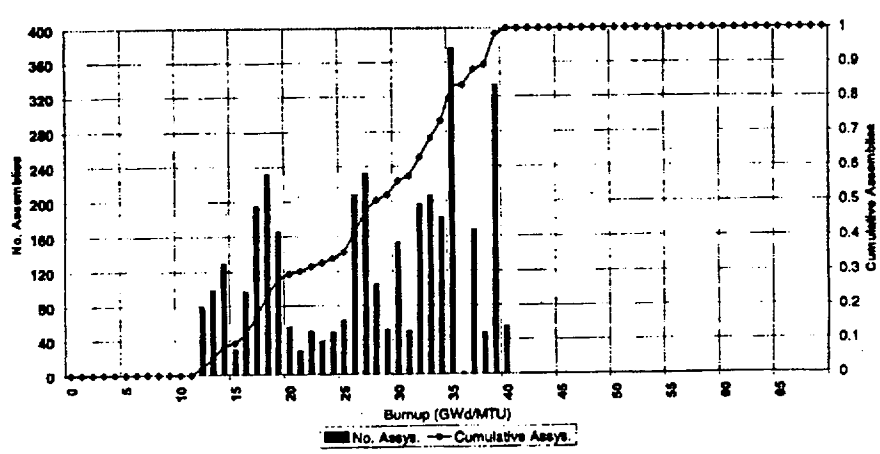


Figure 7.2-5. Distribution of burnup for assemblies with 10 year k_{∞} between 1.07 and 1.08

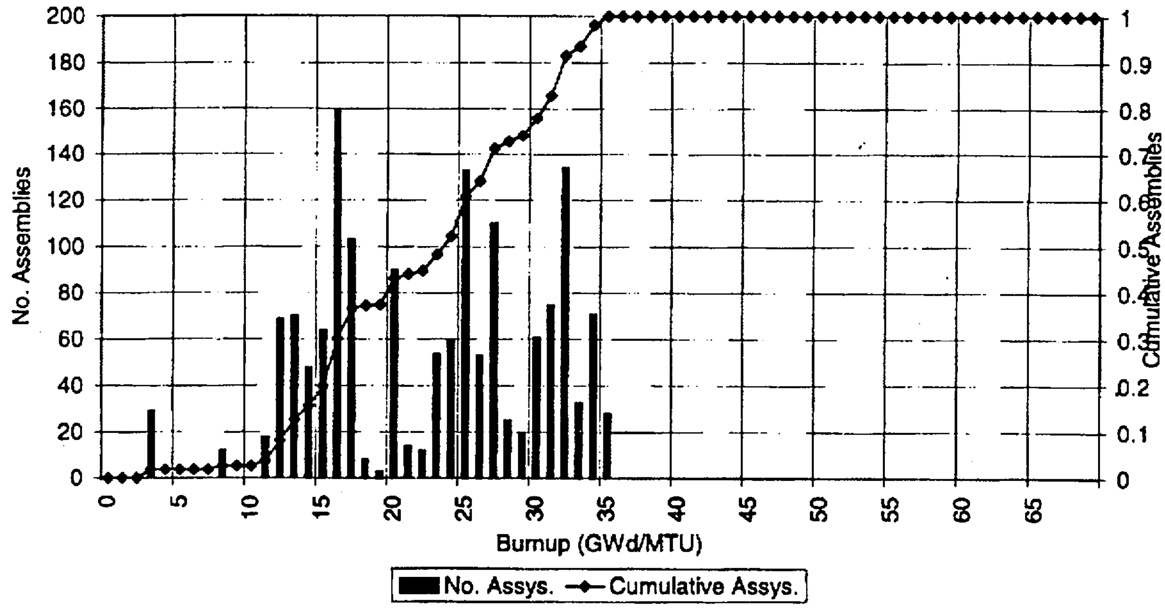


Figure 7.2-6. Distribution of burnup for assemblies with 10 year k_∞ between 1.09 and 1.10

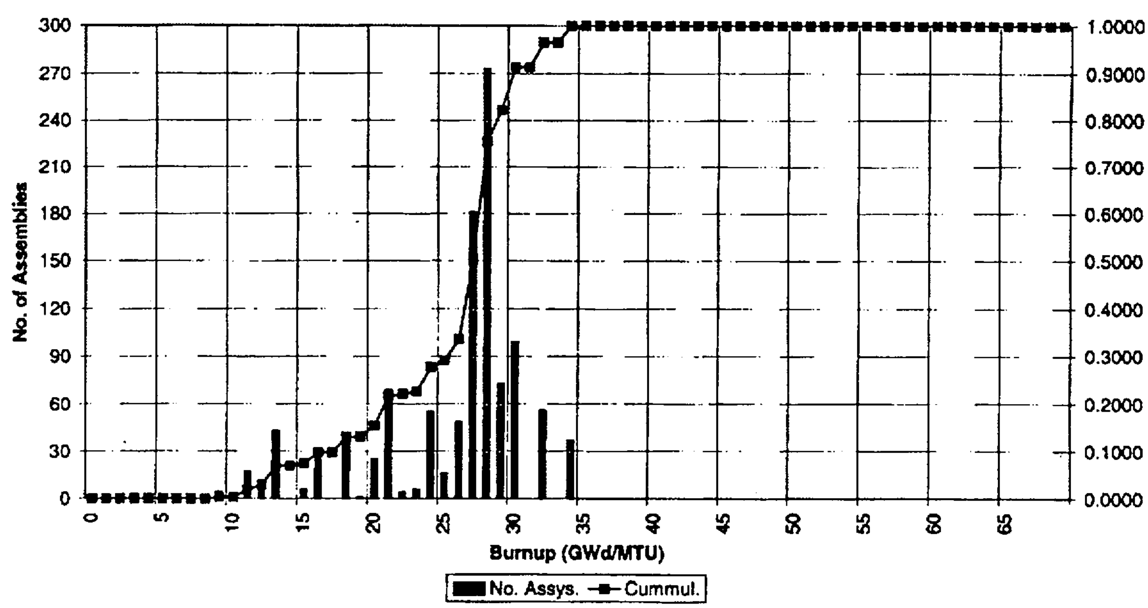


Figure 7.2-7. Distribution of burnup for assemblies with 10 year k_∞ between 1.12 and 1.13

Table 7.2-1. Summary of k_∞ Bin Burnup/Enrichment Pairs and Associated SAS2H Input Data

Bin Name	10 yr k_∞ per assumption 4.3.11	Burnup Coverage for k_∞ group	Burnup (GWd/MTU)	U235 weight%	U234 weight%	U236 weight%	U238 weight%	EFPD at 7.25 MW/assy	SAS2H file name
1.13-l	1.128	0.4%	9	1.7	0.0137	0.0078	98.2784	576	e17b9
1.13-m	1.127	50.5%	27	3.9	0.0338	0.0179	96.0483	1728	e39b27
1.13-h	1.123	100.0%	34	4.9	0.0433	0.0225	95.0342	2176	e49b34
1.10-l	1.103	1.9%	3	0.8	0.0061	0.0037	99.1902	192	ep8b3
1.10-m	1.098	50.0%	23.5	3	0.0254	0.0138	96.9608	1504	e3b235
1.10-h	1.099	100.00%	35	4.5	0.0395	0.0207	95.4398	2240	e45b35
1.08-l	1.080	2.1%	12	1.5	0.0120	0.0069	98.4811	768	e15b12
1.08-m	1.079	50.4%	28	3.25	0.0277	0.0150	96.7073	1792	e325b28
1.08-h	1.076	98.5%	39	4.6	0.0404	0.0212	95.3384	2496	e46b39
1.06-m	1.062	50.0%	32.5	3.5	0.0300	0.0161	96.4539	2080	e35b325
1.06-h	1.059	99.90%	44	4.9	0.0433	0.0225	95.0342	2816	e49b44
1.04-m	1.042	50.0%	38.5	3.85	0.0333	0.0177	96.0990	2464	e385b385
1.04-h	1.037	98.2%	48	4.9	0.0433	0.0225	95.0342	3072	e49b48
cr-1	1.383	n/a	3	4.3	0.0376	0.0198	95.6427	192	e43b3
cr-2	1.296	n/a	13	4.7	0.0414	0.0216	95.2370	832	e47b13

The majority of the input parameters in the SAS2H input files used to perform the depletion and decay are identical to those defined in Reference 5.43 and their development will not be repeated here (see assumption 4.3.6). Only the basis for those parameters which differ from those in the Reference 5.43 input file will be provided in this section. The isotopic distribution of uranium used in Block 4 of the input is determined by the given initial enrichment and the following empirical relationship (Ref. 5.43, p. 14):

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

The effective full power days (EFPD) for each desired burnup is calculated as follows:

EFPD = (Burnup in GWd/MTU * 1,000 MWd/GWd * 0.464 MTU/assy) ÷ 7.25 MW/assy.

Since SCALE 4.3 does not have a predefined mixture for Zircaloy-4, this material was entered as an arbitrary material for zone 2 (the cladding). The density for Zircaloy-4 was taken to be 6.56 g/cm^3 (Ref 5.19, p. I-16). The material composition used for Zircaloy-4 is that given on page I-16 of Ref. 5.19, and is given in Table 4.1-4.

The decay out to 1 million years was run as a separate case from the SAS2H burnup calculation. The decay case is a stand-alone ORIGEN-S problem which utilizes the output from SAS2H and decays to a number of specified times. However, both sequences were run using a single input file for each case as identified in Table 7.2-1, and a sample is provided in Attachment VI. The input files are echoed in the output files, which have an "output" extension. At the end of each SAS2H run, the gram concentrations for the principal isotopes were copied from the SAS2H output into a summary file (*.SUM) using the unix "awk" command and a short "getPI" script (see Attachment V). See Section 9 for information on the input, output files, and summary files, and the "getPI" awk script.

The grams/assembly output per time step was used to calculate the number density of each principal isotope (see assumption 4.3.1). The burnup/enrichment pair number densities for the principal isotopes were calculated from the SAS2H summary files using a short BASIC code, AMIGO.BAS, which also automatically placed them into the appropriate spot in an MCNP input file template (see Section 9.0 for the source code). The AMIGO number density calculations are performed using the following equation (Ref. 5.45, p. 35):

$$N_i = \frac{m_i \rho N_A}{m M_i}$$

where: ρ is the physical density of the UO_2 in g/cm^3,
N_A is Avogadro's Number - 0.602252 x 10^{24} atoms/mole,
M_i is the gram atomic weight of isotope i,
m_i is the gram concentration per assembly of isotope i, and
m is the total mass of UO_2 per assembly in grams.

The units of the resulting number density is in atoms/cm^3. The required units for subsequent use are atoms/b-cm where 1 barn equals 10^{-24} cm^2. The calculation in AMIGO drops the 10^{24} from Avagadro's Number to account for the conversion. As a conservatism in the criticality calculations which will use these number densities, the values are adjusted up to a 96% theoretical UO_2 density (actual pellet is 95%; see Section 4.1.1). Since the number density of oxygen does not change with time, a value of 4.6947x10^{-2} atoms/b-cm was used for all cases (Ref. 5.43, p. 24). AMIGO number density calculations for the 1.13-m fuel were independently checked for accuracy in the NUMDEN sheet of the Excel 7.0 worksheet, BURNRICH.XLW.

AMIGO creates MCNP inputs by searching the lines of a user supplied template for the mnemonics "FUELTOT" and "FUELNUM". When found in the template file, FUELTOT is replaced with the total number density for the fuel region, and FUELNUM is replaced with the MCNP ID#s and number densities of the principal isotopes. An input file is created for each decay time available from the SAS2H summary file that is within the user specified range.

7.3 Analysis of Partially Degraded Basket Configurations with Intact Fuel

The purpose of this section is to describe the MCNP cases needed to fully characterize the possible partially degraded basket configurations. Both the uniformly distributed oxide and the settled oxide configurations were evaluated for 7 plate thicknesses. While Table 4.1-2 indicates that 7 mm is the design thickness of the criticality control plates, a 10 mm thickness was also evaluated in the event that the thickness was increased at some future point in the design process. For the uniformly distributed configurations, iron oxide concentrations of 30 vol%, 35 vol%, and 40 vol% were evaluated for the low, median, and high burnup coverage for the 1.13 bin and the median and high burnup coverage for the 1.10 bin. In some cases 0 vol% iron oxide was also evaluated for the purpose of determining the total worth of the other oxide concentrations (0 vol% is not considered a realistic scenario as discussed in Section 7.1). For the settled scenarios, 58 vol% iron oxide fully covering the bottom 8, 9, and 10 rows of fuel rods in an assembly were evaluated for the low, median, and high burnup coverage for the 1.13 bin and the median and high burnup coverage for the 1.10 bin. For most cases, each burnup/enrichment pair was only evaluated for the 14,000 year decay time, as this has been the time of peak postclosure k_{eff} in previous analyses of a collapsed basket with some boron remaining (Ref. 5.6, Vol. III, p. 6.3-142). However, time effects have been evaluated for 7 mm, 2.5 mm, and 0.1 mm plate thicknesses.

The degraded 21 PWR absorber plate WP was modeled in MCNP by explicitly modeling ¼ of the package and then using two reflective planes to represent the entire package. The composition and dimensions of the containment barriers are modeled explicitly using the information in Sections 4.1.2 and 4.1.3. The details of the outer barrier's skirt were not modeled in detail, since the skirt would not affect the criticality results appreciably (less than the standard deviation in the Monte Carlo method). The fuel assemblies are modeled as part of a lattice array, with the lattice positioned such that it represents a basket structure which has uniformly collapsed towards the bottom of the WP. The assemblies were not modeled as resting on the bottom of the WP because some oxide from corrosion of the side guides may be there to support them, and the approximate cylindrical geometry is more reactive than that which would occur if all assemblies were touching the bottom. Each fuel assembly is treated as a heterogeneous system with the fuel rods, control rod guide tubes, and instrument guide tubes modeled explicitly using the information contained in Section 4.1.1. Fuel rods are modeled with water in the gap region, and guide and instrument tubes are also filled with water only (no oxide). The remaining borated stainless steel plate is modeled at the edge of the assembly lattice cell. Figure 7.3-1 shows the geometry of the MCNP model for the partial basket uniform cases, while Figure 7.3-2 shows the geometry of the MCNP model for the partial basket settled case with 10 fuel rod rows covered and 0.5 mm thick borated stainless steel plate remaining between assemblies. Table 7.3-1 provides the naming convention for the MCNP input and output files (see Section 9 for file information). Sample MCNP input files are provided in Attachment VII for the uniform case and Attachment VIII for the settled case.

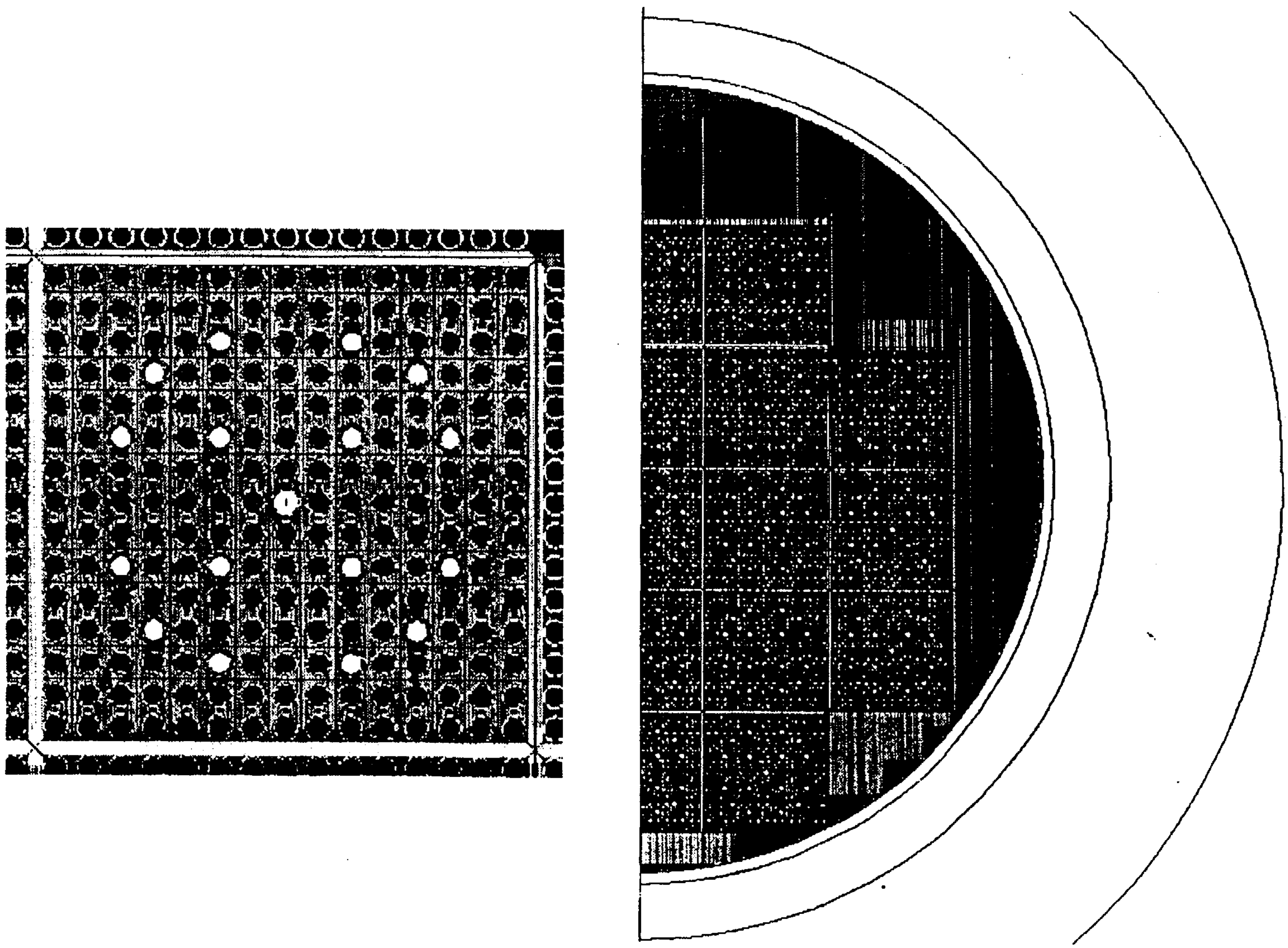


Figure 7.3-1. MCNP partial basket model with uniformly distr[illegible]d oxide. Assembly detail is shown at left.

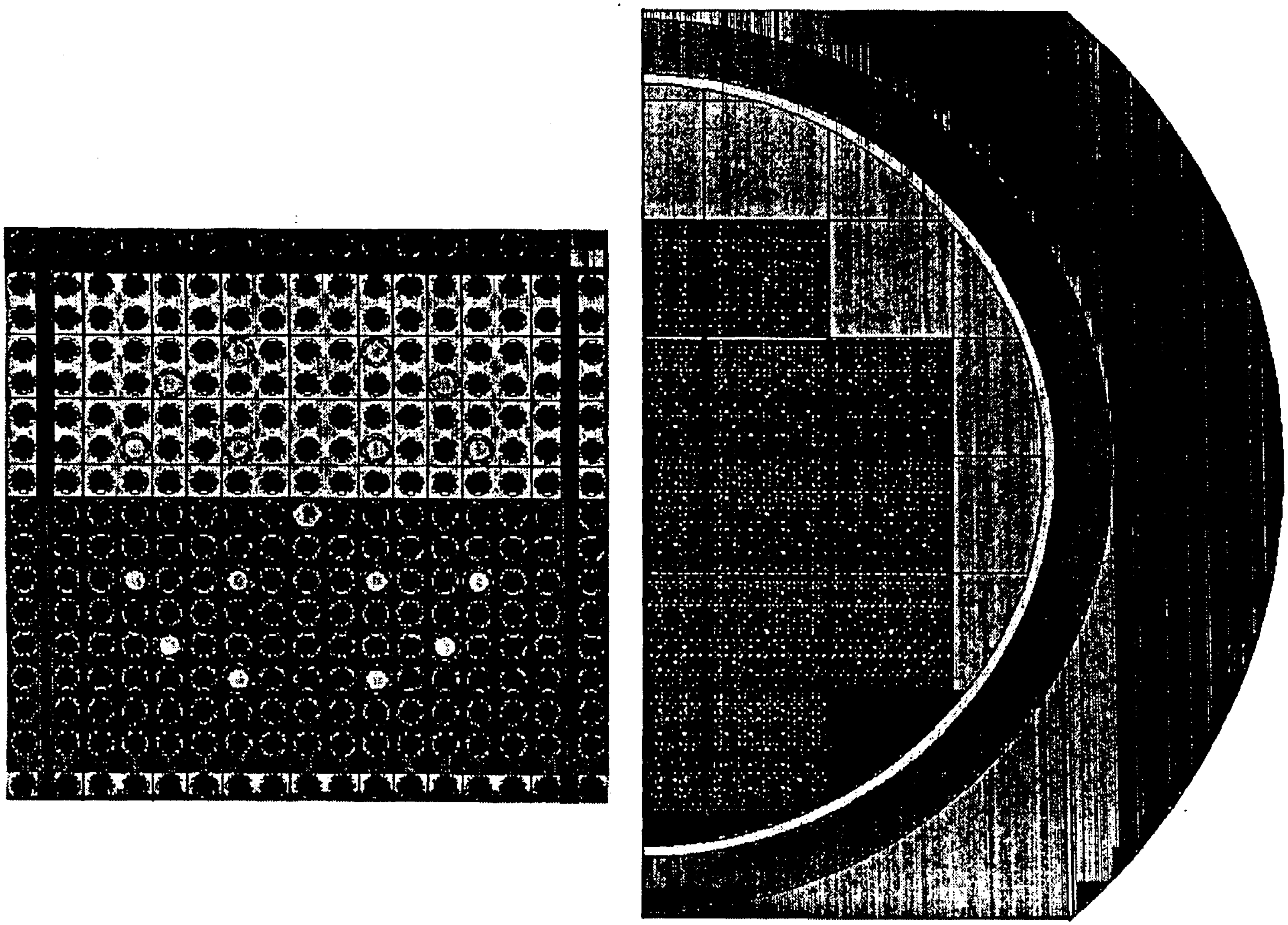


Figure 7.3-2. MCNP partial basket model with 58 vol% settled oxide (covering bottom 8 rod rows) and 7 mm borated stainless steel plate between assemblies. Assembly detail is shown at left.

Table 7.3-1. Naming Convention for Partial Basket MCNP Cases

1st Character Plate Thickness	2nd & 3rd Characters Amount of Oxide	Characters 4 to 6 k_{∞} Bin	Character 7 Decay Time
a = 10 mm b = 7 mm c = 5 mm d = 2.5 mm e = 1 mm f = 0.5 mm g = 0.1 mm	Uniform 00 = no iron oxide 30 = 30 vol% iron oxide 35 = 35 vol% iron oxide 40 = 40 vol% iron oxide Settled 08 = 8 rows covered 09 = 9 rows covered 10 = 10 rows covered	h13 = 1.13-h m13 = 1.13-m l13 = 1.13-l h10 = 1.10-h m10 = 1.10-m	a = 2,000 years b = 4,000 years c = 8,000 years d = 10,000 years e = 12,000 years f = 14,000 years g = 18,000 years h = 25,000 years j = 45,000 years k = 100,000 years

The results of the various cases are provided in the tables on the following pages. Table 7.3-2 presents the results for the uniformly distributed oxide cases for 14,000 years decay. Table 7.3-3 presents the results for all 10 decay times for two of the uniform oxide cases. Table 7.3-4 presents the results for the 58 vol% settled oxide cases for 14,000 years decay. Table 7.3-5 presents the results for all 10 decay times for two of the 58 vol% settled cases.

Table 7.3-2. Partial Basket k_{eff} Results for Uniform Oxide at 14,000 years

Vol% Fe_2O_3	B-SS Plate Thickness (mm)	1.13-h		1.13-m		1.13-l		1.10-h		1.10-m	
		k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
0	10	0.92981	0.00438	0.90077	0.00468	0.81378	0.00354	0.88991	0.00464	0.84392	0.00372
30	10	0.78970	0.00344	0.76174	0.00378	0.66772	0.00364	0.75310	0.00300	0.71067	0.00302
30	7	0.80683	0.00472	0.77960	0.00388	0.68667	0.00274	0.77191	0.00380	0.72225	0.00372
35	7	0.78417	0.00412	0.75827	0.00394	0.66638	0.00386	0.74864	0.00404	0.70235	0.00380
30	5	0.82678	0.00412	0.80300	0.00448	0.70154	0.00350	0.78967	0.00416	0.74207	0.00366
35	5	0.80199	0.00294	0.77443	0.00312	0.68179	0.00374	0.76393	0.00362	0.72363	0.00332
30	2.5	0.86315	0.00406	0.83526	0.00436	0.74073	0.00324	0.82431	0.00398	0.77845	0.00354
40	2.5	0.81769	0.00388	0.78880	0.00438	0.70174	0.00316	0.77890	0.00412	0.73330	0.00316
30	1	0.90732	0.00404	0.88326	0.00360	0.78842	0.00368	0.87059	0.00350	0.82341	0.00398
40	1	0.86006	0.00356	0.83612	0.00334	0.74224	0.00342	0.82300	0.00342	0.77839	0.00270
30	0.5	0.93928	0.00428	0.91158	0.00376	0.82313	0.00388	0.89695	0.00392	0.85309	0.00250
40	0.5	0.88658	0.00284	0.86294	0.00366	0.77465	0.00356	0.84774	0.00376	0.80680	0.00442
30	0.1	0.97255	0.00328	0.95410	0.00372	0.87273	0.00302	0.93808	0.00496	0.89726	0.00394
40	0.1	0.92403	0.00454	0.90248	0.00380	0.82080	0.00402	0.88169	0.00348	0.84497	0.00318

Table 7.3-3. Time Effects on Partial Basket k_{eff} for Selected 33 vol% Uniform Oxide Cases

Decay Time (years)	Vol% Fe_2O_3	B-SS Plate Thickness Remaining (mm)	1.13-h		1.13-m		1.13-l		1.10-h		1.10-m	
			k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
2000	30	7	0.79442	0.00340	0.76711	0.00490	0.68937	0.00394	0.75726	0.00408	0.71708	0.00442
4000	30	7	0.79734	0.00454	0.77161	0.00446	0.69135	0.00364	0.76311	0.00398	0.71832	0.00418
8000	30	7	0.79925	0.00476	0.77564	0.00364	0.68474	0.00350	0.76476	0.00398	0.71980	0.00348
10000	30	7	0.80431	0.00398	0.77638	0.00468	0.68335	0.00288	0.76799	0.00366	0.72004	0.00342
12000	30	7	0.80499	0.00384	0.77663	0.00374	0.68544	0.00320	0.76568	0.00484	0.71983	0.00344
14000	30	7	0.80683	0.00472	0.77960	0.00388	0.68667	0.00274	0.77191	0.00380	0.72225	0.00372
18000	30	7	0.80485	0.00374	0.77688	0.00470	0.68053	0.00382	0.76721	0.00368	0.72098	0.00354
25000	30	7	0.80678	0.00426	0.77501	0.00442	0.67600	0.00298	0.76689	0.00468	0.71830	0.00300
45000	30	7	0.79512	0.00350	0.76448	0.00414	0.66024	0.00402	0.75574	0.00382	0.70227	0.00294
100000	30	7	0.77439	0.00318	0.74502	0.00382	0.64233	0.00316	0.73295	0.00412	0.68103	0.00376
2000	30	2.5	0.85028	0.00432	0.82504	0.00398	0.74647	0.00368	0.81290	0.00414	0.77255	0.00452
4000	30	2.5	0.85212	0.00396	0.82738	0.00350	0.74465	0.00396	0.82059	0.00464	0.77481	0.00384
8000	30	2.5	0.85692	0.00290	0.83427	0.00392	0.74163	0.00248	0.82117	0.00372	0.77573	0.00314
10000	30	2.5	0.85645	0.00386	0.83618	0.00414	0.74150	0.00304	0.82390	0.00366	0.78133	0.00300
12000	30	2.5	0.86396	0.00386	0.83368	0.00432	0.74193	0.00380	0.82528	0.00376	0.77750	0.00264
14000	30	2.5	0.86315	0.00406	0.83526	0.00436	0.74073	0.00324	0.82431	0.00398	0.77845	0.00354
18000	30	2.5	0.86251	0.00338	0.83345	0.00436	0.73821	0.00320	0.82551	0.00442	0.77608	0.00356
25000	30	2.5	0.86686	0.00392	0.83181	0.00372	0.73242	0.00318	0.82364	0.00406	0.77054	0.00350
45000	30	2.5	0.85982	0.00366	0.82120	0.00328	0.71823	0.00346	0.81612	0.00440	0.75904	0.00368
100000	30	2.5	0.83728	0.00384	0.80280	0.00390	0.69529	0.00256	0.79389	0.00392	0.73614	0.00320
2000	40	0.1	0.90423	0.00526	0.88469	0.00300	0.82257	0.00354	0.86601	0.00450	0.83491	0.00464
4000	40	0.1	0.90761	0.00272	0.89211	0.00446	0.82266	0.00298	0.86962	0.00328	0.83894	0.00350
8000	40	0.1	0.91552	0.00306	0.89544	0.00390	0.82281	0.00298	0.87657	0.00400	0.84267	0.00322
10000	40	0.1	0.91673	0.00402	0.89539	0.00346	0.82296	0.00350	0.88501	0.00350	0.83920	0.00366
12000	40	0.1	0.91879	0.00262	0.89364	0.00374	0.82515	0.00354	0.88388	0.00384	0.84598	0.00352
14000	40	0.1	0.92403	0.00454	0.90248	0.00380	0.82080	0.00402	0.88169	0.00348	0.84497	0.00318
18000	40	0.1	0.92510	0.00352	0.90185	0.00256	0.82173	0.00350	0.88975	0.00342	0.85046	0.00354
25000	40	0.1	0.93057	0.00330	0.89966	0.00422	0.81602	0.00318	0.88797	0.00366	0.84532	0.00360
45000	40	0.1	0.91902	0.00276	0.89295	0.00262	0.80300	0.00404	0.88141	0.00386	0.83690	0.00350
100000	40	0.1	0.90882	0.00338	0.88229	0.00326	0.78268	0.00296	0.86701	0.00328	0.81286	0.00332

Table 7.3-4. Partial Basket k_{eff} Results for 58 vol% Settled Oxide at 14,000 years

Fuel Rod Rows Covered	B-SS Plate Thickness (mm)	1.13-h		1.13-m		1.13-l		1.10-h		1.10-m	
		k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
8	10	0.81426	0.00424	0.78600	0.00502	0.69733	0.00240	0.77377	0.00380	0.73454	0.00430
8	7	0.83278	0.00412	0.80454	0.00332	0.71029	0.00432	0.79263	0.00384	0.74996	0.00396
9	7	0.80722	0.00354	0.78330	0.00386	0.69393	0.00392	0.77649	0.00428	0.72799	0.00324
8	5	0.84832	0.00500	0.82299	0.00416	0.72858	0.00252	0.81019	0.00334	0.76409	0.00290
9	5	0.82201	0.00480	0.79672	0.00282	0.70623	0.00272	0.79002	0.00416	0.73905	0.00376
8	2.5	0.88197	0.00336	0.85849	0.00510	0.76804	0.00340	0.84771	0.00486	0.80536	0.00428
10	2.5	0.83842	0.00476	0.80639	0.00378	0.71386	0.00348	0.80212	0.00276	0.75639	0.00442
8	1	0.93080	0.00386	0.90327	0.00398	0.81482	0.00300	0.89041	0.00386	0.85276	0.00380
10	1	0.87887	0.00398	0.85843	0.00370	0.76977	0.00394	0.84450	0.00456	0.80226	0.00266
8	0.5	0.95537	0.00422	0.93366	0.00506	0.84797	0.00414	0.92184	0.00444	0.88166	0.00408
10	0.5	0.91223	0.00358	0.88869	0.00336	0.80397	0.00358	0.87377	0.00366	0.83266	0.00358
8	0.1	0.99735	0.00484	0.97522	0.00530	0.89972	0.00316	0.95564	0.00382	0.92198	0.00376
10	0.1	0.95201	0.00394	0.92626	0.00386	0.85450	0.00352	0.91279	0.00400	0.87553	0.00400

Table 7.3-5. Time Effects on Partial Basket k_{eff} for Selected Settled Oxide Cases

Decay Time (years)	Fuel Rod Rows Covered	B-SS Thickness (mm)	1.13-h		1.13-m		1.13-l		1.10-h		1.10-m	
			k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
2000	8	7	0.81968	0.00522	0.79668	0.00334	0.71385	0.00436	0.7866	0.00458	0.74361	0.00338
4000	8	7	0.82083	0.00460	0.80040	0.00378	0.71532	0.00310	0.7862	0.00286	0.74453	0.00488
8000	8	7	0.82596	0.00472	0.80176	0.00374	0.71688	0.00342	0.78961	0.00448	0.74723	0.004
10000	8	7	0.82788	0.00462	0.80426	0.00408	0.71344	0.00424	0.79237	0.00366	0.75196	0.0045
12000	8	7	0.82521	0.00412	0.80413	0.00396	0.71437	0.00366	0.79578	0.00394	0.74649	0.0032
14000	8	7	0.83278	0.00412	0.80454	0.00332	0.71029	0.00432	0.79263	0.00384	0.74996	0.00396
18000	8	7	0.83212	0.00442	0.80119	0.00404	0.71366	0.00380	0.79124	0.00474	0.75135	0.00458
25000	8	7	0.83031	0.00416	0.80436	0.00412	0.70439	0.00398	0.79446	0.0038	0.74312	0.00388
45000	8	7	0.82001	0.00364	0.79109	0.00346	0.69252	0.00406	0.78086	0.0048	0.72786	0.00376
100000	8	7	0.80444	0.00382	0.77576	0.00388	0.67524	0.00342	0.76311	0.00434	0.70903	0.00368
2000	8	2.5	0.87520	0.00372	0.84608	0.00384	0.76773	0.00382	0.83303	0.0038	0.79574	0.00376
4000	8	2.5	0.87701	0.00362	0.85366	0.00414	0.77058	0.00410	0.83772	0.00522	0.79397	0.00454
8000	8	2.5	0.88350	0.00404	0.85561	0.00440	0.76989	0.00302	0.84566	0.00314	0.80006	0.00488
10000	8	2.5	0.88204	0.00464	0.85818	0.00386	0.76751	0.00506	0.84542	0.0033	0.80392	0.00402
12000	8	2.5	0.88442	0.00464	0.85917	0.00376	0.76484	0.00342	0.84552	0.00438	0.80158	0.00292
14000	8	2.5	0.88197	0.00336	0.85849	0.00510	0.76804	0.00340	0.84771	0.00486	0.80536	0.00428
18000	8	2.5	0.88681	0.00472	0.85647	0.00490	0.76020	0.00350	0.84669	0.00356	0.8014	0.00436
25000	8	2.5	0.89216	0.00460	0.85408	0.00396	0.75837	0.00368	0.84528	0.00398	0.79663	0.00356
45000	8	2.5	0.87621	0.00410	0.84662	0.00412	0.74475	0.00294	0.83947	0.00518	0.78465	0.0048
100000	8	2.5	0.86206	0.00448	0.82738	0.00330	0.71846	0.00384	0.81382	0.0045	0.7597	0.00402
2000	10	0.1	0.93087	0.00408	0.91065	0.00362	0.84982	0.00298	0.89322	0.0041	0.86148	0.00362
4000	10	0.1	0.93318	0.00518	0.91670	0.00354	0.85168	0.00238	0.89932	0.00338	0.86315	0.0038

Table 7.3-5. Time Effects on Partial Basket k_{eff} for Selected Settled Oxide Cases

Decay Time (years)	Fuel Rod Rows Covered	B-SS Thickness (mm)	1.13-h		1.13-m		1.13-l		1.10-h		1.10-m	
			k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
8000	10	0.1	0.94610	0.00318	0.92098	0.00416	0.85614	0.00358	0.90762	0.00378	0.86907	0.00408
10000	10	0.1	0.94883	0.00350	0.92894	0.00404	0.85544	0.00336	0.91083	0.00398	0.86817	0.0037
12000	10	0.1	0.94987	0.00422	0.92751	0.00326	0.85273	0.00320	0.90755	0.00402	0.87483	0.00322
14000	10	0.1	0.95201	0.00394	0.92626	0.00386	0.85450	0.00352	0.91279	0.004	0.87553	0.004
18000	10	0.1	0.95387	0.00422	0.93407	0.00318	0.85193	0.00296	0.91536	0.00428	0.87616	0.00336
25000	10	0.1	0.95868	0.00478	0.93069	0.00336	0.85235	0.00384	0.91697	0.00314	0.87748	0.004
45000	10	0.1	0.95298	0.00444	0.92356	0.00360	0.83586	0.00386	0.90936	0.00462	0.86469	0.0036
100000	10	0.1	0.93891	0.00354	0.90975	0.00400	0.81186	0.00326	0.89438	0.00416	0.84252	0.00348

In addition to the boron remaining in the undegraded borated stainless steel, a significant amount of boron may remain in solution until sufficient flushing of the WP by dripping water occurs. To evaluate this configuration, water and water/oxide mixture number densities for various concentrations of ^{10}B dissolved in the entire water volume of the flooded WP were calculated in the NUMDEN sheet of the Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III). Table 7.3-6 provides the MCNP case names (naming convention differs from that used for previous tables) and k_{eff} results for the 1.13-h fuel in the settled configuration at 14,000 years with various amounts of borated stainless steel remaining and ^{10}B in solution. See Section 9.0 for the MCNP input and output files for these cases.

Table 7.3-6. Effects of ^{10}B in Solution for 14,000 yr 1.13-h Partial Basket Settled Cases

MCNP Case Name	Grams ^{10}B in Solution	B-SS Thickness (mm)	Fuel Rod Rows Covered	k_{eff}	σ	$\Delta k_{eff}/k_{eff}$ (%)
rb10b08	3011.26	7	8	0.61778	0.00147	-25.82%
rb5b08	1505.63	7	8	0.70318	0.00193	-15.56%
rb2b08	602.25	7	8	0.76716	0.00186	-7.88%
rb1b08	301.13	7	8	0.79461	0.0015	-4.58%
rbp5b08	150.56	7	8	0.81381	0.00156	-2.28%
rbp2b08	60.23	7	8	0.82237	0.00239	-1.25%
rbp1b08	30.11	7	8	0.82797	0.00187	-0.58%
rb10b09	3011.26	7	9	0.61689	0.00175	-23.58%
rb5b09	1505.63	7	9	0.69306	0.00232	-14.14%
rb2b09	602.25	7	9	0.75629	0.00219	-6.31%
rb1b09	301.13	7	9	0.78311	0.00219	-2.99%
rbp5b09	150.56	7	9	0.79658	0.00187	-1.32%
rbp2b09	60.23	7	9	0.80211	0.00191	-0.63%
rbp1b09	30.11	7	9	0.80495	0.00217	-0.28%
rb10d08	3011.26	2.5	8	0.66186	0.00193	-24.96%
rb5d08	1505.63	2.5	8	0.74542	0.00164	-15.48%
rb2d08	602.25	2.5	8	0.82285	0.00227	-6.70%
rb1d08	301.13	2.5	8	0.85209	0.00211	-3.39%
rbp5d08	150.56	2.5	8	0.86944	0.00225	-1.42%
rbp2d08	60.23	2.5	8	0.87713	0.00225	-0.55%
rbp1d08	30.11	2.5	8	0.88319	0.00188	0.14%
rb10d10	3011.26	2.5	10	0.64902	0.00172	-22.59%
rb5d10	1505.63	2.5	10	0.72535	0.00214	-13.49%
rb2d10	602.25	2.5	10	0.78561	0.0021	-6.30%
rb1d10	301.13	2.5	10	0.8108	0.00197	-3.29%
rbp5d10	150.56	2.5	10	0.82759	0.00223	-1.29%
rbp2d10	60.23	2.5	10	0.83244	0.00155	-0.71%
rbp1d10	30.11	2.5	10	0.83162	0.00192	-0.81%
rb10g08	3011.26	0.1	8	0.73186	0.00161	-26.62%
rb5g08	1505.63	0.1	8	0.83428	0.00194	-16.35%
rb2g08	602.25	0.1	8	0.92258	0.002	-7.50%
rb1g08	301.13	0.1	8	0.95765	0.00195	-3.98%
rbp5g08	150.56	0.1	8	0.97771	0.00194	-1.97%
rbp2g08	60.23	0.1	8	0.98872	0.00216	-0.87%
rbp1g08	30.11	0.1	8	0.99346	0.00189	-0.39%
rb10g10	3011.26	0.1	10	0.73003	0.00174	-23.32%
rb5g10	1505.63	0.1	10	0.81556	0.00187	-14.33%
rb2g10	602.25	0.1	10	0.88809	0.0016	-6.71%
rb1g10	301.13	0.1	10	0.91914	0.00215	-3.45%
rbp5g10	150.56	0.1	10	0.93386	0.00179	-1.91%
rbp2g10	60.23	0.1	10	0.94266	0.00176	-0.98%
rbp1g10	30.11	0.1	10	0.94577	0.00215	-0.66%

7.4 Analysis of Fully Degraded Basket Configurations with Intact Fuel Assemblies

The purpose of this section is to describe the MCNP cases needed to fully characterize the possible fully degraded basket configurations. Both the uniformly distributed oxide and the settled oxide configurations were evaluated. For the uniformly distributed scenarios, iron oxide concentrations of 30 vol%, 33 vol%, and 40 vol% were evaluated for the low, median, and high burnup coverage for the 1.13, 1.10, and 1.08 bins, and for the median and high burnup coverage for the 1.06 and 1.04 bins. For the settled scenarios, 58 vol% iron oxide fully covering the bottom 3.5 rows of assemblies were evaluated for the median and high burnup coverage for the 1.13 bin and the high burnup coverage for the 1.10 bin. Time effects were evaluated for all configurations from covering the range of 8,000 to 250,000 years.

As with the partial basket model, the fully degraded 21 PWR absorber plate WP was modeled in MCNP by explicitly modeling ¼ of the package and then using two reflective planes to represent the entire package. The composition and dimensions of the containment barriers are modeled explicitly using the information in Sections 4.1.2 and 4.1.3. The details of the outer barrier's skirt were not modeled in detail, since the skirt would not effect the criticality results appreciably (less than the standard deviation in the Monte Carlo method). The fuel assemblies are modeled as part of a lattice array, with the lattice positioned such that it represents a basket structure which has uniformly collapsed towards the bottom of the WP. The assemblies were not modeled as resting on the bottom of the WP because some oxide from corrosion of the side guides may be there to support them, and the approximate cylindrical geometry is more reactive than that which would occur if all assemblies were touching the bottom. Each fuel assembly is treated as a heterogeneous system with the fuel rods, control rod guide tubes, and instrument guide tubes modeled explicitly using the information contained in Section 4.1.1. Fuel rods are modeled with water in the gap region, and guide and instrument tubes are also filled with water only (no oxide). Figure 7.4-1 shows the geometry of the MCNP model for the fully degraded uniform cases, while Figure 7.4-2 shows the geometry of the MCNP model for the fully degraded settled case with the bottom 3.5 assemblies covered. Table 7.4-1 provides the naming convention for the MCNP input and output files (see Section 9 for file information). Sample MCNP input files are provided in Attachment IX for the uniform case and Attachment X for the settled case.

The results of the various cases are provided in the tables presented below. Tables 7.4-2 to 7.4-4 present the results for the 30 vol%, 33 vol%, and 40 vol% uniformly distributed oxide cases. Table 7.4-5 presents the results for the 58 vol% settled cases. The results for these configurations indicate that the 58 vol% settled oxide configuration is the bounding case for the fully degraded WP. In all of the configurations, the peak k_{eff} generally occurs between 10,000 and 35,000 years.

To evaluate the effects of 0.67% boron adsorption onto the iron oxide, water/oxide mixture number densities with adsorbed ^{10}B were calculated in the NUMDEN sheet of the Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III). Both 33 vol% uniform and 58 vol% settled configurations were evaluated for time of peak k_{eff} for the 1.13 cases. Case names are consistent with those given in Table 7.4-1 except that the 1st character is replaced with a "B". Table 7.4-6 presents the k_{eff} and %Δk results for 0.67% ^{10}B adsorption onto the iron oxide. The results indicate that boron adsorption provides less than a 1.4% reduction in k_{eff} for the uniform cases, and a 0.2% reduction for the settled cases. Therefore, this boron retention mechanism cannot be counted on for significant criticality control.

Table 7.4-7 presents the k_{eff} and %Δk results for various concentrations of dissolved ^{10}B in the entire water volume for the 58 vol% settled oxide 1.13 bin cases at the time of peak k_{eff}. Based on the few cases run, it appears that there is a slight trend towards decreasing boron worth with increasing burnup. This is likely the result of the fact that higher burned fuels have higher ^{239}Pu concentrations, and thus a harder spectrum (more epithermal fission) which makes the boron less effective.

Table 7.4-8 presents the results of varying the assembly horizontal/vertical spacing from the base case of 0 cm for the 33 vol% uniform 1.13-h case at the time of peak k_{eff} (the settled case was not examined as most of the assemblies are covered by oxide and do not contribute significantly to k_{eff}). Assembly spacing is adjusted by modifying surfaces 60 to 63 in the base "u33h13g" input. The results indicate that k_{eff} peaks at a value approximately 0.5% higher than the base case at a separation of 0.8 cm.

Table 7.4-9 indicates the effect on peak k_{eff} for the 1.13-h and 1.13-m fuels of a transition from 33 vol% uniformly distributed oxide to 58 vol% settled oxide. The divider for the upper and lower region of the model is the same as that for the top of the oxide/water mixture in the 58 vol% settled cases.

Depending on the amount of pitting on the upper surface, the WP may not be entirely flooded. Table 7.4-10 presents the case names and k_{eff} results for the 1.13-m and 1.13-h fuels in the 33 vol% uniform and 58 vol% settled oxide configurations at the time of peak k_{eff} for various water levels. The WP void space above the water line is filled with air. The results indicate that for the settled configuration, dropping the water level below the third fuel rod row in the fourth assembly from the bottom reduces k_{eff} below 0.91 for the 1.13-h case. While the water level must drop farther in the uniform configuration to achieve the same result, this is partially an artifact of maintaining 33 vol% oxide as the water level is reduced. These cases demonstrate that a fully degraded absorber plate WP which contains only a hydrated oxide will not be a criticality concern.

Table 7.4-11 presents k_{eff} results for varying the amount of oxide for the 58 vol% settled cases from the base case of 3.5 rows covered. The case naming convention is consistent with that shown in Table 7.4-1 except that the "58" is replaced by the number of rows covered ("3" = 3 rows, "4" = 4 rows, and "45" = 4.5 rows). This exercise demonstrates that adding additional steel to the WP initially (so that more oxide is available once it degrades) is an effective means of controling degraded WP criticality under worst cases conditions. This subject is further investigated in Section 7.7.

Table 7.4-12 presents k_{eff} results for the two PWR absorber rod WP burnup/enrichment pairs (cr-1 and cr-2) in the 58 vol% settled oxide and 33 vol% uniform oxide configurations. For the cases with DCRAs, the naming convention is given in Table 7.4-1. The same naming convention, with the 5th character ("r") removed, is used for the cases without DCRAs. The DCRAs were modeled using the dimmensions discussed in assumption 4.3.15, the B_4C material composition provided in Table 4.1-4, and the same oxide amounts as for the absorber plate WP (see assumption 4.3.17). Results are presented with and without the 16 rod DCRAs, indicating that the DCRAs provide an ≈24-25% reduction in k_{eff} for these fuel compositions in the settled configuration, and ≈26-27% reduction for the uniform configuration. Finally, Table 7.4-13 provides an evaluation of assembly spacing effects for the cr-1 burnup/enrichment pair of the absorber rod WP.

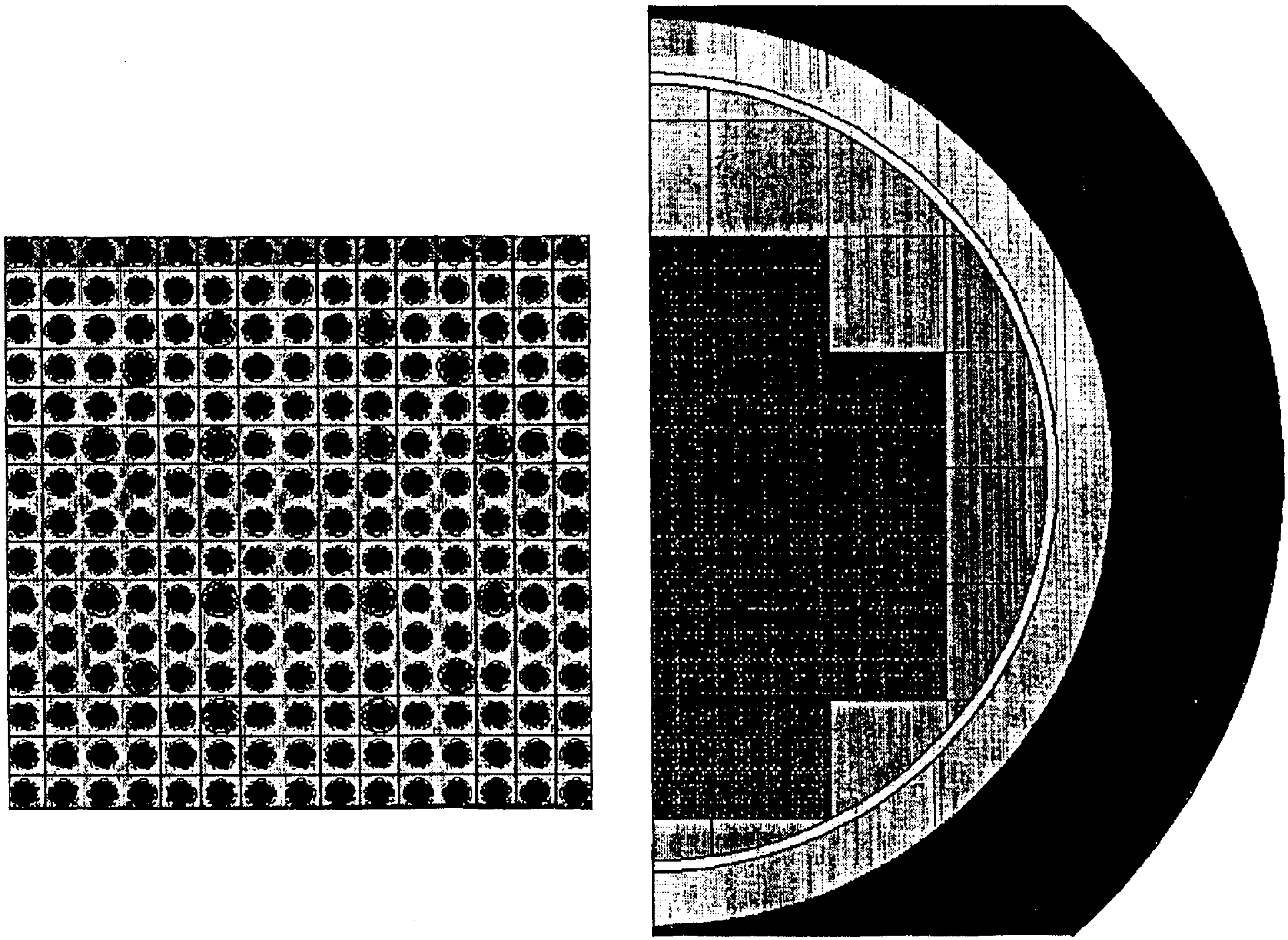


Figure 7.4-1. MCNP fully degraded basket model with uniformly distributed oxide. Assembly detail shown at left.

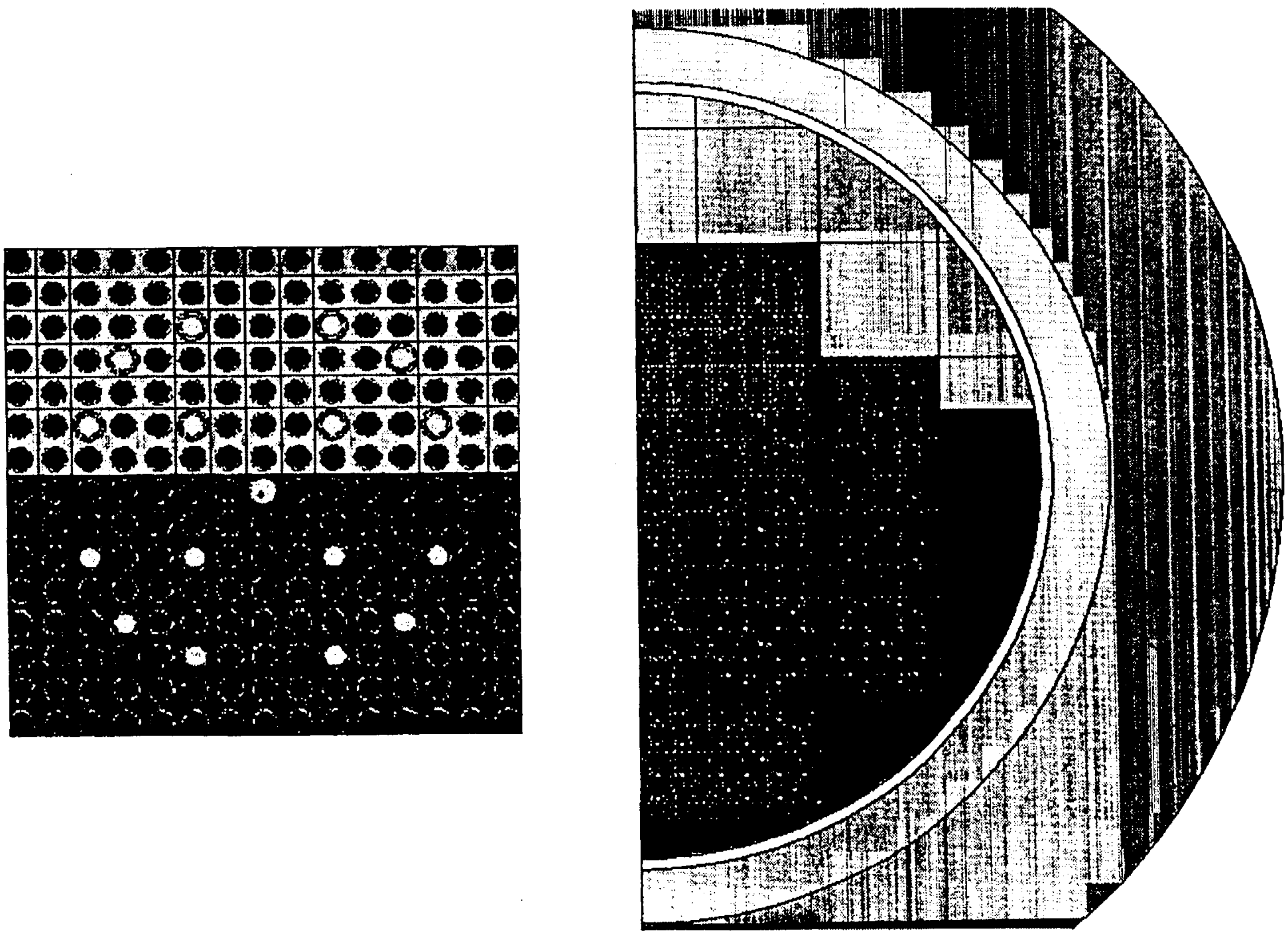


Figure 7.4-2. MCNP fully degraded basket model with 58 vol% settled oxide covering the bottom 3.5 assemblies. Assembly detail is shown at left.

Table 7.4-1. Naming Convention for Fully Degraded WP MCNP Cases

Characters 1 to 3 Oxide Vol% and Distribution	Characters 4 to 6 k_∞ Bin	Character 7 Decay Time
u30 = 30% uniform u33 = 33% uniform u40 = 40% uniform r58 = 58% settled	h13 = 1.13-h h10 = 1.10-h h08 = 1.08-h h06 = 1.06-h h04 = 1.04-h m13 = 1.13-m m10 = 1.10-m m08 = 1.08-m m06 = 1.06-m m04 = 1.04-m l13 = 1.13-l l10 = 1.10-l l08 = 1.08-l cr1 = cr-1 w/ DCRAs cr2 = cr-2 w/ DCRAs	a = 8,000 years b = 10,000 years c = 12,000 years d = 14,000 years e = 18,000 years f = 25,000 years g = 35,000 years h = 45,000 years i = 100,000 years j = 250,000 years

Table 7.4-2. Time Effects on Fully Degraded Basket k_{eff} for 30 Vol% Uniform Oxide Cases

Decay Time (years)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h		1.06-h		1.04-h	
8000	0.97649	0.00344	0.94348	0.004	0.91705	0.00424	0.90146	0.00384	0.87311	0.00366
10000	0.9812	0.00368	0.94599	0.00406	0.92438	0.00414	0.90362	0.00476	0.88218	0.00282
12000	0.98597	0.00382	0.95051	0.00284	0.92673	0.00484	0.9089	0.00336	0.87678	0.00374
14000	0.98853	0.00382	0.95119	0.00438	0.92421	0.00342	0.91319	0.00378	0.88121	0.0043
18000	0.99628	0.0045	0.95391	0.0039	0.92716	0.00426	0.91344	0.00348	0.88434	0.00452
25000	0.99309	0.00388	0.9577	0.00434	0.93164	0.00412	0.91498	0.00346	0.88538	0.0048
35000	0.99045	0.0045	0.95418	0.0033	0.93013	0.0036	0.91195	0.0032	0.87915	0.00382
45000	0.98956	0.0042	0.94813	0.00338	0.9246	0.00374	0.91099	0.00476	0.87934	0.00344
100000	0.97423	0.00336	0.93377	0.0029	0.90642	0.00354	0.88838	0.00358	0.85783	0.00254
250000	0.97543	0.0036	0.92984	0.00426	0.90591	0.00364	0.89038	0.00504	0.85309	0.00356
	1.13-m		1.10-m		1.08-m		1.06-m		1.04-m	
8000	0.95898	0.00456	0.90754	0.00348	0.892	0.00362	0.87593	0.00294	0.86336	0.0037
10000	0.96422	0.00446	0.90799	0.00376	0.89623	0.00288	0.87956	0.00416	0.86298	0.00368
12000	0.96456	0.00516	0.91526	0.00406	0.89752	0.00422	0.88326	0.00398	0.86604	0.00374
14000	0.96924	0.00456	0.91551	0.00322	0.8986	0.00358	0.88373	0.00324	0.86843	0.00422
18000	0.96912	0.0046	0.92031	0.00408	0.90054	0.0035	0.88563	0.0046	0.87093	0.00394
25000	0.97104	0.00426	0.91637	0.00402	0.89994	0.0041	0.88377	0.00364	0.87056	0.00478
35000	0.97095	0.00362	0.90887	0.00324	0.8997	0.00298	0.88162	0.00324	0.86657	0.00286
45000	0.96454	0.00336	0.90764	0.00334	0.88799	0.00308	0.87734	0.00356	0.85713	0.00326
100000	0.95005	0.0044	0.87986	0.0038	0.86469	0.00262	0.85122	0.00318	0.83593	0.00374
250000	0.94472	0.00372	0.88202	0.00372	0.86521	0.00358	0.84934	0.00308	0.83134	0.00336

Table 7.4-3. Time Effects on Fully Degraded Basket k_{eff} for 33 Vol% Uniform Oxide Cases

Decay Time (years)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h		1.06-h		1.04-h	
8000	0.95940	0.00500	0.92205	0.00438	0.90540	0.00410	0.88663	0.00506	0.86148	0.00464
10000	0.96453	0.00408	0.93103	0.00292	0.90654	0.00374	0.88994	0.00426	0.86602	0.00360
12000	0.97014	0.00450	0.92939	0.00408	0.90622	0.00354	0.89175	0.00364	0.86557	0.00484
14000	0.97488	0.00410	0.93531	0.00428	0.91129	0.00430	0.89568	0.00344	0.87014	0.00300
18000	0.97481	0.00432	0.93963	0.00316	0.91234	0.00376	0.89627	0.00330	0.87149	0.00400
25000	0.97950	0.00370	0.94063	0.00478	0.91696	0.00436	0.90117	0.00294	0.87084	0.00312
35000	0.98127	0.00352	0.94241	0.00420	0.91691	0.00342	0.89850	0.00374	0.86825	0.00398
45000	0.97584	0.00424	0.93443	0.00430	0.90820	0.00410	0.89563	0.00364	0.86467	0.00418
100000	0.96078	0.00330	0.91790	0.00402	0.88838	0.00422	0.87539	0.00334	0.83790	0.00346
250000	0.95599	0.00324	0.91676	0.00280	0.88839	0.00388	0.87209	0.00402	0.83832	0.00256
	1.13-m		1.10-m		1.08-m		1.06-m		1.04-m	
8000	0.94780	0.00322	0.89034	0.00268	0.87986	0.00406	0.86300	0.00294	0.84661	0.00418
10000	0.94559	0.00426	0.89416	0.00362	0.87991	0.00392	0.86289	0.00314	0.84513	0.00338
12000	0.94992	0.00406	0.89767	0.00432	0.88083	0.00386	0.86876	0.00334	0.85123	0.00312
14000	0.95091	0.00348	0.90085	0.00280	0.88070	0.00428	0.86942	0.00390	0.84967	0.00336
18000	0.95230	0.00446	0.90109	0.00360	0.88625	0.00372	0.87165	0.00390	0.85503	0.00374
25000	0.95880	0.00304	0.89804	0.00450	0.88413	0.00372	0.86785	0.00420	0.85525	0.00366
35000	0.95597	0.00408	0.89851	0.00322	0.88147	0.00282	0.86730	0.00426	0.85211	0.00390
45000	0.95108	0.00400	0.88650	0.00344	0.87449	0.00380	0.85935	0.00394	0.84109	0.00424
100000	0.93344	0.00308	0.86718	0.00404	0.85119	0.00312				
250000	0.93282	0.00338	0.86507	0.00314	0.85089	0.00286				
	1.13-l		1.10-l		1.08-l					
8000	0.87885	0.00336	0.74746	0.00258	0.81133	0.00314				
10000	0.87710	0.00334	0.74609	0.00320	0.81620	0.00354				
12000	0.88228	0.00300	0.74567	0.00346	0.81349	0.00332				
14000	0.87892	0.00360	0.74414	0.00218	0.81734	0.00252				
18000	0.87972	0.00278	0.73717	0.00300	0.81385	0.00346				
25000	0.87467	0.00304	0.72932	0.00250	0.80625	0.00366				
35000	0.86732	0.00428	0.72132	0.00244	0.79736	0.00380				
45000	0.86190	0.00286	0.71341	0.00302	0.78899	0.00294				
100000	0.84241	0.00320	0.69060	0.00362	0.76311	0.00264				
250000	0.83725	0.00350	0.69082	0.00318	0.75251	0.00294				

Table 7.4-4. Time Effects on Fully Degraded Basket k_{eff} for 40 Vol% Uniform Oxide Cases

Decay Time (years)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h	
8000	0.92783	0.00448	0.88871	0.00364	0.8664	0.00468
10000	0.93185	0.0038	0.89419	0.00454	0.87037	0.00426
12000	0.93349	0.00336	0.89367	0.00346	0.87496	0.00346
14000	0.93259	0.00358	0.89659	0.00474	0.87854	0.004
18000	0.93961	0.00388	0.90302	0.00468	0.87989	0.00296
25000	0.93715	0.00362	0.90235	0.00342	0.87993	0.00352
35000	0.9367	0.0042	0.90071	0.00346	0.8788	0.00398
45000	0.93671	0.00324	0.8961	0.004	0.86997	0.00392
100000	0.92029	0.00506	0.87527	0.00318	0.85109	0.00336
250000	0.92224	0.00332	0.87731	0.00352	0.85134	0.00346
	1.13-m		1.10-m		1.08-m	
8000	0.90653	0.00362	0.85663	0.00392	0.84288	0.00458
10000	0.91058	0.00294	0.86119	0.00326	0.84604	0.00376
12000	0.91151	0.00376	0.85939	0.00352	0.84369	0.00358
14000	0.92032	0.00388	0.8623	0.00418	0.8469	0.00378
18000	0.91843	0.00526	0.86296	0.00276	0.85074	0.00334
25000	0.91832	0.00298	0.8662	0.00268	0.85118	0.00322
35000	0.92094	0.00352	0.85573	0.0034	0.84426	0.0031
45000	0.91052	0.00334	0.85188	0.00276	0.83479	0.00266
100000	0.89471	0.0038	0.82996	0.00396	0.81102	0.00296
250000	0.89517	0.00364	0.82722	0.00482	0.81109	0.0025

Table 7.4-5. Time Effects on Fully Degraded Basket k_{eff} for 58 Vol% Settled Oxide Cases

Decay Time (years)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h		1.06-h		1.04-h	
8000	0.99890	0.00512	0.96647	0.00428	0.94470	0.00454	0.92525	0.00454	0.90404	0.00470
10000	1.00524	0.00354	0.97254	0.00560	0.94585	0.00428	0.93297	0.00262	0.89979	0.00444
12000	1.00927	0.00466	0.97332	0.00524	0.95118	0.00492	0.93368	0.00446	0.90453	0.00546
14000	1.00530	0.00374	0.97561	0.00404	0.94619	0.00426	0.93212	0.00496	0.90438	0.00418
18000	1.01008	0.00530	0.97438	0.00514	0.95400	0.00364	0.94116	0.00556	0.91260	0.00416
25000	1.01860	0.00486	0.98364	0.00614	0.95235	0.00476	0.94242	0.00362	0.91110	0.00352
35000	1.01296	0.00456	0.97519	0.00380	0.95284	0.00346	0.93958	0.00396	0.91557	0.00412
45000	1.01523	0.00356	0.97643	0.00520	0.94864	0.00382	0.93424	0.00466	0.90401	0.00478
100000	1.00509	0.00458	0.96388	0.00462	0.93881	0.00402	0.92127	0.00364	0.88384	0.00442
250000	1.00346	0.00408	0.96210	0.00422	0.93716	0.00346	0.91772	0.00376	0.88439	0.00352
	1.13-m		1.10-m		1.08-m		1.06-m		1.04-m	
8000	0.98997	0.00508	0.93342	0.00362	0.92100	0.00424	0.90939	0.00438	0.88925	0.00348
10000	0.99060	0.00432	0.93822	0.00418	0.92502	0.00404	0.90922	0.00380	0.89300	0.00350
12000	0.99317	0.00494	0.94558	0.00462	0.92541	0.00336	0.91134	0.00512	0.89259	0.00380
14000	0.99534	0.00480	0.94274	0.00436	0.92840	0.00448	0.91036	0.00414	0.89298	0.00460
18000	0.99274	0.00426	0.94613	0.00354	0.92769	0.00474	0.91451	0.00396	0.89437	0.00494
25000	0.99664	0.00492	0.94893	0.00430	0.93136	0.00380	0.91233	0.00384	0.89682	0.00358
35000	0.99766	0.00502	0.94035	0.00388	0.92812	0.00354	0.91454	0.00436	0.89426	0.00366
45000	0.99509	0.00432	0.93628	0.00352	0.92035	0.00444	0.90562	0.00486	0.88630	0.00356
100000	0.97914	0.00320	0.91779	0.00308	0.90279	0.00468	0.88905	0.00398	0.86848	0.00296
250000	0.97992	0.00488	0.91855	0.00410	0.89947	0.00370	0.88820	0.00416	0.86543	0.00362
	1.13-l		1.10-l		1.08-l					
8000	0.93247	0.00424	0.80818	0.00368	0.86661	0.00366				
10000	0.92797	0.00428	0.80556	0.00434	0.86932	0.00434				
12000	0.93130	0.00370	0.80331	0.00306	0.86715	0.00330				
14000	0.93426	0.00506	0.80484	0.00302	0.86922	0.00360				
18000	0.93316	0.00440	0.80229	0.00330	0.86592	0.00304				
25000	0.92631	0.00390	0.79302	0.00324	0.86234	0.00468				
35000	0.92286	0.00358	0.78369	0.00344	0.85044	0.00368				
45000	0.91687	0.00400	0.77854	0.00454	0.84783	0.00368				
100000	0.90259	0.00386	0.75962	0.00372	0.82496	0.00346				
250000	0.89677	0.00394	0.75451	0.00250	0.81900	0.00340				

Table 7.4-6. Effects of Peak Boron Adsorption on Iron Oxide

Bin	Decay Time (years)	33 vol% Uniform			58 vol% Settled		
		k_{eff}	σ	Δk (%)	k_{eff}	σ	Δk (%)
1.13-h	25000	0.96586	0.00175	-1.39%	1.01598	0.00218	-0.26%
1.13-m	35000	0.94447	0.00134	-1.20%	0.99602	0.00188	-0.16%
1.13-l	14000	0.8695	0.00167	-1.07%	0.93223	0.00122	-0.22%

Table 7.4-7. Effects of Dissolved ^{10}B on Fully Degraded Basket w/ 58vol% Settled Oxide k_{eff}

Grams ^{10}B in Solution	1.13-h			1.13-m			1.13-l		
	k_{eff}	σ	Δk (%)	k_{eff}	σ	Δk (%)	k_{eff}	σ	Δk (%)
30112.56	0.37292	0.00098	-63.39%	0.33736	0.00145	-66.18%	0.27577	0.00087	-70.48%
3011.26	0.71735	0.00135	-29.57%	0.67794	0.00178	-32.05%	0.58924	0.00138	-36.93%
1505.63	0.81535	0.00203	-19.95%	0.77506	0.00178	-22.31%	0.69036	0.00165	-26.11%
602.25	0.91192	0.00204	-10.47%	0.88096	0.00181	-11.70%	0.79749	0.00141	-14.64%
301.13	0.95768	0.00150	-5.98%	0.93122	0.00230	-6.66%	0.85199	0.00139	-8.81%
150.56	0.99188	0.00250	-2.62%	0.97043	0.00227	-2.73%	0.89177	0.00258	-4.55%
60.23	1.00380	0.00197	-1.45%	0.98357	0.00164	-1.41%	0.91522	0.00172	-2.04%
30.11	1.00986	0.00186	-0.86%	0.99076	0.00200	-0.69%	0.92085	0.00215	-1.44%
0.00	1.01860	0.00243	0.00%	0.99766	0.00251	0.00%	0.93426	0.00253	0.00%

Table 7.4-8. Effects on Peak k_{eff} of Varying the Fuel Assembly Spacing for the 33 Vol% Uniform Cases

MCNP Case Name	Spacing Between Fuel Assemblies, cm	k_{eff}	σ
u33h13g	none	0.98127	.00176
u3h3g05	0.5	0.98536	.00186
u3h3g11	1.0	0.98658	.00204
u3h3g15	1.5	0.97909	.00190
u3h3g22	2.0	0.97561	.00237

Table 7.4-9. Peak k_{eff} Results for Transition from 33 Vol% Uniform Oxide to 58 Vol% Settled Oxide

Vol % Oxide		1.13-h			1.13-m		
Upper Region	Lower Region	k_{eff}	σ	case ID	k_{eff}	σ	MCNP Case Name
33	33	0.96595	0.00211	r33h13g.o	0.95068	0.00196	r33m13f.o
28.7	36	0.96112	0.00194	r36h13g.o	0.93612	0.00217	r36m13f.o
26.1	38	0.95473	0.00206	r38h13g.o	0.93365	0.00158	r38m13f.o
22.2	41	0.95233	0.00181	r41h13g.o	0.93399	0.00206	r41m13f.o
19.6	43	0.95343	0.00195	r43h13g.o	0.93266	0.00147	r43m13f.o
15.7	46	0.95797	0.00194	r46h13g.o	0.93746	0.00157	r46m13f.o
13	48	0.96813	0.00156	r48h13g.o	0.94736	0.00211	r48m13f.o
9.1	51	0.97723	0.00189	r51h13g.o	0.95829	0.00174	r51m13f.o
6.5	53	0.98407	0.00219	r53h13g.o	0.96797	0.00199	r53m13f.o
2.6	56	1.00614	0.00249	r56h13g.o	0.98371	0.00267	r56m13f.o
0	58	1.01870	0.00243	r58h13g.o	0.99359	0.00193	r58m13f.o

Table 7.4-10. Effects of Internal Water Level on Peak Fully Degraded WP k_{eff}

MCNP Case Name	Water Height Relative to Top of Upper Assy. (cm)	Rows of Assys. Below Water Line	k_{eff}	σ	MCNP Case Name	Water Height Relative to Top of Upper Assy. (cm)	Rows of Assys. Below Water Line	k_{eff}	σ
33 Vol% Uniform Oxide - 1.13-h - 25,000 years					58 Vol% Settled Oxide - 1.13-h - 35,000 years				
u33h13a1	21.30	5	0.98127	0.00176	r58h13a1	21.30	5	1.01623	0.00268
u33h13a2	0	5	0.97677	0.00152	r58h13a2	0	5	1.00593	0.00205
u33h13a3	-20.30	4	0.96635	0.00168	r58h13aw	-17.31	4.2	0.91346	0.00175
u33h13a4	-40.60	3	0.94071	0.00150	r58h13bw	-18.76	4.133	0.90712	0.00170
u33h13aw	-53.58	2.4	0.91003	0.00178	r58h13a3	-20.30	4	0.87914	0.00199
u33h13a5	-60.90	2	0.88949	0.00179	-	-	-	-	-
33 Vol% Uniform Oxide - 1.13-m - 35,000 years					58 Vol% Settled Oxide - 1.13-m - 25,000 years				
u33m13a1	21.30	5	0.95880	0.00152	r58m13a1	21.30	5	0.99656	0.00201
u33m13a2	0	5	0.95913	0.00252	r58m13a2	0	5	0.98569	0.00186
u33m13a3	-20.30	4	0.94149	0.00184	r58m13aw	-12.98	4.4	0.92672	0.00185
u33m13a4	-40.60	3	0.92591	0.00142	r58m13bw	-14.43	4.333	0.91801	0.00180
u33m13aw	-46.37	2.733	0.90840	0.00175	r58m13cw	-15.87	4.267	0.91090	0.00129
u33m13a5	-60.90	2	0.86734	0.00175	r58m13a3	-20.30	4	0.85541	0.00178

Table 7.4-11. Effects of Oxide Level on 25,000 year Fully Degraded 58 vol% Settled WP k_{eff}

Assembly Rows Covered	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h	
3	1.06922	0.00404	1.03066	0.00364	1.00786	0.0037
4	0.95485	0.00684	0.91484	0.00648	0.8927	0.00416
4.5	0.86004	0.00352	0.82257	0.00322	0.80013	0.00342
	1.13-m		1.10-m		1.08-m	
3	1.04552	0.00406	0.99641	0.00492	0.97969	0.00332
4	0.93053	0.00468	0.87782	0.00628	0.86528	0.00516
4.5	0.84022	0.00356	0.78306	0.0028	0.76956	0.00288
	1.13-l		1.10-l		1.08-l	
3	0.97952	0.0033	0.84257	0.00244	0.91064	0.00318
4	0.86032	0.00542	0.7326	0.00414	0.7985	0.00368
4.5	0.75953	0.00368	0.62904	0.00266	0.70032	0.00276
	1.06-h		1.04-h		cr-1	
3	0.98761	0.00332	0.95911	0.00412	1.27278	0.00244
4	0.87786	0.00418	0.85456	0.00502	1.14182	0.0063
4.5	0.78917	0.00436	0.76458	0.00266	1.05067	0.00334
	1.06-m		1.04-m		cr-2	
3	0.96403	0.00352	0.94751	0.00308	1.2157	0.0043
4	0.85124	0.00504	0.83424	0.00558	1.08923	0.00474
4.5	0.75963	0.00312	0.7468	0.0032	1.00032	0.00446

Table 7.4-12. k_{eff} Results for Absorber Rod WP Fuels with and without 16 Rod DCRAs

Burnup/ Enrich. Pair	Decay Time (years)	58 Vol% Settled				33 Vol% Uniform			
		without DCRAs		with 16 rod DCRAs		w/o DCRAs		with 16 rod DCRAs	
		k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
cr-1	8000	1.21268	0.00392	0.91382	0.00584	1.18462	0.00406	0.86380	0.00418
	10000	1.21325	0.00450	0.91715	0.00474	1.18060	0.00376	0.86603	0.00466
	12000	1.21087	0.00480	0.90751	0.00508	1.18225	0.00472	0.86382	0.00284
	14000	1.21129	0.00440	0.91157	0.00494	1.18280	0.00474	0.86408	0.00456
	18000	1.21070	0.00444	0.91066	0.00478	1.18425	0.00288	0.86595	0.00424
	25000	1.21464	0.00410	0.91253	0.00418	1.18004	0.00446	0.86228	0.00494
	35000	1.20968	0.00496	0.90923	0.00380	1.17711	0.00458	0.86076	0.00484
	45000	1.21114	0.00400	0.91625	0.00544	1.18136	0.00440	0.86317	0.00568
	100000	1.21247	0.00476	0.91233	0.00462	1.18206	0.00394	0.85475	0.00326
cr-2	8000	1.15478	0.00452	0.86963	0.00488	1.11821	0.00320	0.82703	0.00434
	10000	1.15596	0.00422	0.87521	0.00458	1.12163	0.00422	0.82424	0.00510
	12000	1.15617	0.00368	0.86991	0.00600	1.12595	0.00394	0.82318	0.00372
	14000	1.16037	0.00322	0.87219	0.00390	1.12962	0.00412	0.82478	0.00426
	18000	1.15607	0.00556	0.87638	0.00508	1.12789	0.00468	0.82469	0.00454
	25000	1.16360	0.00430	0.87859	0.00470	1.12942	0.00484	0.83002	0.00432
	35000	1.16062	0.00410	0.87166	0.00486	1.12899	0.00600	0.82314	0.00422
	45000	1.16026	0.00506	0.86992	0.00450	1.13141	0.00602	0.82534	0.00330
	100000	1.15605	0.00308	0.86913	0.00464	1.12186	0.00392	0.81415	0.00394

Table 7.4-13 Effects on Peak k_{eff} of Varying the Fuel Assembly Spacing for the cr-1 33 Vol% Uniform Cases

MCNP Case Name	Spacing Between Fuel Assemblies (cm)	k_{eff}	σ
c33cr1b	none	.86603	0.00233
c3c1b05	0.5	.88807	0.00204
c3c1b10	1.0	.90609	0.00227
c3c1b15	1.5	.91630	0.00226
c3c1b20	2.0	.91928	0.00254

7.5 Analysis of Fully Degraded Basket Configurations with Degraded Fuel Assemblies

The purpose of this section is to describe the MCNP cases needed to characterize the possible fully degraded basket configurations with degraded fuel assemblies. Only the 33 vol% uniform case has been evaluated, as consolidation of the fuel rods in the 58 vol% settled case would cause the rods in the top 1.5 assembly rows that are currently in clear water to settle below the oxide layer. Thus, evaluation at 33 vol% uniform is bounding for the settled oxide scenario as well. As this evaluation of sensitivity to consolidation is performed primarily to demonstrate that collapsed assemblies are less reactive than intact assemblies, only the 1.13-h fuel (bounding for the absorber plate WP) will be evaluated at a decay time of 25,000 years. The MCNP model "u30h13f" was used as a base case, with surfaces 26 to 29 modified to reduce rod pitch, and surfaces 60 to 63 modified to change assembly spacing (assembly spacing in vertical direction was always 0 cm). A 27% reduction in rod clearance corresponds to a 0 cm clearance between guide tubes and adjacent fuel rods. Fuel rod consolidation in only the vertical direction and in both vertical and horizontal directions was evaluated. Variations in spacing of the consolidated assemblies was also performed. The MCNP case names and results are provided in Table 7.5-1.

Table 7.5-1. Effects of Reduced Pitch for 1.13-h fuel at 25,000 years

MCNP Case Name	% Original Fuel Rod Clearance		Assembly Horizontal Spacing	k_{eff}	2σ
	Vertical	Horizontal			
u30h13f	100%	100%	0 cm	0.99309	0.00388
upv73a0	73%	100%	0 cm	0.97300	0.00448
up73aC	73%	73%	1.1 cm*	0.96998	0.00400
up73a0	73%	73%	0 cm	0.95799	0.00338
upv0a0	0%	100%	0 cm	0.91239	0.00366
up0aC	0%	0%	4.9 cm*	0.81261	0.00392
up0a50	0%	0%	2.45 cm	0.85417	0.00338
up0a0	0%	0%	0 cm	0.79258	0.00342

* - spacing maintains original assembly center-to-center spacing

A final case ("upile") run with all of the fuel rods touching and completely settled into a cylinder segment at the bottom of the WP (with a volume equal to that displaced by 21 PWR assemblies) yielded a k_{eff} of 0.65588 ± 0.00394. Figure 7.5-1 shows the geometry for this fully degraded basket and fuel assembly configuration. Based on these results, it is evident that any degradation of the assembly structure, be it by corrosion of the grid spacers or dynamic loading, will result in reduced k_{eff} values.

As the above analyses indicated reduced reactivity with further consolidation, completely degraded fuel with only pellet size and smaller particles of fuel distributed in the oxide was not explicitly evaluated. Previous studies (Ref. 5.52, Appendix) of fuel rubble conducted as part of the Three Mile Island Unit 2 defueling examined the k_{eff} of spherical UO_2 particles (evaluated at enrichments of 2.34% and 2.96%) distributed in borated water, and found an optimum particle size of 3.5 cm in diameter and occupying 66% of the total volume. Since a fuel pellet is much smaller than this particle size, an increase in k_{eff} above that shown for fully consolidated rods (pellets occupy ≈58 vol% of a pin cell) would not be expected.

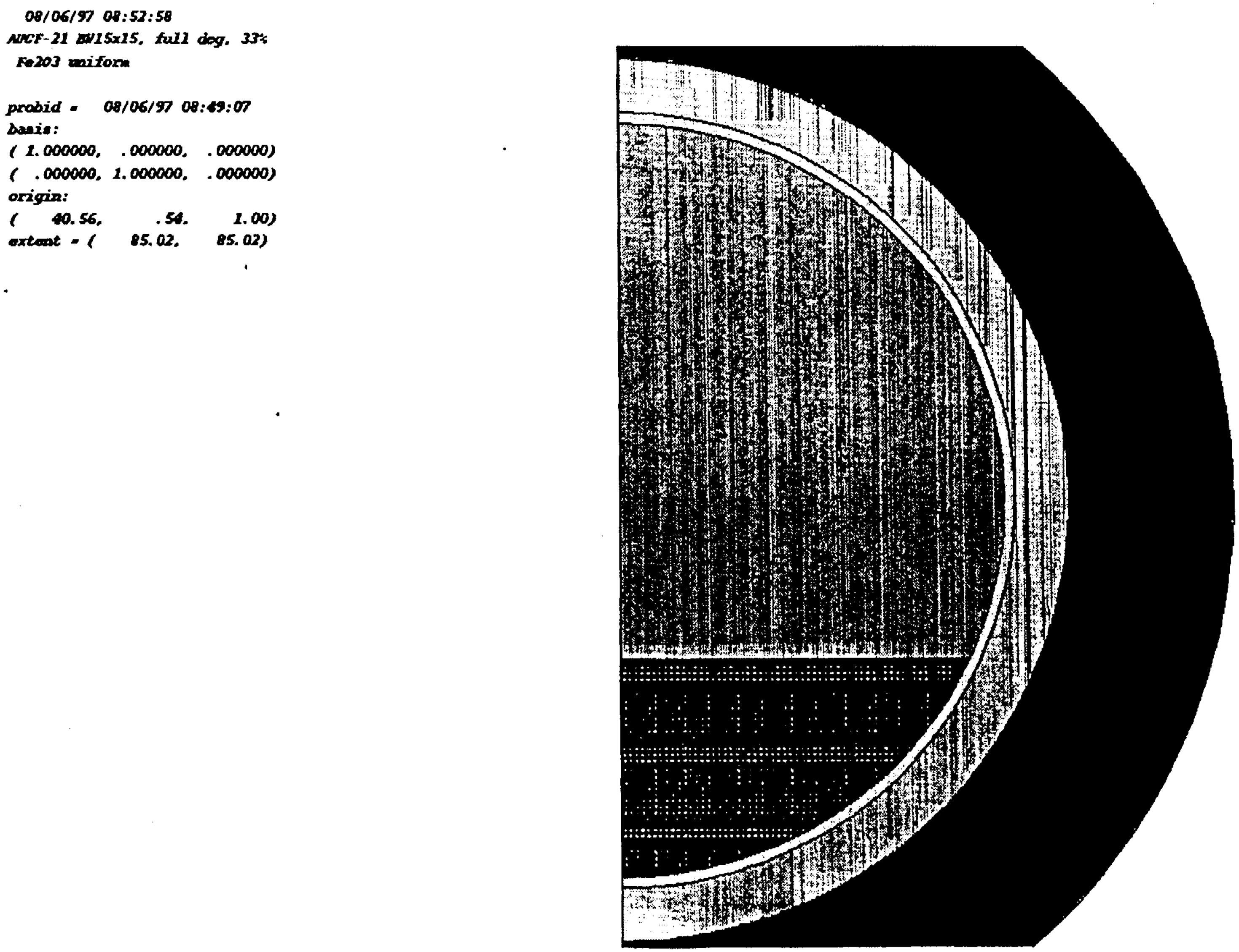


Figure 7.5-1. MCNP fully degraded basket model with degrad el spacer grids, intact fuel rods, and uniform oxide distribution

7.6 Development of Regressions Representing k_{eff} of Degraded Configurations

The purpose of this section is to develop regressions which relate the k_{eff} for a particular class of configurations evaluated in Sections 7.3 and 7.4 (e.g., intact fuel with fully degraded basket and oxide settled to bottom of WP) to various parameters for that class (e.g., time, burnup, enrichment, assemblies covered by oxide, etc...). This will simplify application of the data in future probabilistic analyses.

Using the results from the MCNP cases for the partial basket configurations evaluated in 7.3, separate multivariate nonlinear regressions were developed for the uniform and settled oxide configurations. The uniform regression used the MCNP cases given in Tables 7.3-2, 7.3-3, 7.4-2, and 7.4-4 (uniform data from Section 7.4 used for 0 mm B-SS thickness points), and the settled regression used the cases given in Tables 7.3-4 and 7.3-5. Both regressions were performed in the PARTBASK RESULTS sheet of the attached Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III) using the Excel regression tool. Various forms of the regression equation were tried, and the results for the equation which provided the best fit to the data are provided in Table 7.6-1. The form of the regression equation in both cases is as follows:

$$k_{eff}+2\sigma = C_0+C_1b+C_2b^2+C_3a+C_4a^2+C_5Ln(t)+C_6Ln(t)^2+C_7Ln(t)^3+C_8O+C_9T+C_{10}T^2+C_{11}T^3$$

where b is burnup in GWd/MTU, a is initial enrichment in wt%, t is decay time in years, T is thickness of borated stainless steel remaining in mm, and O is either vol% oxide for the uniform oxide configuration, or fuel rod rows covered for the settled cases. Note that for the uniform case, the vol% of Fe_2O_3 uniformly distributed throughout the WP void space may be quickly obtained by multiplying the kg of Fe released by basket corrosion by a factor of 4.9998E-3. The regression is applicable for times from 2,000 to 100,000 years, enrichments between 1.7% and 4.9%, burnups between 9 and 35 GWd/MTU, plate thicknesses from 0 to 10 mm, and oxide amounts of 0% to 40% for uniform distribution, or 8 to 10 rows covered for oxide settled within an assembly. However, Table 7.6-3 presents the results of test cases which were run to show that this regression still provides reasonable (and slightly conservative) results for even the most reactive high enrichment/low burnup fuels which were not included in the original dataset from which it was developed. The adjusted R^2 is ≈0.99 for both regressions, indicating a very good fit to the data. Further statistical data (such as residuals) can be found in the spreadsheet file.

Using the results from the MCNP cases for the fully degraded basket configurations evaluated in Section 7.4, separate multivariate nonlinear regressions were developed for the uniform and settled oxide configurations. The uniform regression used the MCNP cases given in Tables 7.3-2 to 7.3-4, and the settled regression used the cases given in Table 7.4-5. The regressions were performed in the UNIFORM RESULTS and SETTLED RESULTS sheets of the Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III), using the Excel regression tool. Various forms of the regression equation were tried, and the results for the equation which provided the best fit to the data are provided in Table 7.6-2. The form of the regression equation in both cases is as follows:

$$k_{eff}+2\sigma = C_0+C_1Ln(t)+C_2b+C_3a+C_4Ln(t)^2+C_5Ln(t)^3+C_6b^2+C_7b^3+C_8a^2+C_9a^3+C_{10}Ln(t)b+C_{11}Ln(t)a+C_{12}O$$

where b is burnup in GWd/MTU, a is initial enrichment in wt%, t is decay time, and O is vol% oxide for the uniform oxide configuration and assembly rows covered for the settled cases. The regression is applicable for times from 8,000 to 250,000 years, enrichments between 0.8% and 4.9%, burnups between

3 and 48 GWd/MTU, and oxide amounts of 30% to 40% for uniform distribution and 3 to 4.5 assembly rows covered for settled. The adjusted R^2 is ≈0.99 for both regressions, indicating a very good fit to the data. Further statistical data (such as residuals) can be found in the spreadsheet file.

Table 7.6-1. Regression Results for Partially Degraded Basket WP $k_{eff}+2\sigma$

Regression Parameter	Uniform Oxide	Settled Oxide
C_0	2.35498	1.72095
C_1	-6.6737e-03	-6.7237e-03
C_2	-1.8096e-05	-1.6667e-05
C_3	1.4180e-01	1.3348e-01
C_4	-7.1354e-03	-6.0497e-03
C_5	-5.1930e-01	-3.1232e-01
C_6	5.9471e-02	3.7442e-02
C_7	-2.2406e-03	-1.4715e-03
C_8	-5.0889e-03	-1.6797e-02
C_9	-7.4906e-02	-6.6316e-02
C_{10}	1.0646e-02	9.4036e-03
C_{11}	-5.2334e-04	-4.6905e-04
Adjusted R Square	0.98970	0.98497
Standard Error	0.00831	0.00846
Observations	277	205

Table 7.6-2. Regression Results for Fully Degraded Basket WP $k_{eff}+2\sigma$

Regression Parameter	33% Uniform Oxide	58% Settled Oxide
C_0	-5.12955	-1.25161
C_1	1.65615	6.83154e-01
C_2	-8.52852e-03	-6.65133e-03
C_3	2.92660e-01	2.66145e-01
C_4	-1.53971e-01	-6.40282e-02
C_5	4.67070e-03	1.92631e-03
C_6	6.89640e-05	-2.67041e-05
C_7	-1.63227e-07	6.12197e-07
C_8	-6.71372e-02	-6.18276e-02
C_9	5.36083e-03	5.20352e-03
C_{10}	-4.08151e-04	-1.36497e-04
C_{11}	7.23708e-03	5.08490e-03
C_{12}	-5.25978e-03	-1.40918e-01
Adjusted R Square	0.99254	0.99073
Standard Error	0.00463	0.00906
Observations	286	283

Table 7.6-3. Test of Partial Basket Regression For Burnup/Enrichments Outside of the Initial Dataset

Settled Partial Basket										
Time (years)	Burnup GWd/MTU	% Enrich.	Rows Covered	B-SS thickness (mm)	Regression $k_{eff}+2\sigma$	MCNP test cases				% Difference
						case name	k_{eff}	σ	$k_{eff}+2\sigma$	
10000	3	4.3	8	7	1.01400	B08CR1D	1.00132	0.00209	1.00550	0.84%
14000	3	4.3	8	10	0.98703	A08CR1F	0.98456	0.00207	0.98870	-0.17%
14000	13	4.7	8	10	0.94873	A08CR2F	0.94081	0.00286	0.94653	0.23%
14000	3	4.3	0	10	1.12140	A00CR1F	1.10723	0.00277	1.11277	0.78%
14000	13	4.7	0	10	1.08311	A00CR2F	1.06813	0.00300	1.07413	0.84%
Uniform Partial Basket										
Time (years)	Burnup GWd/MTU	% Enrich.	Vol %	B-SS (mm)	Regression $k_{eff}+2\sigma$	MCNP test cases				% Difference
						case name	k_{eff}	σ	$k_{eff}+2\sigma$	
10000	3	4.3	30	7	0.98912	B30CR1D	0.98139	0.00203	0.98545	0.37%
14000	3	4.3	30	10	0.96517	A30CR1F	0.95675	0.00199	0.96073	0.46%
14000	13	4.7	30	10	0.92657	A30CR2F	0.91892	0.00285	0.92462	0.21%
14000	3	4.3	0	10	1.11784	A00CR1F	1.10723	0.00277	1.11277	0.46%
14000	13	4.7	0	10	1.07924	A00CR2F	1.06813	0.00300	1.07413	0.48%

The data from Table 7.3-6 was used to develop a multivariate regression for predicting the $\Delta k_{eff}/k_{eff}$ resulting from various amounts of boron remaining in solution for the partially degraded basket with various amounts of iron oxide settled to the bottom of each assembly, and various plate thickness remaining. The regression was performed in the BORON sheet of the Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III), using the Excel regression tool. Various forms of the regression equation were tried, and the results for the equation which provided the best fit to the data are provided in Table 7.6-4. The form of the regression equation is as follows:

$$\Delta k_{eff}/k_{eff} = C_0 + C_1\ln(B) + C_2\ln(B)^2 + C_3\ln(B)^3 + C_4T + C_5O$$

where b is burnup in GWd/MTU, B is the total grams of ^{10}B in solution in the fully flooded WP, T is thickness of borated stainless steel remaining in mm, and O is fuel rod rows covered. The regression is applicable for 0.03 to 3 kg of ^{10}B in the fully flooded WP (8.2 to 820 ppm ^{10}B).

Table 7.6-4. Regression Parameters for $\Delta k/k_{eff}$ as a Function of Dissolved ^{10}B for the 58 vol% Settled Oxide Partially Degraded Basket Configuration

C_0	6.37971e-03
C_1	-6.07375e-02
C_2	2.08433e-02
C_3	-2.21564e-03
C_4	3.59713e-04
C_5	4.23685e-03
Adjusted R Square	0.99337
Standard Error	0.00676
Observations	48

Finally, the data from Table 7.4-7 was used to develop a multivariate regression for predicting the $\Delta k/k_{eff}$ resulting from various amounts of boron remaining in solution for the fully degraded basket with 58 vol% iron oxide settled to the bottom. The regression was performed in the BORON sheet of the Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III), using the Excel regression tool. Various forms of the regression equation were tried, and the results for the equation which provided the best fit to the data are provided in Table 7.6-5. The form of the regression equation is as follows:

$$\Delta k_{eff}/k_{eff} = C_0 + C_1 \ln(B) + C_2 \ln(B)^2 + C_3 \ln(B)^3$$

where b is burnup in GWd/MTU, and B is the total grams of ^{10}B in solution in the fully flooded WP. The regression is applicable for 0.03 to 3 kg of ^{10}B in the fully flooded WP (8.2 to 820 ppm ^{10}B).

Table 7.6-5. Regression Parameters for $\Delta k/k_{eff}$ as a Function of Dissolved ^{10}B for the 58 vol% Settled Oxide Fully Degraded Configuration

C_0	2.32558e-02
C_1	-3.56383e-02
C_2	1.42821e-02
C_3	-1.91685e-03
Adjusted R Square	0.97302
Standard Error	0.01905
Observations	22

7.7 Options for Reducing k_{eff} of Degraded Configurations

This section discusses design options for lowering fully degraded WP k_{eff}. Section 7.7.1 discusses adding additional carbon steel to the intact 21 PWR absorber plate WP basket so that sufficient iron oxide is produced upon its degradation to maintain a k_{eff} less than 0.91 for the most reactive fuel to be loaded into it. Section 7.7.2 discusses altering the loading scheme for the current 21 PWR absorber plate WP to prevent the peak k_{eff} for the worst fully degraded configuration from exceeding a given value.

7.7.1 Adding Additional Carbon Steel

The purpose of this section is to determine the amount of additional carbon steel that needs to be added to the container to reduce the k_{eff} below 0.91 after degradation of the basket. A k_{eff} of 0.91 is used here as the criticality safety limit based on an assumed bias and uncertainty in the method of calculation of 4% (see assumption 4.3.16) and the current 5% regulatory margin (see Section 4.2). This evaluation will assume a settled volume fraction of 58% (worst configuration identified thus far) for the 1.13-h k_{∞} bin at its peak. Once the amount of additional carbon steel necessary for the settled case is determined, the amount for the uniformly distributed case is found to ensure that both configurations are covered. The VOLMASS sheet of the Excel 7.0 worksheet BURNRICH.XLW, allows determination of the volume fractions of iron oxide as a function of additional carbon steel material mass added, and the level of the iron oxide in the intact fuel assemblies. This spreadsheet was used to develop the number of fuel rods covered by the oxide in the MCNP models.

The first case examined was for the 1.13-h bin. An iteration process was initiated to determine the number of assemblies/rods that had to be covered to obtain about a 0.91 k_{eff}. The previous evaluations considered ≈3.5 assemblies covered (3 assemblies plus 8 rod rows). The peak reactivity for the 58% settled cases was 1.0186 for a 25,000 year decay period (see Table 7.4-5). Cases for 4 assemblies plus 3 rods filled, plus 4 rods, and plus 8 rods were examined first. These gave k_{eff} values of 0.915, 0.908, and 0.863, respectively. Interpolation between the 4 and 3 row cases, indicate a k_{eff} of 0.91 would be obtained for 3.7 rods covered in the fifth assembly for the 58% settled iron oxide case. The spread sheet indicated that this would require an additional 1,355 kg of carbon steel in the container initially to reach that level. For the uniform case this corresponds to an iron oxide volume fraction of 39.51%. A series of uniform cases for 25,000 year decay, with volume percents of 38.85%, 42.79%, and 45.68% yielded k_{eff} values of 0.951, 0.927, and 0.911. Based upon extrapolation from the last two cases, a 0.91 k_{eff} should be obtained for a uniform oxide volume percent of 45.93% or 2,659 additional kg of carbon steel. The cases executed for this evaluation are listed in Table 7.7.1-1.

A similar procedure was followed for the 1.13-m cases at the peak at 35,000 years decay. The required mass of carbon steel for the 58 vol% settled cases was 1,067 kg (38.09 vol% uniform) to give a k_{eff} of about 0.91. This covered about 1.64 rods in the fifth assembly. For the uniform case, a value of about 41.55 vol% oxide (1,770 kg carbon steel) was required to give the 0.91 value as seen from Table 7.7.1-1.

For the 1.13-l cases, with a peak k_{eff} at 14,000 years, 10.66 rods in the fourth assembly need to be covered for the 58 vol% settled configuration. This corresponds to a uniform volume fraction of about 34.03 vol% (243 kg additional carbon steel). Based upon Table 7.4-3, at 33vol%, the k_{eff} is only about 0.88, so that uniform fractions below about 30% would be required for $k_{eff} < 0.91$. This is below that available from complete degradation of the basket, so additional material would not be needed to cover the uniform cases.

Table 7.7.1-1. k_{eff} Results for Additional Carbon Steel Cases

Case/ID	k_{eff}	2σ	Decay (years)	Oxide Cover Assy/Rows	Uniform Vol%	Additional Carbon Steel (kg)
1.13-h						
settled, r58h1342.o	0.91447	0.00368	25000	4/3	-	-
settled, r58h1343.o	0.90801	0.00358	25000	4/4	-	-
settled, r58h1345.o	0.86259	0.00352	25000	4/8	-	-
uniform,u39h13f.o	0.95068	0.00386	25000	4/2.7	38.85%	1215
uniform, u43h13f.o	0.92723	0.00416	25000	-	42.79%	2018
uniform, u45h13f.o	0.91141	0.00342	25000	-	45.68%	2607
1.13-m						
settled, r58m134.o	0.93171	0.00488	35000	4/0	-	-
settled, r58m1341.o	0.90515	0.00488	35000	4/2	-	-
settled, r58m1343.o	0.88085	0.00400	35000	4/3	-	-
uniform, u38m13g.o	0.92586	0.00438	35000	4/1.53	38.02%	1052
uniform, u42m13g.o	0.91108	0.00342	35000	-	40.00%	1455
uniform, u44m13g.o	0.89471	0.00436	35000	-	44.40%	2348
1.13-l						
settled, r58l1310.o	0.91438	0.00320	14000	3/10	-	-
settled, r58l1370.o	0.90774	0.00408	14000	3/11	-	-
settled, r58l138.o	0.88759	0.00578	14000	3/13	-	-

7.7.2 Altering WP Loading Scheme

Another option for reducing the peak k_{eff} of a fully degraded WP is to alter the loading scheme for the current 21 PWR absorber plate WP (as defined in Ref. 5.5) to prevent the peak k_{eff} for the worst fully degraded configuration from exceeding a given value. Based on the analyses in Sections 7.3 and 7.4, it is evident that the worst fully degraded configuration is the flooded WP with a fully degraded basket, 58 vol% oxide settled to the bottom, and no boron remaining. For each of the 13 burnup/enrichment pairs (k_∞ bins) evaluated in Table 7.4-5, the peak k_{eff}+2σ was selected, and an initial multivariate regression was performed in the SET LOADCURVE sheet of the attached Excel 7.0 spreadsheet, BURNRICH.XLW (see Section 9.0 and Attachment III), using the Excel regression tool. Various forms of the regression equation were tried, and the results for the equation which provided the best fit to the data are provided in Table 7.7.2-3. The form of the regression equation is as follows:

$$Peak\ k_{eff}+2\sigma = C_0+C_1B+C_2E+C_3B^2+C_4E^2+C_5B^3+C_6E^3$$

where B is burnup in GWd/MTU, and E is initial enrichment in wt%. Based on this first regression, additional burnup/enrichment pairs were selected with predicted peak k_{eff} values in the range of 0.91, 0.93, 0.95, and 1.0, to better extend the range of the regression. The selected burnup/enrichment pairs, and the associated SAS2H input data (see Section 7.2 for method of calculation), are given in Table 7.7.2-1.

Table 7.7.2-1. Summary of Additional Burnup/Enrichment Pairs and Associated SAS2H Input Data for 58 Vol% Settled Peak k_{eff} Curve Verification Cases

	10 yr k_∞ per assumption 4.3.11	Burnup (GWd/MTU)	U235 weight%	U234 weight%	U236 weight%	U238 weight%	EFPD at 7.25 MW/assy	SAS2H case
Settled 3.5 row k_{eff}=0.91	1.109	10	1.603	0.0129	0.0074	98.3767	640	e16b10
	1.073	20	2.275	0.0188	0.0105	97.6957	1280	e228b20
	1.057	30	3.142	0.0267	0.0145	96.8168	1920	e314b30
	1.039	45	4.568	0.0401	0.0210	95.3709	2880	e457b45
Settled 3.5 row k_{eff}=0.93	1.120	10	1.72	0.0139	0.0079	98.2582	640	e172b10
	1.086	20	2.435	0.0203	0.0112	97.5335	1280	e244b20
	1.071	30	3.363	0.0288	0.0155	96.5928	1920	e336b30
	1.048	45	4.787	0.0422	0.0220	95.1488	2880	e479b45
Settled 3.5 row k_{eff}=0.95	1.131	10	1.843	0.0150	0.0085	98.1335	640	e184b10
	1.100	20	2.606	0.0218	0.0120	97.3602	1280	e261b20
	1.086	30	3.597	0.0310	0.0165	96.3555	1920	e36b30
	1.057	45	4.993	0.0442	0.0230	94.9399	2880	e499b45
Settled 3.5 row k_{eff}= 1	1.160	10	2.187	0.0181	0.0101	97.7849	640	e219b10
	1.135	20	3.092	0.0263	0.0142	96.8675	1280	e309b20
	1.073	45	5.449	0.0485	0.0251	94.4774	2880	e545b45

Using the isotopics for each burnup/enrichment pair, 58 vol% settled MCNP cases (identical to those discussed in Section 7.4 except for the number densities) were run for the 10,000 to 35,000 year time period, which is the approximate time frame of the peak k_{eff}. The burnup/enrichment pair number densities for the principal isotopes were calculated from SAS2H output summary files in the same manner as in Section 7.2. The results of these additional MCNP cases are summarized in Table 7.7.2-2 (see Section 9.0 for the output files). The multivariate regression was then computed a second time using the peak $k_{eff}+2\sigma$ for the original 13 cases plus the additional cases. The results of this second regression are also provided in Table 7.7.2-3. The adjusted R^2 of 0.987 indicates that the fit is good. The actual and predicted peak $k_{eff}+2\sigma$ values used in the development of the second regression are provided in Table 7.7.2-4, along with the residuals. Based on the second regression, Figure 7.7.2-1 shows the approximate locus of burnup/enrichment pairs which correspond to peak k_{eff} values of 0.91, 0.93, 0.95, and 1.0. This second regression may be used in place of assumption 4.3.11, and the 1.13 k_∞ upper bound discussed in Ref. 5.5, to define the range of burnup/enrichments pairs which may be loaded into the 21 PWR absorber plate WP to maintain the peak k_{eff} below a specific value. This value must be determined based on the administrative margin and the bias in the method of calculation, of which the latter is not determined for this analysis. For the worst case 58 vol% settled oxide configuration, Table 7.7.2-5 demonstrates the effect of using 16 rod DCRAs on the k_{eff} of those k_∞ bins with k_{eff} values greater than 0.91 in Table 7.4-5. Similarly, Table 7.7.2-6 presents the k_{eff} results of adding DCRAs to the same fuels for the 33 vol% uniform oxide configuration. The naming convention for these cases is consistant with that shown in Table 7.4-1, except that the first character is replaced with a "C" to indicate that DCRAs are present. DCRA dimmensions are given in assumption 4.3.15, and material compositions are given in Table 4.1-4.

Table 7.7.2-2. k_{eff} Results for 58 Vol% Settled Peak k_{eff} Curve Verification Cases

MCNP Case Name	Decay Time (years)	Burnup (GWd/MTU)	% Enrichment	k_{eff}	2σ
R58LA1B	10000	10	1.6	0.90667	0.00416
R58LA1C	12000	10	1.6	0.90612	0.00328
R58LA1D	14000	10	1.6	0.90808	0.00440
R58LA1E	18000	10	1.6	0.90803	0.00412
R58LA1F	25000	10	1.6	0.89989	0.00382
R58LA1G	35000	10	1.6	0.90138	0.00362
R58LA2B	10000	20	2.28	0.89226	0.00512
R58LA2C	12000	20	2.28	0.89870	0.00374
R58LA2D	14000	20	2.28	0.89466	0.00382
R58LA2E	18000	20	2.28	0.89158	0.00326
R58LA2F	25000	20	2.28	0.89721	0.00384
R58LA2G	35000	20	2.28	0.89137	0.00374
R58LA3B	10000	30	3.14	0.89648	0.00358
R58LA3C	12000	30	3.14	0.89871	0.00418
R58LA3D	14000	30	3.14	0.90178	0.00448
R58LA3E	18000	30	3.14	0.90280	0.00354
R58LA3F	25000	30	3.14	0.89835	0.00580
R58LA3G	35000	30	3.14	0.89661	0.00332
R58LA4B	10000	45	4.57	0.89940	0.00538
R58LA4C	12000	45	4.57	0.90401	0.00432
R58LA4D	14000	45	4.57	0.90601	0.00412
R58LA4E	18000	45	4.57	0.90718	0.00416

Table 7.7.2-2. k_{eff} Results for 58 Vol% Settled Peak k_{eff} Curve Verification Cases

MCNP Case Name	Decay Time (years)	Burnup (GWd/MTU)	% Enrichment	k_{eff}	2σ
R58LA4F	25000	45	4.57	0.90576	0.00368
R58LA4G	35000	45	4.57	0.90671	0.00440
R58LB1B	10000	10	1.72	0.92074	0.00398
R58LB1C	12000	10	1.72	0.92486	0.00346
R58LB1D	14000	10	1.72	0.92108	0.00508
R58LB1E	18000	10	1.72	0.92225	0.00428
R58LB1F	25000	10	1.72	0.92407	0.00416
R58LB1G	35000	10	1.72	0.91684	0.00376
R58LB2B	10000	20	2.44	0.91196	0.00448
R58LB2C	12000	20	2.44	0.91419	0.00394
R58LB2D	14000	20	2.44	0.91381	0.00328
R58LB2E	18000	20	2.44	0.91590	0.00284
R58LB2F	25000	20	2.44	0.91545	0.00318
R58LB2G	35000	20	2.44	0.90836	0.00348
R58LB3B	10000	30	3.36	0.91950	0.00386
R58LB3C	12000	30	3.36	0.91905	0.00482
R58LB3D	14000	30	3.36	0.92210	0.00426
R58LB3E	18000	30	3.36	0.92326	0.00346
R58LB3F	25000	30	3.36	0.91958	0.00384
R58LB3G	35000	30	3.36	0.92221	0.00378
R58LB4B	10000	45	4.79	0.91175	0.00498
R58LB4C	12000	45	4.79	0.91786	0.00494
R58LB4D	14000	45	4.79	0.91992	0.00434
R58LB4E	18000	45	4.79	0.92092	0.00438
R58LB4F	25000	45	4.79	0.92301	0.00402
R58LB4G	35000	45	4.79	0.92334	0.00372
R58LC1B	10000	10	1.84	0.94049	0.00502
R58LC1C	12000	10	1.84	0.94338	0.00436
R58LC1D	14000	10	1.84	0.94341	0.00378
R58LC1E	18000	10	1.84	0.93705	0.00410
R58LC1F	25000	10	1.84	0.93582	0.00496
R58LC1G	35000	10	1.84	0.93421	0.00454
R58LC2B	10000	20	2.61	0.93280	0.00336
R58LC2C	12000	20	2.61	0.92989	0.00370
R58LC2D	14000	20	2.61	0.93398	0.00440
R58LC2E	18000	20	2.61	0.94025	0.00406
R58LC2F	25000	20	2.61	0.93728	0.00444
R58LC2G	35000	20	2.61	0.93224	0.00560
R58LC3B	10000	30	3.6	0.93803	0.00562
R58LC3C	12000	30	3.6	0.93878	0.00384
R58LC3D	14000	30	3.6	0.94272	0.00478
R58LC3E	18000	30	3.6	0.94864	0.00412

Table 7.7.2-2. k_{eff} Results for 58 Vol% Settled Peak k_{eff} Curve Verification Cases

MCNP Case Name	Decay Time (years)	Burnup (GWd/MTU)	% Enrichment	k_{eff}	2σ
R58LC3F	25000	30	3.6	0.94351	0.00460
R58LC3G	35000	30	3.6	0.94127	0.00412
R58LC4B	10000	45	4.99	0.92856	0.00552
R58LC4C	12000	45	4.99	0.92840	0.00392
R58LC4D	14000	45	4.99	0.93564	0.00362
R58LC4E	18000	45	4.99	0.93687	0.00394
R58LC4F	25000	45	4.99	0.93752	0.00370
R58LC4G	35000	45	4.99	0.93883	0.00412
R58LD1B	10000	10	2.19	0.99048	0.00356
R58LD1C	12000	10	2.19	0.98735	0.00372
R58LD1D	14000	10	2.19	0.98956	0.00472
R58LD1E	18000	10	2.19	0.98615	0.00560
R58LD1F	25000	10	2.19	0.98802	0.00436
R58LD1G	35000	10	2.19	0.98707	0.00364
R58LD2B	10000	20	3.09	0.97864	0.00490
R58LD2C	12000	20	3.09	0.98234	0.00360
R58LD2D	14000	20	3.09	0.98568	0.00446
R58LD2E	18000	20	3.09	0.98514	0.00376
R58LD2F	25000	20	3.09	0.98517	0.00416
R58LD2G	35000	20	3.09	0.98400	0.00348
R58LD3B	10000	45	5.45	0.95992	0.00428
R58LD3C	12000	45	5.45	0.96064	0.00410
R58LD3D	14000	45	5.45	0.96160	0.00392
R58LD3E	18000	45	5.45	0.97201	0.00472
R58LD3F	25000	45	5.45	0.97006	0.00518
R58LD3G	35000	45	5.45	0.97330	0.00486

Table 7.7.2-3. Regression Results for 58 Vol% Settled Peak k_{eff} as a Function of Burnup and Enrichment

Regression Constants	First Fit (Sect. 7.4 Data Only)	Second Fit (Sect. 7.4 + new cases)
C_0	6.08171e-01	6.40653e-01
C_1	-1.05737e-02	-1.02912e-02
C_2	3.46934e-01	3.00169e-01
C_3	1.40880e-07	-2.54581e-05
C_4	-6.71155e-02	-4.90929e-02
C_5	5.80601e-07	9.92035e-07
C_6	5.66667e-03	3.64521e-03
Adjusted R Square	0.99330	0.98723
Standard Error	0.00454	0.00483

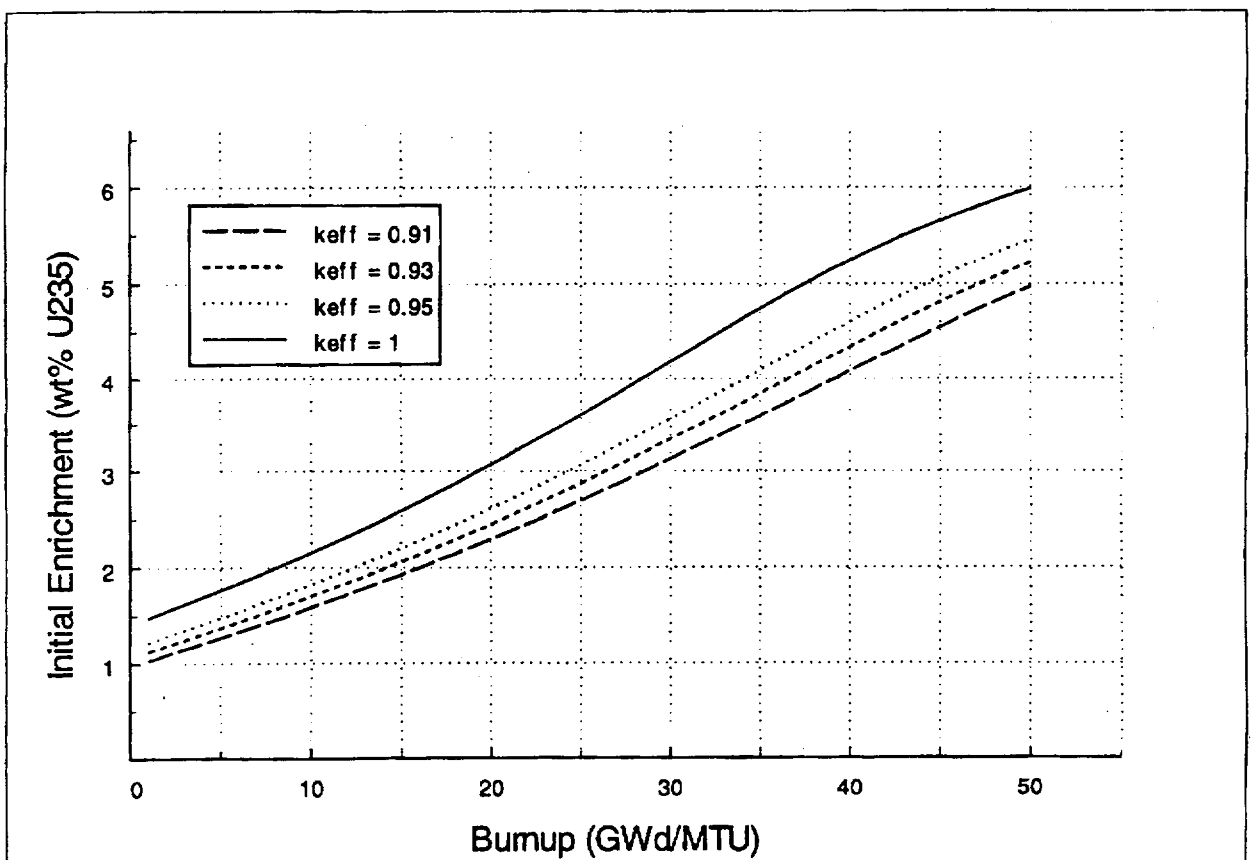


Figure 7.7.2-1. Peak $k_{eff}+2\sigma$ as a Function of Burnup and Enrichment for the Flooded Fully Degraded WP Basket with 58 Vol% Iron Oxide Settled to the Bottom and No Boron Remaining

Table 7.7.2-4. Additional Second Regression Goodness-of-Fit Information for Fully Degraded WP with 58Vol% Settled Oxide Peak $k_{eff} + 2\sigma$

Burnup (GWd/MTU)	Initial Enrichment (wt%)	MCNP Peak k_{eff}+2σ	Regression Peak k_{eff}+2σ	Residuals
9	1.7	0.9393	0.93301	0.00631
27	3.9	1.0027	1.00394	-0.00126
34	4.9	1.0235	1.02128	0.00218
3	0.8	0.8119	0.82016	-0.00830
23.5	3	0.9532	0.95472	-0.00149
35	4.5	0.9898	0.98061	0.00917
12	1.5	0.8737	0.86730	0.00636
28	3.25	0.9352	0.93646	-0.00130
39	4.6	0.9576	0.95620	0.00144
32.5	3.5	0.9189	0.91885	0.00005
44	4.9	0.9467	0.94402	0.00270
38.5	3.85	0.9004	0.89931	0.00109
48	4.9	0.9197	0.91869	0.00100
10	1.603	0.9125	0.90622	0.00626
10	1.72	0.92832	0.92579	0.00253
10	1.843	0.94774	0.94547	0.00227
10	2.187	0.99428	0.99598	-0.00170
20	2.275	0.90244	0.90430	-0.00186
20	2.435	0.91874	0.92504	-0.00630
20	2.606	0.94431	0.94593	-0.00162
20	3.092	0.99014	0.99911	-0.00897
30	3.142	0.90634	0.90734	-0.00100
30	3.363	0.92672	0.92867	-0.00195
30	3.597	0.95276	0.94996	0.00280
45	4.568	0.91134	0.91062	0.00072
45	4.787	0.92706	0.92819	-0.00113
45	4.993	0.94295	0.94499	-0.00204
45	5.449	0.97816	0.98413	-0.00597

Table 7.7.2-5. Time Effects on Fully Degraded Basket k_{eff} for 58 Vol% Settled Oxide With 16 Rod DCRAs In All Assemblies

Decay Time (yrs)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h	
8000	0.75204	0.00546	0.72064	0.0042	0.7019	0.00424
10000	0.75655	0.00424	0.72691	0.00454	0.70756	0.00468
12000	0.75566	0.00526	0.72715	0.00424	0.70914	0.00228
14000	0.75651	0.00476	0.72998	0.00442	0.70956	0.00394
18000	0.75747	0.00368	0.73203	0.0032	0.70852	0.00432
25000	0.7599	0.00448	0.72613	0.00378	0.70927	0.0045
35000	0.75875	0.00464	0.72444	0.00468	0.70356	0.00322
45000	0.75386	0.00362	0.71759	0.00456	0.69672	0.00458
100000	0.73849	0.0031	0.70075	0.00408	0.68402	0.00366
	1.13-m		1.10-m		1.08-m	
8000	0.73572	0.0051	0.68735	0.00358	0.68221	0.00352
10000	0.74013	0.0052	0.68664	0.0043	0.67753	0.00318
12000	0.73847	0.00348	0.69208	0.00432	0.67563	0.00434
14000	0.73576	0.00364	0.69008	0.00492	0.68044	0.0033
18000	0.73716	0.00418	0.68715	0.00458	0.67465	0.00454
25000	0.73445	0.0041	0.68899	0.00358	0.67482	0.00396
35000	0.73093	0.00466	0.68231	0.00422	0.67211	0.00374
45000	0.72928	0.00416	0.67621	0.0038	0.66733	0.0051
100000	0.71176	0.00422	0.65886	0.00388	0.64952	0.0044
	1.13-l					
8000	0.6628	0.00342				
10000	0.66474	0.00304				
12000	0.66606	0.00354				
14000	0.66419	0.00366				
18000	0.66124	0.00354				
25000	0.65743	0.00396				
35000	0.65509	0.0033				
45000	0.64841	0.00394				
100000	0.62743	0.0032				

Table 7.7.2-6. Time Effects on Fully Degraded Basket k_{eff} for 33 Vol% Uniform Oxide With 16 Rod DCRAs In All Assemblies

Decay (years)	k_{eff}	2σ	k_{eff}	2σ	k_{eff}	2σ
	1.13-h		1.10-h		1.08-h	
8000	0.70195	0.00452	0.67601	0.00384	0.65841	0.00466
10000	0.70828	0.00374	0.67213	0.00396	0.65448	0.00328
12000	0.70670	0.00416	0.67477	0.00510	0.65751	0.00376
14000	0.70669	0.00302	0.67939	0.00378	0.66029	0.00464
18000	0.71118	0.00340	0.67673	0.00318	0.66125	0.00394
25000	0.71312	0.00458	0.67612	0.00378	0.65582	0.00364
35000	0.70693	0.00444	0.66659	0.00384	0.65466	0.00504
45000	0.70063	0.00280	0.66538	0.00434	0.65036	0.00372
100000	0.68661	0.00444	0.64954	0.00426	0.63074	0.00376
	1.13-m		1.10-m		1.08-m	
8000	0.68420	0.00462	0.63768	0.00294	0.62883	0.00304
10000	0.68178	0.00320	0.63810	0.00322	0.63098	0.00390
12000	0.68563	0.00356	0.63464	0.00338	0.62647	0.00326
14000	0.68822	0.00378	0.63806	0.00426	0.62754	0.00400
18000	0.68695	0.00320	0.63649	0.00338	0.62712	0.00400
25000	0.68501	0.00330	0.63502	0.00354	0.62820	0.00436
35000	0.67843	0.00266	0.63111	0.00450	0.61921	0.00336
45000	0.67134	0.00372	0.62420	0.00342	0.61169	0.00334
100000	0.65772	0.00416	0.60451	0.00310	0.59097	0.00310
	1.13-l					
8000	0.61110	0.00274				
10000	0.60694	0.00412				
12000	0.60810	0.00278				
14000	0.60865	0.00326				
18000	0.60384	0.00362				
25000	0.60356	0.00324				
35000	0.59380	0.00330				
45000	0.58766	0.00356				
100000	0.57205	0.00306				

8. Conclusions

In compliance with the M&O Quality Administrative Procedures, the design results presented in this document can not be used for procurement, fabrication, or construction unless properly identified, tracked as TBV, and controlled by the appropriate procedures. Furthermore, the bias and uncertainty in the method of calculation used for this analysis are also TBV. The bias and uncertainty will be determined at some future point based on the work currently being performed by the WPD Criticality Analysis Methodology Group to develop a bounding method for performing disposal criticality analysis using burnup credit with the SAS2H/MCNP code system (see assumption 4.3.16).

This evaluation provided a refinement of the PWR AUCF WP degradation scenarios discussed in previous degraded mode analyses (see Section 7.1), performed parametric criticality analysis on the resulting configurations for each scenario to identify those which may be of concern (as well as eliminate some configurations from further concern; see Sections 7.2 to 7.5), and developed k_{eff} regressions to be used in future analyses of criticality probability for the current PWR WP designs (see Section 7.6). Potential design options for reducing the k_{eff} of the degraded configurations (see Section 7.7) were also discussed.

The worst case degraded configuration was identified in Section 7.4 as a flooded absorber plate WP with a fully degraded basket, no boron remaining, and all oxide corrosion products settled to the bottom of the WP (settled oxide k_{eff} values are ≈4% higher than uniform oxide for fully degraded basket with the same amount of oxide). However, the worst projected fuel for the absorber rod WP never exceeded a k_{eff} of 0.92 in the same configuration when 16 rod natural B_4C DCRAs were used. Furthermore, configurations involving unflooded absorber plate WPs with only hydrated oxide settled to the bottom were eliminated from further consideration in Section 7.4. Also, Section 7.5 verified that mechanisms which result in collapse of the fuel spacer grids and consolidation of the fuel rods, such as dynamic loading (e.g., rockfall) or spacer grid corrosion, will reduce k_{eff} by 2% to 20% depending on the amount of consolidation.

Section 7.6 accomplished the primary objective of this analysis by using the data from Sections 7.3 and 7.4 to develop multivariate nonlinear regressions which relate the k_{eff} for a particular class of configurations (e.g., intact fuel with fully degraded basket and oxide settled to bottom of WP) to various parameters for that class (e.g., time, burnup, enrichment, assemblies covered by oxide, etc...). For the settled oxide configurations, regressions were also developed which provide the $\Delta k_{eff}/k_{eff}$ resulting from various amounts of boron in solution (which would be present in a flooded WP during corrosion of the borated stainless steel). The regression equations and their use are discussed further in Section 7.6.

Finally, Section 7.7 identified options for reducing the peak postclosure k_{eff} of the absorber plate WP. The first option involves adding sufficient (2,659 kg) carbon steel to the intact basket to reduce the k_{eff} to below 0.91 for all fuels currently planned to be loaded into the absorber plate WP ($1.0 \le k_{\infty} < 1.13$; see Ref. 5.5). This carbon steel has the effect of providing additional iron oxide when it corrodes, which is insoluble, occupies a greater volume than the undegraded steel (e.g., excludes moderator), and is a fair neutron absorber. The second option does not require any change to the WP designs, but requires abandoning the use of k_{∞} as a means for binning fuel assemblies into one WP type or another, and results in a greater number of absorber rod WPs. Section 7.7.2 provides a regression which gives the peak k_{eff}

of the worst degraded configuration for the absorber plate WP as a function of the burnup and enrichment of the fuel assemblies, and can be used to determine which fuel should be placed in the absorber rod WP.

9. Attachments

The hardcopy attachments are listed in Table 9-1 below.

Table 9-1. List of Attachments

Attachment Number	Description	Pages	Date
I	Source Code for BURNRICH.C	2	8/5/97
II	Source Code for AMIGO.BAS	4	8/5/97
III	Calculations from Excel 7.0 spreadsheet BURNRICH.XLW	14	8/21/97
IV	Calculations from Mathcad+ 6.0 worksheet BORIDE.MCD	5	8/21/97
V	getPI awk script	1	8/5/97
VI	Sample SAS2H/ORIGEN-S input file (e49b34.input)	2	8/21/97
VII	Sample MCNP input for Partially Degraded Basket w/ Uniform Oxide (b30h13a)	6	8/12/97
VIII	Sample MCNP input for Partially Degraded Basket w/ Settled Oxide (b08h13a)	7	8/12/97
IX	Sample MCNP input for Fully Degraded Basket w/ Uniform Oxide (u33h13a)	3	8/12/97
X	Sample MCNP input for Fully Degraded Basket w/ Settled Oxide (r58h13f)	4	8/12/97
XI	Summary of curie content of TSPA-95 radionuclides (Ref. 5.33, Table 7.6-1) as a function of time from the SAS2H/ORIGEN-S output file for e49b34 (4.9% enrichment, 34 GWd/MTU burnup). Note that nuclides not present at a given time are not listed. This information is summarized for use in a future analysis of internal criticality consequences	20	8/31/97

The following supporting documents are in electronic form on three Colorado Trakker® tapes and two floppy disks (Ref. 5.57) and are listed below. Each file is identified by it's name, size (in bytes), and the date and time of last access. The files are grouped into directories according to their associated application and subject. There are a total of 2,802 files listed.

```
..\AMIGO
AMIGO    BAS     12,865  07-04-97  4:56p AMIGO.BAS
R58      TMP      9,241  07-03-97  5:04p R58.tmp
A08      TMP     17,594  07-04-97  3:30p A08.tmp
A30      TMP     14,353  07-04-97  3:31p A30.tmp
B08      TMP     17,590  07-04-97  3:33p B08.tmp
B09      TMP     17,593  07-04-97  3:34p B09.tmp
B30      TMP     14,299  07-04-97  3:35p B30.tmp
B33      TMP     11,554  07-07-97  4:44p B33.TMP
B35      TMP     14,302  07-04-97  5:04p B35.tmp
BF10     TMP     17,830  07-07-97  4:19p BF10.TMP
```

BR58	TMP	9,467	07-07-97	4:18p	BR58.TMP
C08	TMP	17,596	07-04-97	5:09p	C08.tmp
C09	TMP	17,593	07-04-97	3:52p	C09.tmp
C30	TMP	14,299	07-04-97	3:53p	C30.tmp
C35	TMP	14,299	07-04-97	3:55p	C35.tmp
D08	TMP	17,600	07-04-97	4:09p	D08.TMP
D10	TMP	17,600	07-04-97	4:13p	D10.TMP
D30	TMP	14,303	07-04-97	4:17p	D30.TMP
D40	TMP	14,302	07-04-97	4:20p	D40.TMP
E08	TMP	17,594	07-04-97	4:26p	E08.TMP
E10	TMP	17,595	07-04-97	4:30p	E10.TMP
E30	TMP	14,299	07-04-97	4:33p	E30.TMP
E40	TMP	14,298	07-04-97	4:36p	E40.TMP
F08	TMP	17,599	07-04-97	4:40p	F08.TMP
F10	TMP	17,600	07-04-97	4:57p	F10.TMP
F30	TMP	14,302	07-04-97	4:42p	F30.TMP
F40	TMP	14,301	07-04-97	4:43p	F40.TMP
G08	TMP	17,599	07-04-97	4:45p	G08.TMP
G10	TMP	17,600	07-04-97	4:47p	G10.TMP
G30	TMP	14,302	07-04-97	4:50p	G30.TMP
G40	TMP	14,302	07-04-97	4:53p	G40.TMP
A00	TMP	14,412	07-04-97	3:26p	A00.tmp
R58CR	TMP	9,390	07-09-97	11:42a	R58CR.TMP
RB1	TMP	9,307	07-07-97	4:23p	RB1.TMP
RB10	TMP	9,309	07-07-97	4:18p	RB10.TMP
RB2	TMP	9,307	07-08-97	5:46p	RB2.TMP
RB5	TMP	9,307	07-08-97	5:39p	RB5.TMP
RBC	TMP	9,368	07-07-97	4:27p	RBC.TMP
RBP1	TMP	9,310	07-07-97	4:31p	RBP1.TMP
RBP2	TMP	9,309	07-08-97	5:47p	RBP2.TMP
RBP5	TMP	9,309	07-08-97	6:04p	RBP5.TMP
U30	TMP	8,333	07-03-97	12:09p	U30.TMP
U33	TMP	8,335	07-03-97	12:12p	U33.TMP
U40	TMP	8,331	07-03-97	12:11p	U40.TMP
R3	TMP	9,246	07-25-97	8:41a	R3.TMP
R4	TMP	9,245	07-25-97	8:33a	R4.TMP
R45	TMP	9,246	07-25-97	8:47a	R45.TMP

..\Burnrich

BURNRICH	C	6,027	06-21-97	8:30a	BURNRICH.C
BURNRICH	OUT	447,930	04-08-97	4:03p	BURNRICH.OUT

..\Excel

BURNRICH	XLW	2,228,736	08-01-97	4:41p	BURNRICH.XLW

..\Mathcad

BORIDE	MCD	10,257	08-01-97	4:41p	boride.mcd

..\MCNPcases\Sect7-3\Tab73-6

RB10B08		18,600	08-05-97	11:11a	rb10b08
RB10B08	O	332,803	08-05-97	11:11a	rb10b08.O
RB10B09		18,592	08-05-97	11:11a	rb10b09
RB10B09	O	333,371	08-05-97	11:11a	rb10b09.O
RB10D08		18,604	08-05-97	11:11a	rb10d08
RB10D08	O	332,773	08-05-97	11:11a	rb10d08.O
RB10D10		18,604	08-05-97	11:11a	rb10d10
RB10D10	O	332,977	08-05-97	11:11a	rb10d10.O
RB10G08		18,603	08-05-97	11:11a	rb10g08
RB10G08	O	332,947	08-05-97	11:11a	rb10g08.O
RB10G10		18,604	08-05-97	11:11a	rb10g10
RB10G10	O	333,124	08-05-97	11:11a	rb10g10.O
RB1B08		18,600	08-05-97	11:11a	rb1b08
RB1B08	O	333,136	08-05-97	11:11a	rb1b08.O
RB1B09		18,592	08-05-97	11:11a	rb1b09
RB1B09	O	333,082	08-05-97	11:11a	rb1b09.O
RB1D08		18,604	08-05-97	11:11a	rb1d08
RB1D08	O	333,031	08-05-97	11:11a	rb1d08.O
RB1D10		18,604	08-05-97	11:11a	rb1d10
RB1D10	O	332,899	08-05-97	11:11a	rb1d10.O
RB1G08		18,603	08-05-97	11:11a	rb1g08
RB1G08	O	333,039	08-05-97	11:11a	rb1g08.O
RB1G10		18,604	08-05-97	11:11a	rb1g10
RB1G10	O	332,740	08-05-97	11:11a	rb1g10.O
RB2B08		18,600	08-05-97	11:11a	rb2b08
RB2B09		18,592	08-05-97	11:11a	rb2b09
RB2D08		18,604	08-05-97	11:11a	rb2d08
RB2D10		18,604	08-05-97	11:11a	rb2d10
RB2G08		18,603	08-05-97	11:11a	rb2g08
RB5B09	O	333,315	08-05-97	11:11a	rb5b09.O
RB2B09	O	333,292	07-16-97	2:07p	rb2b09.O
RBP2B09	O	333,202	08-05-97	11:11a	rbp2b09.O

```
RBP2G10   O     333,144  08-05-97 11:12a rbp2g10.o
RB5G08    O     333,124  08-05-97 11:11a rb5g08.o
RBP5B09   O     333,112  08-05-97 11:12a rbp5b09.o
RBP2B08   O     333,061  08-05-97 11:11a rbp2b08.o
RBP5B08   O     333,031  08-05-97 11:12a rbp5b08.o
RBP2G08   O     333,019  08-05-97 11:11a rbp2g08.o
RBP5G08   O     333,004  08-05-97 11:12a rbp5g08.o
RBP5D08   O     332,997  08-05-97 11:12a rbp5d08.o
RB2D08    O     332,977  08-05-97 11:11a rb2d08.o
RB2G10    O     332,950  08-05-97 11:11a rb2g10.o
RB2B08    O     332,950  07-16-97  2:07p rb2b08.o
RB5D10    O     332,947  08-05-97 11:11a rb5d10.o
RB2D10    O     332,920  08-05-97 11:11a rb2d10.o
RBP2D08   O     332,850  08-05-97 11:11a rbp2d08.o
RB5D08    O     332,817  08-05-97 11:11a rb5d08.o
RB5G10    O     332,800  08-05-97 11:11a rb5g10.o
RB2G08    O     332,773  08-05-97 11:11a rb2g08.o
RBP5D10   O     332,767  08-05-97 11:12a rbp5d10.o
RBP2D10   O     332,767  08-05-97 11:11a rbp2d10.o
RB5B08    O     332,662  08-05-97 11:11a rb5b08.o
RBP5G10   O     332,541  08-05-97 11:12a rbp5g10.o
RB2G10           18,604  08-05-97 11:11a rb2g10
RB5B08           18,600  08-05-97 11:11a rb5b08
RB5B09           18,592  08-05-97 11:11a rb5b09
RB5D08           18,604  08-05-97 11:11a rb5d08
RB5D10           18,604  08-05-97 11:11a rb5d10
RB5G08           18,603  08-05-97 11:11a rb5g08
RB5G10           18,604  08-05-97 11:11a rb5g10
RBP1B08          18,600  08-05-97 11:11a rbp1b08
RBP1B08   O     333,061  08-05-97 11:11a rbp1b08.o
RBP1B09          18,592  08-05-97 11:11a rbp1b09
RBP1B09   O     333,055  08-05-97 11:11a rbp1b09.o
RBP1D08          18,604  08-05-97 11:11a rbp1d08
RBP1D08   O     333,024  08-05-97 11:11a rbp1d08.o
RBP1D10          18,604  08-05-97 11:11a rbp1d10
RBP1D10   O     332,767  08-05-97 11:11a rbp1d10.o
RBP1G08          18,603  08-05-97 11:11a rbp1g08
RBP1G08   O     332,884  08-05-97 11:11a rbp1g08.o
RBP1G10          18,604  08-05-97 11:11a rbp1g10
RBP1G10   O     333,015  08-05-97 11:11a rbp1g10.o
RBP2B08          18,600  08-05-97 11:11a rbp2b08
RBP2B09          18,592  08-05-97 11:12a rbp2b09
RBP2D08          18,604  08-05-97 11:12a rbp2d08
RBP2D10          18,604  08-05-97 11:12a rbp2d10
RBP2G08          18,603  08-05-97 11:12a rbp2g08
RBP2G10          18,604  08-05-97 11:12a rbp2g10
RBP5B08          18,600  08-05-97 11:12a rbp5b08
RBP5B09          18,592  08-05-97 11:12a rbp5b09
RBP5D08          18,604  08-05-97 11:12a rbp5d08
RBP5D10          18,604  08-05-97 11:12a rbp5d10
RBP5G08          18,603  08-05-97 11:12a rbp5g08
RBP5G10          18,604  08-05-97 11:12a rbp5g10

..\MCNPcases\Sect7-3\Tab732&3
G40H13B          15,279  07-07-97  9:34a G40H13B
G30H13F   O     270,588  07-07-97  9:35a G30H13F.O
G40H13A          15,280  07-07-97  9:34a G40H13A
G40H13A   O     271,372  07-07-97  9:31a G40H13A.O
G30H13F          15,249  07-07-97  9:34a G30H13F
G40H13B   O     271,289  07-07-97  9:31a G40H13B.O
G40H13C          15,280  07-07-97  9:34a G40H13C
G40H13C   O     271,259  07-07-97  9:31a G40H13C.O
G40H13D          15,281  07-07-97  9:34a G40H13D
G40H13D   O     271,289  07-07-97  9:31a G40H13D.O
G40H13E          15,250  07-07-97  9:34a G40H13E
G40H13E   O     270,752  07-07-97  9:31a G40H13E.O
G40H13F          15,249  07-07-97  9:34a G40H13F
G40H13F   O     270,911  07-07-97  9:31a G40H13F.O
G40H13G          15,186  07-07-97  9:34a G40H13G
G40H13G   O     269,443  07-07-97  9:31a G40H13G.O
G40H13H          15,186  07-07-97  9:34a G40H13H
G40H13H   O     269,691  07-07-97  9:31a G40H13H.O
G40H13I          15,186  07-07-97  9:34a G40H13I
G40H13I   O     269,838  07-07-97  9:31a G40H13I.O
G40H13J          15,184  07-07-97  9:34a G40H13J
G40H13J   O     269,664  07-07-97  9:31a G40H13J.O
A30H13F          15,300  07-07-97  9:34a A30H13F
A30H13F   O     270,740  07-07-97  9:31a A30H13F.O
A00H13F   O     264,943  07-07-97  9:31a A00H13F.O
A00H13F          15,302  07-07-97  9:33a A00H13F
B30H13G   O     269,519  07-07-97  9:31a B30H13G.O
```

B30H13A	O	270,948	07-07-97	9:31a	B30H13A.O
B30H13B		15,276	07-07-97	9:33a	B30H13B
B30H13B	O	271,095	07-07-97	9:31a	B30H13B.O
B30H13C		15,277	07-07-97	9:34a	B30H13C
B30H13C	O	270,921	07-07-97	9:31a	B30H13C.O
B30H13D		15,278	07-07-97	9:33a	B30H13D
B30H13D	O	271,095	07-07-97	9:31a	B30H13D.O
B30H13E		15,247	07-07-97	9:34a	B30H13E
B30H13E	O	270,588	07-07-97	9:31a	B30H13E.O
B30H13F		15,246	07-07-97	9:33a	B30H13F
B30H13F	O	270,581	07-07-97	9:31a	B30H13F.O
B30H13G		15,183	07-07-97	9:34a	B30H13G
B30H13A		15,277	07-07-97	9:34a	B30H13A
B30H13H		15,183	07-07-97	9:33a	B30H13H
B30H13H	O	269,629	07-07-97	9:31a	B30H13H.O
B30H13I		15,183	07-07-97	9:34a	B30H13I
B30H13I	O	269,463	07-07-97	9:31a	B30H13I.O
B30H13J		15,181	07-07-97	9:33a	B30H13J
B30H13J	O	269,350	07-07-97	9:31a	B30H13J.O
B35H13F		15,249	07-07-97	9:34a	B35H13F
B35H13F	O	270,615	07-07-97	9:31a	B35H13F.O
C30H13F	O	270,498	07-07-97	9:31a	C30H13F.O
C30H13F		15,246	07-07-97	9:34a	C30H13F
C35H13F		15,246	07-07-97	9:33a	C35H13F
C35H13F	O	270,434	07-07-97	9:31a	C35H13F.O
D30H13H		15,187	07-07-97	9:34a	D30H13H
D30H13A	O	270,951	07-07-97	9:31a	D30H13A.O
D30H13B		15,280	07-07-97	9:34a	D30H13B
D30H13B	O	271,068	07-07-97	9:31a	D30H13B.O
D30H13C		15,281	07-07-97	9:33a	D30H13C
D30H13C	O	271,125	07-07-97	9:31a	D30H13C.O
D30H13D		15,282	07-07-97	9:34a	D30H13D
D30H13D	O	271,125	07-07-97	9:31a	D30H13D.O
D30H13E		15,251	07-07-97	9:33a	D30H13E
D30H13E	O	270,461	07-07-97	9:31a	D30H13E.O
D30H13F		15,250	07-07-97	9:34a	D30H13F
D30H13F	O	270,720	07-07-97	9:31a	D30H13F.O
D30H13G		15,187	07-07-97	9:33a	D30H13G
D30H13G	O	269,602	07-07-97	9:31a	D30H13G.O
D30H13A		15,281	07-07-97	9:33a	D30H13A
D30H13H	O	269,343	07-07-97	9:31a	D30H13H.O
D30H13I		15,187	07-10-97	5:22p	D30H13I
D30H13I	O	270,651	07-10-97	5:22p	D30H13I.O
D30H13J		15,185	07-07-97	9:34a	D30H13J
D30H13J	O	269,527	07-07-97	9:31a	D30H13J.O
D40H13F		15,249	07-07-97	9:34a	D40H13F
D40H13F	O	270,956	07-07-97	9:31a	D40H13F.O
E30H13F	O	270,588	07-07-97	9:31a	E30H13F.O
E30H13F		15,246	07-07-97	9:34a	E30H13F
E40H13F		15,245	07-07-97	9:34a	E40H13F
E40H13F	O	270,779	07-07-97	9:31a	E40H13F.O
F30H13F	O	270,498	07-07-97	9:31a	F30H13F.O
F30H13F		15,249	07-07-97	9:34a	F30H13F
F40H13F		15,248	07-07-97	9:34a	F40H13F
F40H13F	O	270,809	07-07-97	9:31a	F40H13F.O
A00L13F	O	264,681	07-10-97	5:11p	A00L13F.O
G40L13J	O	269,391	07-10-97	5:11p	G40L13J.O
G40L13I	O	269,535	07-10-97	5:11p	G40L13I.O
G40L13H	O	269,697	07-10-97	5:11p	G40L13H.O
G40L13G	O	269,443	07-10-97	5:11p	G40L13G.O
G40L13F	O	270,561	07-10-97	5:11p	G40L13F.O
G40L13E	O	270,677	07-10-97	5:11p	G40L13E.O
G40L13D	O	271,041	07-10-97	5:11p	G40L13D.O
G40L13C	O	271,436	07-10-97	5:11p	G40L13C.O
G40L13B	O	271,188	07-10-97	5:11p	G40L13B.O
G40L13A	O	271,320	07-10-97	5:11p	G40L13A.O
D30L13J	O	269,227	07-10-97	5:11p	D30L13J.O
D30L13I	O	269,527	07-10-97	5:11p	D30L13I.O
D30L13H	O	269,500	07-10-97	5:11p	D30L13H.O
D30L13G	O	269,257	07-10-97	5:11p	D30L13G.O
D30L13F	O	270,645	07-10-97	5:11p	D30L13F.O
D30L13E	O	270,611	07-10-97	5:11p	D30L13E.O
D30L13D	O	271,046	07-10-97	5:11p	D30L13D.O
D30L13C	O	270,957	07-10-97	5:11p	D30L13C.O
D30L13B	O	270,951	07-10-97	5:11p	D30L13B.O
D30L13A	O	270,948	07-10-97	5:11p	D30L13A.O
B30L13J	O	269,485	07-10-97	5:11p	B30L13J.O
B30L13I	O	269,346	07-10-97	5:11p	B30L13I.O
B30L13H	O	269,380	07-10-97	5:11p	B30L13H.O
B30L13G	O	269,493	07-10-97	5:11p	B30L13G.O
B30L13F	O	270,630	07-10-97	5:11p	B30L13F.O

B30L13E	O	270,450	07-10-97	5:11p	B30L13E.O
B30L13D	O	271,110	07-10-97	5:11p	B30L13D.O
B30L13C	O	271,080	07-10-97	5:11p	B30L13C.O
B30L13B	O	271,118	07-10-97	5:11p	B30L13B.O
B30L13A	O	271,102	07-10-97	5:11p	B30L13A.O
A00L13F		15,361	07-08-97	4:27p	A00L13F
D30L13D		15,285	07-08-97	4:27p	D30L13D
G40L13D		15,284	07-08-97	4:27p	G40L13D
D30L13C		15,284	07-08-97	4:27p	D30L13C
G40L13C		15,283	07-08-97	4:27p	G40L13C
D30L13A		15,282	07-08-97	4:27p	D30L13A
G40L13A		15,281	07-08-97	4:27p	G40L13A
D30L13B		15,281	07-08-97	4:27p	D30L13B
B30L13D		15,281	07-08-97	4:27p	B30L13D
G40L13B		15,280	07-08-97	4:27p	G40L13B
B30L13C		15,280	07-08-97	4:27p	B30L13C
B30L13A		15,278	07-08-97	4:27p	B30L13A
B30L13B		15,277	07-08-97	4:27p	B30L13B
D30L13F		15,252	07-08-97	4:27p	D30L13F
G40L13F		15,251	07-08-97	4:27p	G40L13F
D30L13E		15,251	07-08-97	4:27p	D30L13E
G40L13E		15,250	07-08-97	4:27p	G40L13E
B30L13F		15,248	07-08-97	4:27p	B30L13F
B30L13E		15,247	07-08-97	4:27p	B30L13E
D30L13I		15,189	07-08-97	4:27p	D30L13I
D30L13J		15,189	07-08-97	4:27p	D30L13J
D30L13G		15,189	07-08-97	4:27p	D30L13G
G40L13I		15,188	07-08-97	4:27p	G40L13I
G40L13J		15,188	07-08-97	4:27p	G40L13J
G40L13G		15,188	07-08-97	4:27p	G40L13G
D30L13H		15,188	07-08-97	4:27p	D30L13H
G40L13H		15,187	07-08-97	4:27p	G40L13H
B30L13J		15,185	07-08-97	4:27p	B30L13J
B30L13I		15,185	07-08-97	4:27p	B30L13I
B30L13G		15,185	07-08-97	4:27p	B30L13G
B30L13H		15,184	07-08-97	4:27p	B30L13H
G40M13B	O	271,290	07-10-97	5:05p	G40M13B.O
D30M13D	O	271,125	07-10-97	5:05p	D30M13D.O
D30M13B	O	271,125	07-10-97	5:05p	D30M13B.O
B30M13C	O	271,095	07-10-97	5:05p	B30M13C.O
B30M13B	O	271,068	07-10-97	5:05p	B30M13B.O
G40M13A	O	271,041	07-10-97	5:05p	G40M13A.O
G40M13C	O	271,011	07-10-97	5:05p	G40M13C.O
G40M13D	O	270,984	07-10-97	5:05p	G40M13D.O
D30M13C	O	270,978	07-10-97	5:05p	D30M13C.O
D30M13A	O	270,978	07-10-97	5:05p	D30M13A.O
B30M13D	O	270,921	07-10-97	5:05p	B30M13D.O
B30M13A	O	270,914	07-10-97	5:05p	B30M13A.O
G40M13E	O	270,810	07-10-97	5:05p	G40M13E.O
E40L13F	O	270,783	07-10-97	5:05p	E40L13F.O
G30M13F	O	270,770	07-10-97	5:05p	G30M13F.O
F40L13F	O	270,752	07-10-97	5:05p	F40L13F.O
C30M13F	O	270,750	07-10-97	5:05p	C30M13F.O
B30M13F	O	270,750	07-10-97	5:05p	B30M13F.O
D30M13F	O	270,745	07-10-97	5:05p	D30M13F.O
E40M13F	O	270,708	07-10-97	5:05p	E40M13F.O
F40M13F	O	270,663	07-10-97	5:05p	F40M13F.O
D30M13E	O	270,645	07-10-97	5:05p	D30M13E.O
C35M13F	O	270,630	07-10-97	5:05p	C35M13F.O
B35L13F	O	270,618	07-10-97	5:05p	B35L13F.O
B30M13E	O	270,615	07-10-97	5:05p	B30M13E.O
G30L13F	O	270,600	07-10-97	5:05p	G30L13F.O
E30M13F	O	270,600	07-10-97	5:05p	E30M13F.O
B35M13F	O	270,588	07-10-97	5:05p	B35M13F.O
D40L13F	O	270,561	07-10-97	5:05p	D40L13F.O
A30M13F	O	270,536	07-10-97	5:05p	A30M13F.O
A30L13F	O	270,536	07-10-97	5:05p	A30L13F.O
G40M13F	O	270,504	07-10-97	5:05p	G40M13F.O
F30L13F	O	270,498	07-10-97	5:05p	F30L13F.O
C30L13F	O	270,498	07-10-97	5:05p	C30L13F.O
E30L13F	O	270,490	07-10-97	5:05p	E30L13F.O
C35L13F	O	270,471	07-10-97	5:05p	C35L13F.O
F30M13F	O	270,468	07-10-97	5:05p	F30M13F.O
D30M13I	O	269,527	07-10-97	5:05p	D30M13I.O
G40M13J	O	269,518	07-10-97	5:05p	G40M13J.O
G40M13I	O	269,517	07-10-97	5:05p	G40M13I.O
D30M13H	O	269,502	07-10-97	5:05p	D30M13H.O
B30M13I	O	269,497	07-10-97	5:05p	B30M13I.O
D30M13J	O	269,470	07-10-97	5:05p	D30M13J.O
B30M13G	O	269,470	07-10-97	5:05p	B30M13G.O
G40M13H	O	269,386	07-10-97	5:05p	G40M13H.O

D30M13G	O	269,380	07-10-97	5:05p	D30M13G.O
B30M13H	O	269,353	07-10-97	5:05p	B30M13H.O
B30M13J	O	269,350	07-10-97	5:05p	B30M13J.O
G40M13G	O	269,290	07-10-97	5:05p	G40M13G.O
A00M13F	O	264,943	07-10-97	5:05p	A00M13F.O
D40M13F	O	272,080	07-10-97	5:22p	D40M13F.O
A00M13F		15,356	07-10-97	5:06p	A00M13F
A30L13F		15,302	07-10-97	5:06p	A30L13F
A30M13F		15,297	07-10-97	5:06p	A30M13F
D30M13D		15,281	07-10-97	5:06p	D30M13D
G40M13D		15,280	07-10-97	5:06p	G40M13D
D30M13B		15,280	07-10-97	5:06p	D30M13B
G40M13B		15,279	07-10-97	5:06p	G40M13B
D30M13C		15,279	07-10-97	5:06p	D30M13C
G40M13C		15,278	07-10-97	5:06p	G40M13C
D30M13A		15,278	07-10-97	5:06p	D30M13A
G40M13A		15,277	07-10-97	5:06p	G40M13A
B30M13D		15,277	07-10-97	5:06p	B30M13D
B30M13B		15,276	07-10-97	5:06p	B30M13B
B30M13C		15,275	07-10-97	5:06p	B30M13C
B30M13A		15,274	07-10-97	5:06p	B30M13A
G30L13F		15,251	07-10-97	5:06p	G30L13F
D40L13F		15,251	07-10-97	5:06p	D40L13F
F30L13F		15,251	07-10-97	5:06p	F30L13F
B35L13F		15,251	07-10-97	5:06p	B35L13F
F40L13F		15,250	07-10-97	5:06p	F40L13F
C35L13F		15,248	07-10-97	5:06p	C35L13F
E30L13F		15,248	07-10-97	5:06p	E30L13F
C30L13F		15,248	07-10-97	5:06p	C30L13F
E40L13F		15,247	07-10-97	5:06p	E40L13F
D30M13F		15,247	07-10-97	5:06p	D30M13F
F30M13F		15,246	07-10-97	5:06p	F30M13F
D40M13F		15,246	07-10-97	5:22p	D40M13F
D30M13E		15,246	07-10-97	5:06p	D30M13E
G30M13F		15,246	07-10-97	5:06p	G30M13F
G40M13F		15,246	07-10-97	5:06p	G40M13F
B35M13F		15,246	07-10-97	5:06p	B35M13F
G40M13E		15,245	07-10-97	5:06p	G40M13E
F40M13F		15,245	07-10-97	5:06p	F40M13F
E30M13F		15,243	07-10-97	5:06p	E30M13F
C35M13F		15,243	07-10-97	5:06p	C35M13F
C30M13F		15,243	07-10-97	5:06p	C30M13F
B30M13F		15,243	07-10-97	5:06p	B30M13F
E40M13F		15,242	07-10-97	5:06p	E40M13F
B30M13E		15,242	07-10-97	5:06p	B30M13E
D30M13J		15,186	07-10-97	5:06p	D30M13J
D30M13I		15,185	07-10-97	5:06p	D30M13I
G40M13J		15,185	07-10-97	5:06p	G40M13J
D30M13H		15,185	07-10-97	5:06p	D30M13H
G40M13H		15,184	07-10-97	5:06p	G40M13H
G40M13I		15,184	07-10-97	5:06p	G40M13I
D30M13G		15,184	07-10-97	5:06p	D30M13G
G40M13G		15,183	07-10-97	5:06p	G40M13G
B30M13J		15,182	07-10-97	5:06p	B30M13J
B30M13I		15,181	07-10-97	5:06p	B30M13I
B30M13H		15,181	07-10-97	5:06p	B30M13H
B30M13G		15,180	07-10-97	5:06p	B30M13G
G40M10J	O	270,959	08-05-97	11:06a	G40M10J.O
G40M10I	O	270,989	08-05-97	11:06a	G40M10I.O
G40M10H	O	270,962	08-05-97	11:06a	G40M10H.O
G40M10G	O	270,932	08-05-97	11:06a	G40M10G.O
G40M10E	O	272,227	08-05-97	11:06a	G40M10E.O
G40M10D	O	272,719	08-05-97	11:06a	G40M10D.O
G40M10C	O	272,580	08-05-97	11:06a	G40M10C.O
G40M10B	O	272,587	08-05-97	11:06a	G40M10B.O
G40M10A	O	272,709	08-05-97	11:06a	G40M10A.O
D30M10J	O	270,678	08-05-97	11:06a	D30M10J.O
D30M10I	O	270,798	08-05-97	11:06a	D30M10I.O
D30M10H	O	270,798	08-05-97	11:06a	D30M10H.O
D30M10G	O	270,768	08-05-97	11:06a	D30M10G.O
D30M10E	O	271,825	08-05-97	11:06a	D30M10E.O
D30M10D	O	272,671	08-05-97	11:06a	D30M10D.O
D30M10C	O	272,246	08-05-97	11:06a	D30M10C.O
D30M10B	O	272,219	08-05-97	11:06a	D30M10B.O
D30M10A	O	272,525	08-05-97	11:06a	D30M10A.O
B30M10J	O	270,847	08-05-97	11:06a	B30M10J.O
B30M10I	O	270,671	08-05-97	11:06a	B30M10I.O
B30M10H	O	270,798	08-05-97	11:06a	B30M10H.O
B30M10G	O	270,678	08-05-97	11:06a	B30M10G.O
B30M10E	O	272,048	08-05-97	11:06a	B30M10E.O
B30M10D	O	272,423	08-05-97	11:06a	B30M10D.O

B30M10C	O	272,396	08-05-97	11:06a	B30M10C.O
B30M10B	O	272,242	08-05-97	11:06a	B30M10B.O
B30M10A	O	272,408	08-05-97	11:06a	B30M10A.O
B30M10C		15,278	08-05-97	11:07a	B30M10C
B30M10E		15,248	08-05-97	11:07a	B30M10E
B30M10H		15,180	08-05-97	11:07a	B30M10H
B30M10J		15,183	08-05-97	11:07a	B30M10J
D30M10B		15,282	08-05-97	11:07a	D30M10B
D30M10D		15,281	08-05-97	11:07a	D30M10D
D30M10G		15,188	08-05-97	11:07a	D30M10G
D30M10I		15,186	08-05-97	11:07a	D30M10I
G40M10A		15,281	08-05-97	11:07a	G40M10A
G40M10C		15,281	08-05-97	11:07a	G40M10C
G40M10E		15,251	08-05-97	11:07a	G40M10E
G40M10H		15,183	08-05-97	11:07a	G40M10H
G40M10J		15,186	08-05-97	11:07a	G40M10J
G40M10I		15,185	08-05-97	11:07a	G40M10I
G40M10G		15,187	08-05-97	11:07a	G40M10G
G40M10D		15,280	08-05-97	11:07a	G40M10D
G40M10B		15,281	08-05-97	11:07a	G40M10B
D30M10J		15,187	08-05-97	11:07a	D30M10J
D30M10H		15,184	08-05-97	11:07a	D30M10H
D30M10E		15,252	08-05-97	11:07a	D30M10E
D30M10C		15,282	08-05-97	11:07a	D30M10C
D30M10A		15,282	08-05-97	11:07a	D30M10A
B30M10I		15,182	08-05-97	11:07a	B30M10I
B30M10G		15,184	08-05-97	11:07a	B30M10G
B30M10D		15,277	08-05-97	11:07a	B30M10D
B30M10B		15,278	08-05-97	11:07a	B30M10B
B30M10A		15,278	08-05-97	11:07a	B30M10A
G40H10F	O	270,779	08-05-97	1:10p	G40H10F.O
G30H10F	O	270,630	08-05-97	1:10p	G30H10F.O
F40H10F	O	270,922	08-05-97	1:10p	F40H10F.O
F30H10F	O	270,434	08-05-97	1:10p	F30H10F.O
E30H10F	O	264,950	08-05-97	1:10p	E30H10F.O
D40H10F	O	270,454	08-05-97	1:10p	D40H10F.O
D30H10F	O	270,498	08-05-97	1:10p	D30H10F.O
C35H10F	O	270,468	08-05-97	1:10p	C35H10F.O
B35H10F	O	270,471	08-05-97	1:10p	B35H10F.O
B30H10F	O	270,491	08-05-97	1:10p	B30H10F.O
A30H10F	O	270,713	08-05-97	1:10p	A30H10F.O
A00H10F	O	265,041	08-05-97	1:10p	A00H10F.O
D30H10F		15,250	08-05-97	1:11p	D30H10F
D40H10F		15,249	08-05-97	1:11p	D40H10F
F30H10F		15,249	08-05-97	1:11p	F30H10F
G30H10F		15,249	08-05-97	1:11p	G30H10F
G40H10F		15,249	08-05-97	1:11p	G40H10F
B35H10F		15,249	08-05-97	1:11p	B35H10F
F40H10F		15,248	08-05-97	1:11p	F40H10F
E30H10F		15,246	08-05-97	1:11p	E30H10F
C35H10F		15,246	08-05-97	1:11p	C35H10F
C30H10F		15,246	08-05-97	1:11p	C30H10F
B30H10F		15,246	08-05-97	1:11p	B30H10F
E40H10F		15,245	08-05-97	1:11p	E40H10F
A00M10F		15,361	08-05-97	1:21p	A00M10F
A00H10F		15,359	08-05-97	1:21p	A00H10F
A30M10F		15,302	08-05-97	1:21p	A30M10F
A30H10F		15,300	08-05-97	1:21p	A30H10F
D30H10D		15,283	08-05-97	1:21p	D30H10D
D30H10A		15,283	08-05-97	1:21p	D30H10A
G40H10D		15,282	08-05-97	1:21p	G40H10D
G40H10A		15,282	08-05-97	1:21p	G40H10A
D30H10B		15,282	08-05-97	1:21p	D30H10B
G40H10B		15,281	08-05-97	1:21p	G40H10B
D30H10C		15,280	08-05-97	1:21p	D30H10C
B30H10D		15,279	08-05-97	1:21p	B30H10D
G40H10C		15,279	08-05-97	1:21p	G40H10C
B30H10A		15,279	08-05-97	1:21p	B30H10A
B30H10B		15,278	08-05-97	1:21p	B30H10B
B30H10C		15,276	08-05-97	1:21p	B30H10C
D30M10F		15,252	08-05-97	1:21p	D30M10F
D30H10E		15,251	08-05-97	1:21p	D30H10E
G30M10F		15,251	08-05-97	1:21p	G30M10F
F30M10F		15,251	08-05-97	1:21p	F30M10F
D40M10F		15,251	08-05-97	1:21p	D40M10F
G40M10F		15,251	08-05-97	1:21p	G40M10F
B35M10F		15,251	08-05-97	1:21p	B35M10F
G40H10E		15,250	08-05-97	1:21p	G40H10E
F40M10F		15,250	08-05-97	1:21p	F40M10F
C30M10F		15,248	08-05-97	1:21p	C30M10F
C35M10F		15,248	08-05-97	1:21p	C35M10F

E30M10F		15,248	08-05-97	1:21p	E30M10F
B30M10F		15,248	08-05-97	1:21p	B30M10F
E40M10F		15,247	08-05-97	1:21p	E40M10F
B30H10E		15,247	08-05-97	1:21p	B30H10E
D30H10J		15,189	08-05-97	1:21p	D30H10J
G40H10J		15,188	08-05-97	1:21p	G40H10J
D30H10I		15,187	08-05-97	1:21p	D30H10I
G40H10I		15,186	08-05-97	1:21p	G40H10I
D30H10H		15,185	08-05-97	1:21p	D30H10H
B30H10J		15,185	08-05-97	1:21p	B30H10J
G40H10H		15,184	08-05-97	1:21p	G40H10H
D30H10G		15,184	08-05-97	1:21p	D30H10G
G40H10G		15,183	08-05-97	1:21p	G40H10G
B30H10I		15,183	08-05-97	1:21p	B30H10I
B30H10H		15,181	08-05-97	1:21p	B30H10H
B30H10G		15,180	08-05-97	1:21p	B30H10G
G40H10D	O	271,188	08-05-97	1:21p	G40H10D.O
D30H10C	O	271,125	08-05-97	1:21p	D30H10C.O
D30H10D	O	271,110	08-05-97	1:21p	D30H10D.O
G40H10A	O	271,109	08-05-97	1:21p	G40H10A.O
D30H10A	O	271,095	08-05-97	1:21p	D30H10A.O
B30H10C	O	271,068	08-05-97	1:21p	B30H10C.O
B30H10A	O	271,036	08-05-97	1:21p	B30H10A.O
G40H10C	O	271,014	08-05-97	1:21p	G40H10C.O
G40H10B	O	271,011	08-05-97	1:21p	G40H10B.O
D30H10B	O	270,978	08-05-97	1:21p	D30H10B.O
B30H10D	O	270,978	08-05-97	1:21p	B30H10D.O
B30H10B	O	270,921	08-05-97	1:21p	B30H10B.O
B35M10F	O	270,777	08-05-97	1:21p	B35M10F.O
G40M10F	O	270,693	08-05-97	1:21p	G40M10F.O
D40M10F	O	270,651	08-05-97	1:21p	D40M10F.O
D30H10E	O	270,645	08-05-97	1:21p	D30H10E.O
F30M10F	O	270,630	08-05-97	1:21p	F30M10F.O
A30M10F	O	270,593	08-05-97	1:21p	A30M10F.O
C35M10F	O	270,590	08-05-97	1:21p	C35M10F.O
B30H10E	O	270,588	08-05-97	1:21p	B30H10E.O
F40M10F	O	270,561	08-05-97	1:21p	F40M10F.O
G40H10E	O	270,531	08-05-97	1:21p	G40H10E.O
E30M10F	O	270,498	08-05-97	1:21p	E30M10F.O
D30M10F	O	270,498	08-05-97	1:21p	D30M10F.O
B30M10F	O	270,498	08-05-97	1:21p	B30M10F.O
C30M10F	O	270,471	08-05-97	1:21p	C30M10F.O
G30M10F	O	270,461	08-05-97	1:21p	G30M10F.O
E40M10F	O	270,369	08-05-97	1:21p	E40M10F.O
B30H10G	O	269,592	08-05-97	1:21p	B30H10G.O
G40H10G	O	269,548	08-05-97	1:21p	G40H10G.O
D30H10I	O	269,546	08-05-97	1:21p	D30H10I.O
D30H10H	O	269,527	08-05-97	1:22p	D30H10H.O
B30H10J	O	269,470	08-05-97	1:22p	B30H10J.O
G40H10I	O	269,443	08-05-97	1:22p	G40H10I.O
G40H10J	O	269,406	08-05-97	1:22p	G40H10J.O
G40H10H	O	269,386	08-05-97	1:22p	G40H10H.O
D30H10G	O	269,373	08-05-97	1:22p	D30H10G.O
D30H10J	O	269,350	08-05-97	1:22p	D30H10J.O
B30H10I	O	269,350	08-05-97	1:22p	B30H10I.O
B30H10H	O	269,323	08-05-97	1:22p	B30H10H.O
A00M10F	O	265,019	08-05-97	1:22p	A00M10F.O

..\MCNPcases\Sect7-3\Tab734&5

G10H13F		18,552	07-07-97	9:34a	G10H13F
G08H13F	O	318,512	07-07-97	9:35a	G08H13F.O
G10H13A		18,583	07-07-97	9:34a	G10H13A
G10H13A	O	319,397	07-07-97	9:32a	G10H13A.O
G10H13B		18,582	07-07-97	9:34a	G10H13B
G10H13B	O	319,454	07-07-97	9:32a	G10H13B.O
G10H13C		18,583	07-07-97	9:34a	G10H13C
G10H13C	O	319,447	07-07-97	9:32a	G10H13C.O
G10H13D		18,584	07-07-97	9:34a	G10H13D
G10H13D	O	319,307	07-07-97	9:32a	G10H13D.O
G10H13E		18,553	07-07-97	9:34a	G10H13E
G10H13E	O	318,562	07-07-97	9:31a	G10H13E.O
G08H13F		18,551	07-07-97	9:34a	G08H13F
G10H13F	O	318,569	07-07-97	9:31a	G10H13F.O
G10H13G		18,489	07-07-97	9:34a	G10H13G
G10H13G	O	316,981	07-07-97	9:31a	G10H13G.O
G10H13H		18,489	07-07-97	9:34a	G10H13H
G10H13H	O	317,229	07-07-97	9:31a	G10H13H.O
G10H13I		18,489	07-07-97	9:34a	G10H13I
G10H13I	O	317,229	07-07-97	9:31a	G10H13I.O
G10H13J		18,487	07-07-97	9:34a	G10H13J
G10H13J	O	317,229	07-07-97	9:31a	G10H13J.O

B09H13F		18,540	07-07-97	9:33a	B09H13F
B08H13A		18,573	07-07-97	9:34a	B08H13A
B08H13A	O	319,176	07-07-97	9:32a	B08H13A.O
B08H13B		18,572	07-07-97	9:34a	B08H13B
B08H13B	O	318,912	07-07-97	9:32a	B08H13B.O
B08H13C		18,573	07-07-97	9:33a	B08H13C
B08H13C	O	319,338	07-07-97	9:32a	B08H13C.O
B08H13D		18,574	07-07-97	9:34a	B08H13D
B08H13D	O	319,206	07-07-97	9:32a	B08H13D.O
B08H13E		18,543	07-07-97	9:33a	B08H13E
B08H13E	O	318,615	07-07-97	9:32a	B08H13E.O
B08H13F		18,542	07-07-97	9:34a	B08H13F
B08H13F	O	318,615	07-07-97	9:32a	B08H13F.O
B08H13G		18,479	07-07-97	9:33a	B08H13G
B08H13G	O	317,324	07-07-97	9:32a	B08H13G.O
B08H13H		18,479	07-07-97	9:34a	B08H13H
B08H13H	O	317,275	07-07-97	9:32a	B08H13H.O
B08H13I		18,479	07-07-97	9:33a	B08H13I
B08H13I	O	317,083	07-07-97	9:32a	B08H13I.O
B08H13J		18,477	07-07-97	9:34a	B08H13J
B08H13J	O	317,377	07-07-97	9:32a	B08H13J.O
A08H13F	O	318,585	07-07-97	9:31a	A08H13F.O
B09H13F	O	318,609	07-07-97	9:31a	B09H13F.O
A08H13F		18,546	07-07-97	9:34a	A08H13F
C08H13F	O	318,461	07-07-97	9:31a	C08H13F.O
C08H13F		18,548	07-07-97	9:34a	C08H13F
C09H13F		18,545	07-07-97	9:33a	C09H13F
C09H13F	O	318,615	07-07-97	9:31a	C09H13F.O
D08H13I	O	318,516	07-10-97	5:21p	D08H13I.O
D08H13A	O	318,857	07-07-97	9:32a	D08H13A.O
D08H13B		18,582	07-07-97	9:33a	D08H13B
D08H13B	O	318,936	07-07-97	9:32a	D08H13B.O
D08H13C		18,583	07-07-97	9:34a	D08H13C
D08H13C	O	319,176	07-07-97	9:32a	D08H13C.O
D08H13D		18,584	07-07-97	9:33a	D08H13D
D08H13D	O	319,176	07-07-97	9:32a	D08H13D.O
D08H13E		18,553	07-07-97	9:34a	D08H13E
D08H13E	O	318,396	07-07-97	9:32a	D08H13E.O
D08H13F		18,552	07-07-97	9:33a	D08H13F
D08H13F	O	318,585	07-07-97	9:32a	D08H13F.O
D08H13G		18,489	07-07-97	9:34a	D08H13G
D08H13G	O	317,071	07-07-97	9:32a	D08H13G.O
D08H13H		18,489	07-07-97	9:33a	D08H13H
D08H13H	O	317,245	07-07-97	9:32a	D08H13H.O
D08H13I		18,489	07-10-97	5:21p	D08H13I
D08H13A		18,583	07-07-97	9:34a	D08H13A
D08H13J		18,487	07-10-97	5:22p	D08H13J
D08H13J	O	318,543	07-10-97	5:22p	D08H13J.O
D10H13F		18,552	07-07-97	9:34a	D10H13F
D10H13F	O	318,468	07-07-97	9:31a	D10H13F.O
E10H13F	O	318,806	07-07-97	9:31a	E10H13F.O
E08H13F	O	318,558	07-07-97	9:31a	E08H13F.O
E10H13F		18,547	07-07-97	9:34a	E10H13F
E08H13F		18,546	07-07-97	9:34a	E08H13F
F08H13F	O	318,385	07-07-97	9:31a	F08H13F.O
F08H13F		18,551	07-07-97	9:34a	F08H13F
F10H13F		18,552	07-07-97	9:34a	F10H13F
F10H13F	O	318,512	07-07-97	9:31a	F10H13F.O
G10L13J	O	317,346	07-10-97	5:12p	G10L13J.O
G10L13I	O	317,523	07-10-97	5:12p	G10L13I.O
G10L13H	O	317,459	07-10-97	5:12p	G10L13H.O
G10L13G	O	318,227	07-10-97	5:20p	G10L13G.O
G10L13F	O	318,615	07-10-97	5:12p	G10L13F.O
G10L13E	O	318,806	07-10-97	5:12p	G10L13E.O
G10L13D	O	319,059	07-10-97	5:12p	G10L13D.O
G10L13C	O	318,882	07-10-97	5:12p	G10L13C.O
G10L13B	O	319,556	07-10-97	5:12p	G10L13B.O
G10L13A	O	319,149	07-10-97	5:12p	G10L13A.O
D08L13J	O	316,947	07-10-97	5:12p	D08L13J.O
D08L13I	O	317,238	07-10-97	5:12p	D08L13I.O
D08L13H	O	317,226	07-10-97	5:12p	D08L13H.O
D08L13G	O	317,370	07-10-97	5:12p	D08L13G.O
D08L13F	O	318,615	07-10-97	5:12p	D08L13F.O
D08L13E	O	318,291	07-10-97	5:12p	D08L13E.O
D08L13D	O	319,258	07-10-97	5:12p	D08L13D.O
D08L13C	O	319,206	07-10-97	5:12p	D08L13C.O
D08L13B	O	319,044	07-10-97	5:12p	D08L13B.O
D08L13A	O	318,855	07-10-97	5:12p	D08L13A.O
B08L13J	O	316,951	07-10-97	5:12p	B08L13J.O
B08L13I	O	316,981	07-10-97	5:12p	B08L13I.O
B08L13H	O	317,407	07-10-97	5:12p	B08L13H.O

B08L13G	O	317,252	07-10-97	5:12p	B08L13G.O
B08L13F	O	318,796	07-10-97	5:12p	B08L13F.O
B08L13E	O	318,588	07-10-97	5:12p	B08L13E.O
B08L13D	O	318,885	07-10-97	5:12p	B08L13D.O
B08L13C	O	318,912	07-10-97	5:12p	B08L13C.O
B08L13B	O	319,191	07-10-97	5:12p	B08L13B.O
B08L13A	O	319,017	07-10-97	5:12p	B08L13A.O
E08L13F	O	318,264	07-10-97	5:12p	E08L13F.O
D10L13F	O	318,588	07-10-97	5:12p	D10L13F.O
C09L13F	O	318,108	07-10-97	5:12p	C09L13F.O
C08L13F	O	318,291	07-10-97	5:12p	C08L13F.O
B09L13F	O	318,666	07-10-97	5:12p	B09L13F.O
A08L13F	O	318,615	07-10-97	5:12p	A08L13F.O
G08L13F		18,553	07-08-97	4:26p	G08L13F
F10L13F		18,554	07-08-97	4:26p	F10L13F
B09L13F		18,542	07-08-97	4:26p	B09L13F
A08L13F		18,548	07-08-97	4:26p	A08L13F
C09L13F		18,547	07-08-97	4:26p	C09L13F
D10L13F		18,554	07-08-97	4:26p	D10L13F
E08L13F		18,548	07-08-97	4:26p	E08L13F
F08L13F		18,553	07-08-97	4:26p	F08L13F
E10L13F		18,549	07-08-97	4:26p	E10L13F
C08L13F		18,550	07-08-97	4:26p	C08L13F
G10L13D		18,587	07-08-97	4:26p	G10L13D
D08L13D		18,587	07-08-97	4:26p	D08L13D
G10L13C		18,586	07-08-97	4:26p	G10L13C
D08L13C		18,586	07-08-97	4:26p	D08L13C
G10L13A		18,584	07-08-97	4:26p	G10L13A
D08L13A		18,584	07-08-97	4:26p	D08L13A
G10L13B		18,583	07-08-97	4:26p	G10L13B
D08L13B		18,583	07-08-97	4:26p	D08L13B
B08L13D		18,577	07-08-97	4:26p	B08L13D
B08L13C		18,576	07-08-97	4:26p	B08L13C
B08L13A		18,574	07-08-97	4:26p	B08L13A
B08L13B		18,573	07-08-97	4:26p	B08L13B
G10L13F		18,554	07-08-97	4:26p	G10L13F
D08L13F		18,554	07-08-97	4:26p	D08L13F
G10L13E		18,553	07-08-97	4:26p	G10L13E
D08L13E		18,553	07-08-97	4:26p	D08L13E
B08L13F		18,544	07-08-97	4:26p	B08L13F
B08L13E		18,543	07-08-97	4:26p	B08L13E
D08L13J		18,491	07-08-97	4:26p	D08L13J
G10L13G		18,491	07-10-97	5:20p	G10L13G
G10L13J		18,491	07-08-97	4:26p	G10L13J
G10L13I		18,491	07-08-97	4:26p	G10L13I
D08L13I		18,491	07-08-97	4:26p	D08L13I
D08L13G		18,491	07-08-97	4:26p	D08L13G
G10L13H		18,490	07-08-97	4:26p	G10L13H
D08L13H		18,490	07-08-97	4:26p	D08L13H
B08L13I		18,481	07-08-97	4:26p	B08L13I
B08L13J		18,481	07-08-97	4:26p	B08L13J
B08L13G		18,481	07-08-97	4:26p	B08L13G
B08L13H		18,480	07-08-97	4:26p	B08L13H
D08M13C	O	319,308	07-10-97	5:03p	D08M13C.O
B08M13A	O	319,179	07-10-97	5:03p	B08M13A.O
G10M13A	O	319,176	07-10-97	5:03p	G10M13A.O
B08M13C	O	319,176	07-10-97	5:03p	B08M13C.O
D08M13A	O	319,172	07-10-97	5:03p	D08M13A.O
B08M13D	O	319,149	07-10-97	5:03p	B08M13D.O
D08M13B	O	319,134	07-10-97	5:03p	D08M13B.O
B08M13B	O	319,032	07-10-97	5:03p	B08M13B.O
G10M13B	O	319,029	07-10-97	5:03p	G10M13B.O
G10M13C	O	318,885	07-10-97	5:03p	G10M13C.O
D08M13D	O	318,885	07-10-97	5:03p	D08M13D.O
G10M13D	O	318,855	07-10-97	5:03p	G10M13D.O
B09M13F	O	318,621	07-10-97	5:03p	B09M13F.O
C08M13F	O	318,615	07-10-97	5:03p	C08M13F.O
D08M13E	O	318,588	07-10-97	5:03p	D08M13E.O
C09M13F	O	318,588	07-10-97	5:03p	C09M13F.O
F08M13F	O	318,585	07-10-97	5:03p	F08M13F.O
D08M13F	O	318,585	07-10-97	5:03p	D08M13F.O
B08M13E	O	318,585	07-10-97	5:03p	B08M13E.O
A08M13F	O	318,558	07-10-97	5:03p	A08M13F.O
G10M13F	O	318,441	07-10-97	5:03p	G10M13F.O
G10M13E	O	318,426	07-10-97	5:03p	G10M13E.O
D10M13F	O	318,423	07-10-97	5:03p	D10M13F.O
B08M13F	O	318,382	07-10-97	5:03p	B08M13F.O
F10M13F	O	318,377	07-10-97	5:03p	F10M13F.O
E10M13F	O	318,321	07-10-97	5:03p	E10M13F.O
E08M13F	O	318,291	07-10-97	5:03p	E08M13F.O
G10M13J	O	317,348	07-10-97	5:03p	G10M13J.O

B08M13I	O	317,248	07-10-97	5:03p	B08M13I.O
G10M13I	O	317,218	07-10-97	5:03p	G10M13I.O
G10M13H	O	317,218	07-10-97	5:03p	G10M13H.O
D08M13I	O	317,101	07-10-97	5:03p	D08M13I.O
D08M13H	O	317,098	07-10-97	5:03p	D08M13H.O
B08M13H	O	317,098	07-10-97	5:03p	B08M13H.O
B08M13G	O	317,056	07-10-97	5:03p	B08M13G.O
D08M13J	O	316,981	07-10-97	5:03p	D08M13J.O
B08M13J	O	316,981	07-10-97	5:03p	B08M13J.O
G10M13G	O	316,951	07-10-97	5:03p	G10M13G.O
D08M13G	O	316,924	07-10-97	5:03p	D08M13G.O
G08M13F	O	319,562	07-10-97	5:20p	G08M13F.O
G10M13D		18,583	07-10-97	5:04p	G10M13D
D08M13D		18,583	07-10-97	5:04p	D08M13D
G10M13B		18,582	07-10-97	5:04p	G10M13B
D08M13B		18,582	07-10-97	5:04p	D08M13B
G10M13C		18,581	07-10-97	5:04p	G10M13C
D08M13C		18,581	07-10-97	5:04p	D08M13C
G10M13A		18,580	07-10-97	5:04p	G10M13A
D08M13A		18,580	07-10-97	5:04p	D08M13A
B08M13D		18,573	07-10-97	5:04p	B08M13D
B08M13B		18,572	07-10-97	5:04p	B08M13B
B08M13C		18,571	07-10-97	5:04p	B08M13C
B08M13A		18,570	07-10-97	5:04p	B08M13A
G10M13F		18,549	07-10-97	5:04p	G10M13F
D10M13F		18,549	07-10-97	5:04p	D10M13F
F10M13F		18,549	07-10-97	5:04p	F10M13F
D08M13F		18,549	07-10-97	5:04p	D08M13F
G08M13F		18,548	07-10-97	5:20p	G08M13F
F08M13F		18,548	07-10-97	5:04p	F08M13F
G10M13E		18,548	07-10-97	5:04p	G10M13E
D08M13E		18,548	07-10-97	5:04p	D08M13E
C08M13F		18,545	07-10-97	5:04p	C08M13F
E10M13F		18,544	07-10-97	5:04p	E10M13F
E08M13F		18,543	07-10-97	5:04p	E08M13F
A08M13F		18,543	07-10-97	5:04p	A08M13F
C09M13F		18,542	07-10-97	5:04p	C09M13F
B08M13F		18,539	07-10-97	5:04p	B08M13F
B08M13E		18,538	07-10-97	5:04p	B08M13E
B09M13F		18,537	07-10-97	5:04p	B09M13F
G10M13J		18,488	07-10-97	5:04p	G10M13J
D08M13J		18,488	07-10-97	5:04p	D08M13J
G10M13H		18,487	07-10-97	5:04p	G10M13H
G10M13I		18,487	07-10-97	5:04p	G10M13I
D08M13I		18,487	07-10-97	5:04p	D08M13I
D08M13H		18,487	07-10-97	5:04p	D08M13H
G10M13G		18,486	07-10-97	5:04p	G10M13G
D08M13G		18,486	07-10-97	5:04p	D08M13G
B08M13J		18,478	07-10-97	5:04p	B08M13J
B08M13I		18,477	07-10-97	5:04p	B08M13I
B08M13H		18,477	07-10-97	5:04p	B08M13H
B08M13G		18,476	07-10-97	5:04p	B08M13G
F08L13F	O	318,710	07-10-97	5:12p	F08L13F.O
E10L13F	O	318,588	07-10-97	5:12p	E10L13F.O
F10L13F	O	318,553	07-10-97	5:12p	F10L13F.O
B08H10A		18,575	08-05-97	11:04a	B08H10A
B08H10A	O	319,002	08-05-97	11:04a	B08H10A.O
B08H10B		18,574	08-05-97	11:04a	B08H10B
B08H10B	O	319,424	08-05-97	11:04a	B08H10B.O
B08H10C		18,572	08-05-97	11:04a	B08H10C
B08H10C	O	318,885	08-05-97	11:04a	B08H10C.O
B08H10D		18,575	08-05-97	11:04a	B08H10D
B08H10D	O	318,855	08-05-97	11:04a	B08H10D.O
B08H10E		18,543	08-05-97	11:04a	B08H10E
B08H10E	O	318,585	08-05-97	11:04a	B08H10E.O
B08H10G		18,476	08-05-97	11:04a	B08H10G
B08H10G	O	317,086	08-05-97	11:04a	B08H10G.O
B08H10H		18,477	08-05-97	11:04a	B08H10H
B08H10H	O	317,377	08-05-97	11:04a	B08H10H.O
B08H10I		18,479	08-05-97	11:04a	B08H10I
B08H10I	O	317,113	08-05-97	11:04a	B08H10I.O
B08H10J		18,481	08-05-97	11:04a	B08H10J
B08H10J	O	316,924	08-05-97	11:04a	B08H10J.O
D08H10A		18,585	08-05-97	11:04a	D08H10A
D08H10A	O	319,206	08-05-97	11:04a	D08H10A.O
D08H10B		18,584	08-05-97	11:04a	D08H10B
D08H10B	O	318,912	08-05-97	11:04a	D08H10B.O
D08H10C		18,582	08-05-97	11:04a	D08H10C
D08H10C	O	319,206	08-05-97	11:04a	D08H10C.O
D08H10D		18,585	08-05-97	11:04a	D08H10D
D08H10D	O	319,390	08-05-97	11:04a	D08H10D.O

D08H10E		18,553	08-05-97	11:04a	D08H10E
D08H10E	O	318,453	08-05-97	11:04a	D08H10E.O
D08H10G		18,486	08-05-97	11:04a	D08H10G
D08H10G	O	317,275	08-05-97	11:04a	D08H10G.O
D08H10H		18,487	08-05-97	11:04a	D08H10H
D08H10H	O	316,981	08-05-97	11:04a	D08H10H.O
D08H10I		18,489	08-05-97	11:04a	D08H10I
D08H10I	O	317,128	08-05-97	11:04a	D08H10I.O
D08H10J		18,491	08-05-97	11:04a	D08H10J
D08H10J	O	316,944	08-05-97	11:04a	D08H10J.O
G10H10A		18,585	08-05-97	11:04a	G10H10A
G10H10A	O	319,277	08-05-97	11:04a	G10H10A.O
G10H10B		18,584	08-05-97	11:04a	G10H10B
G10H10B	O	319,280	08-05-97	11:04a	G10H10B.O
G10H10C		18,582	08-05-97	11:04a	G10H10C
G10H10C	O	319,228	08-05-97	11:04a	G10H10C.O
G10H10D		18,585	08-05-97	11:04a	G10H10D
G10H10D	O	319,250	08-05-97	11:04a	G10H10D.O
G10H10E		18,553	08-05-97	11:04a	G10H10E
G10H10E	O	318,512	08-05-97	11:04a	G10H10E.O
G10H10G		18,486	08-05-97	11:04a	G10H10G
G10H10G	O	317,331	08-05-97	11:04a	G10H10G.O
G10H10H		18,487	08-05-97	11:04a	G10H10H
G10H10H	O	317,213	08-05-97	11:04a	G10H10H.O
G10H10I		18,489	08-05-97	11:04a	G10H10I
G10H10I	O	317,315	08-05-97	11:04a	G10H10I.O
G10H10J		18,491	08-05-97	11:04a	G10H10J
G10H10J	O	317,536	08-05-97	11:04a	G10H10J.O
B08M10A		18,574	08-05-97	11:12a	B08M10A
B08M10A	O	320,474	08-05-97	11:12a	B08M10A.O
B08M10B		18,574	08-05-97	11:12a	B08M10B
B08M10B	O	320,442	08-05-97	11:12a	B08M10B.O
B08M10C		18,574	08-05-97	11:12a	B08M10C
B08M10C	O	320,315	08-05-97	11:12a	B08M10C.O
B08M10D		18,573	08-05-97	11:12a	B08M10D
B08M10D	O	320,183	08-05-97	11:12a	B08M10D.O
B08M10E		18,544	08-05-97	11:12a	B08M10E
B08M10E	O	319,729	08-05-97	11:12a	B08M10E.O
B08M10G		18,480	08-05-97	11:12a	B08M10G
B08M10G	O	318,705	08-05-97	11:12a	B08M10G.O
B08M10H		18,476	08-05-97	11:12a	B08M10H
B08M10H	O	318,369	08-05-97	11:12a	B08M10H.O
B08M10I		18,478	08-05-97	11:12a	B08M10I
B08M10I	O	318,705	08-05-97	11:12a	B08M10I.O
B08M10J		18,479	08-05-97	11:12a	B08M10J
B08M10J	O	318,411	08-05-97	11:12a	B08M10J.O
D08M10A		18,584	08-05-97	11:12a	D08M10A
D08M10A	O	320,447	08-05-97	11:12a	D08M10A.O
D08M10B		18,584	08-05-97	11:12a	D08M10B
D08M10B	O	320,153	08-05-97	11:12a	D08M10B.O
D08M10C		18,584	08-05-97	11:12a	D08M10C
D08M10C	O	320,609	08-05-97	11:12a	D08M10C.O
D08M10D		18,583	08-05-97	11:12a	D08M10D
D08M10D	O	320,300	08-05-97	11:12a	D08M10D.O
D08M10E		18,554	08-05-97	11:12a	D08M10E
D08M10E	O	319,913	08-05-97	11:12a	D08M10E.O
D08M10G		18,490	08-05-97	11:12a	D08M10G
D08M10G	O	318,399	08-05-97	11:12a	D08M10G.O
D08M10H		18,486	08-05-97	11:12a	D08M10H
D08M10H	O	318,543	08-05-97	11:12a	D08M10H.O
D08M10I		18,488	08-05-97	11:12a	D08M10I
D08M10I	O	318,396	08-05-97	11:12a	D08M10I.O
D08M10J		18,489	08-05-97	11:12a	D08M10J
D08M10J	O	318,546	08-05-97	11:12a	D08M10J.O
G10M10A		18,584	08-05-97	11:12a	G10M10A
G10M10A	O	320,827	08-05-97	11:12a	G10M10A.O
G10M10B		18,584	08-05-97	11:12a	G10M10B
G10M10B	O	320,722	08-05-97	11:12a	G10M10B.O
G10M10C		18,584	08-05-97	11:12a	G10M10C
G10M10C	O	320,725	08-05-97	11:12a	G10M10C.O
G10M10D		18,583	08-05-97	11:12a	G10M10D
G10M10D	O	320,458	08-05-97	11:12a	G10M10D.O
G10M10E		18,554	08-05-97	11:12a	G10M10E
G10M10E	O	319,660	08-05-97	11:12a	G10M10E.O
G10M10G		18,490	08-05-97	11:12a	G10M10G
G10M10G	O	318,674	08-05-97	11:12a	G10M10G.O
G10M10H		18,486	08-05-97	11:12a	G10M10H
G10M10H	O	318,500	08-05-97	11:12a	G10M10H.O
G10M10I		18,488	08-05-97	11:12a	G10M10I
G10M10I	O	318,470	08-05-97	11:12a	G10M10I.O
G10M10J		18,489	08-05-97	11:12a	G10M10J

```
G10M10J  O      318,527  08-05-97 11:12a G10M10J.O
G10H10F  O      318,938  08-05-97  1:09p G10H10F.O
G08H10F  O      318,569  08-05-97  1:09p G08H10F.O
F10H10F  O      318,490  08-05-97  1:09p F10H10F.O
F08H10F  O      318,585  08-05-97  1:09p F08H10F.O
E10H10F  O      318,814  08-05-97  1:09p E10H10F.O
E08H10F  O      318,264  08-05-97  1:09p E08H10F.O
D10H10F  O      318,671  08-05-97  1:09p D10H10F.O
D08H10F  O      318,615  08-05-97  1:09p D08H10F.O
C09H10F  O      318,588  08-05-97  1:09p C09H10F.O
C08H10F  O      318,321  08-05-97  1:09p C08H10F.O
B09H10F  O      318,482  08-05-97  1:09p B09H10F.O
B08H10F  O      318,291  08-05-97  1:09p B08H10F.O
A08H10F  O      318,264  08-05-97  1:09p A08H10F.O
F10H10F          18,552  08-05-97  1:12p F10H10F
G10H10F          18,552  08-05-97  1:12p G10H10F
D10H10F          18,552  08-05-97  1:12p D10H10F
D08H10F          18,552  08-05-97  1:12p D08H10F
G08H10F          18,551  08-05-97  1:12p G08H10F
F08H10F          18,551  08-05-97  1:12p F08H10F
C08H10F          18,548  08-05-97  1:12p C08H10F
E10H10F          18,547  08-05-97  1:12p E10H10F
E08H10F          18,546  08-05-97  1:12p E08H10F
A08H10F          18,546  08-05-97  1:12p A08H10F
C09H10F          18,545  08-05-97  1:12p C09H10F
B08H10F          18,542  08-05-97  1:12p B08H10F
B09H10F          18,540  08-05-97  1:12p B09H10F
E10M10F  O      318,717  08-05-97  1:20p E10M10F.O
F10M10F  O      318,615  08-05-97  1:20p F10M10F.O
B09M10F  O      318,590  08-05-97  1:20p B09M10F.O
F08M10F  O      318,585  08-05-97  1:20p F08M10F.O
D08M10F  O      318,585  08-05-97  1:20p D08M10F.O
C09M10F  O      318,468  08-05-97  1:20p C09M10F.O
E08M10F  O      318,441  08-05-97  1:20p E08M10F.O
A08M10F  O      318,423  08-05-97  1:20p A08M10F.O
B08M10F  O      318,411  08-05-97  1:20p B08M10F.O
G10M10F  O      318,291  08-05-97  1:20p G10M10F.O
D10M10F  O      318,291  08-05-97  1:20p D10M10F.O
G08M10F  O      318,264  08-05-97  1:20p G08M10F.O
C08M10F  O      318,264  08-05-97  1:20p C08M10F.O
G10M10F          18,554  08-05-97  1:20p G10M10F
F10M10F          18,554  08-05-97  1:20p F10M10F
D10M10F          18,554  08-05-97  1:20p D10M10F
D08M10F          18,554  08-05-97  1:20p D08M10F
G08M10F          18,553  08-05-97  1:20p G08M10F
F08M10F          18,553  08-05-97  1:20p F08M10F
C08M10F          18,550  08-05-97  1:20p C08M10F
E10M10F          18,549  08-05-97  1:20p E10M10F
E08M10F          18,548  08-05-97  1:20p E08M10F
A08M10F          18,548  08-05-97  1:20p A08M10F
C09M10F          18,547  08-05-97  1:20p C09M10F
B08M10F          18,544  08-05-97  1:20p B08M10F
B09M10F          18,542  08-05-97  1:20p B09M10F
G08L13F  O      319,810  08-05-97  1:43p G08L13F.O

..\MCNPcases\Sect7-4\Tab74-10\r58
R58H13A1         10,192  08-05-97  9:44a r58h13a1
R58H13A1 O      201,366  08-05-97  9:44a r58h13a1.o
R58H13A2         10,195  08-05-97  9:44a r58h13a2
R58H13A2 O      197,826  08-05-97  9:44a r58h13a2.o
R58H13A3         11,958  08-05-97  9:44a r58h13a3
R58H13A3 O      221,064  08-05-97  9:44a r58h13a3.o
R58H13AW         12,178  08-05-97  9:44a r58h13aw
R58H13AW O      223,399  08-05-97  9:44a r58h13aw.o
R58H13BW         12,183  08-05-97  9:44a r58h13bw
R58H13BW O      223,428  08-05-97  9:44a r58h13bw.o
R58M13A1         10,189  08-05-97  9:44a r58m13a1
R58M13A1 O      198,088  08-05-97  9:44a r58m13a1.o
R58M13A2         10,192  08-05-97  9:44a r58m13a2
R58M13A2 O      199,447  08-05-97  9:44a r58m13a2.o
R58M13A3         11,954  08-05-97  9:44a r58m13a3
R58M13A3 O      221,307  08-05-97  9:44a r58m13a3.o
R58M13AW         12,151  08-05-97  9:44a r58m13aw
R58M13AW O      223,042  08-05-97  9:44a r58m13aw.o
R58M13BW         12,167  08-05-97  9:44a r58m13bw
R58M13BW O      222,859  08-05-97  9:44a r58m13bw.o
R58M13CW         12,168  08-05-97  9:44a r58m13cw
R58M13CW O      223,560  08-05-97  9:44a r58m13cw.o
        22 file(s)      2,480,913 bytes

..\MCNPcases\Sect7-4\Tab74-10\u33
```

```
U33H13A1            9,282  08-05-97   9:44a u33h13a1
U33H13A1 O        175,378  08-05-97   9:44a u33h13a1.o
U33H13A2            9,287  08-05-97   9:44a u33h13a2
U33H13A2 O        176,780  08-05-97   9:44a u33h13a2.o
U33H13A3           10,928  08-05-97   9:44a u33h13a3
U33H13A3 O        198,216  08-05-97   9:44a u33h13a3.o
U33H13A4           10,929  08-05-97   9:44a u33h13a4
U33H13A4 O        198,216  08-05-97   9:44a u33h13a4.o
U33H13A5           10,930  08-05-97   9:44a u33h13a5
U33H13A5 O        198,438  08-05-97   9:44a u33h13a5.o
U33H13AW           11,864  08-05-97   9:44a u33h13aw
U33H13AW O        204,176  08-05-97   9:44a u33h13aw.o
U33M13A1            9,280  08-05-97   9:44a u33m13a1
U33M13A1 O        176,927  08-05-97   9:44a u33m13a1.o
U33M13A2            9,285  08-05-97   9:44a u33m13a2
U33M13A2 O        176,862  08-05-97   9:44a u33m13a2.o
U33M13A3           10,926  08-05-97   9:44a u33m13a3
U33M13A3 O        198,217  08-05-97   9:44a u33m13a3.o
U33M13A4           10,927  08-05-97   9:44a u33m13a4
U33M13A4 O        198,317  08-05-97   9:44a u33m13a4.o
U33M13A5           10,928  08-05-97   9:44a u33m13a5
U33M13A5 O        198,439  08-05-97   9:44a u33m13a5.o
U33M13AW           11,850  08-05-97   9:44a u33m13aw
U33M13AW O        202,629  08-05-97   9:44a u33m13aw.o
        24 file(s)      2,429,011 bytes

..\MCNPcases\Sect7-4\Tab74-11
R3CR1F             10,134  08-05-97   1:25p R3CR1F
R3CR1F     O      196,481  08-05-97   1:25p R3CR1F.O
R3CR2F             10,134  08-05-97   1:25p R3CR2F
R3CR2F     O      196,571  08-05-97   1:25p R3CR2F.O
R3H04F             10,131  08-05-97   1:25p R3H04F
R3H04F     O      196,121  08-05-97   1:25p R3H04F.O
R3H06F             10,131  08-05-97   1:26p R3H06F
R3H06F     O      196,181  08-05-97   1:26p R3H06F.O
R3H08F             10,137  08-05-97   1:26p R3H08F
R3H08F     O      196,433  08-05-97   1:26p R3H08F.O
R3H10F             10,133  08-05-97   1:26p R3H10F
R3H10F     O      196,436  08-05-97   1:26p R3H10F.O
R3H13F             10,135  08-05-97   1:26p R3H13F
R3H13F     O      196,300  08-05-97   1:26p R3H13F.O
R3L08F             10,131  08-05-97   1:26p R3L08F
R3L08F     O      196,268  08-05-97   1:26p R3L08F.O
R3L10F             10,134  08-05-97   1:26p R3L10F
R3L10F     O      196,466  08-05-97   1:26p R3L10F.O
R3L13F             10,136  08-05-97   1:26p R3L13F
R3L13F     O      196,677  08-05-97   1:26p R3L13F.O
R3M04F             10,134  08-05-97   1:26p R3M04F
R3M04F     O      196,268  08-05-97   1:26p R3M04F.O
R3M06F             10,134  08-05-97   1:26p R3M06F
R3M06F     O      196,334  08-05-97   1:26p R3M06F.O
R3M08F             10,138  08-05-97   1:26p R3M08F
R3M08F     O      196,628  08-05-97   1:26p R3M08F.O
R3M10F             10,132  08-05-97   1:26p R3M10F
R3M10F     O      196,650  08-05-97   1:26p R3M10F.O
R3M13F             10,133  08-05-97   1:26p R3M13F
R3M13F     O      196,424  08-05-97   1:26p R3M13F.O
R45CR1F            10,134  08-05-97   1:26p R45CR1F
R45CR1F    O      196,466  08-05-97   1:26p R45CR1F.O
R45CR2F            10,134  08-05-97   1:26p R45CR2F
R45CR2F    O      196,473  08-05-97   1:26p R45CR2F.O
R45H04F            10,131  08-05-97   1:26p R45H04F
R45H04F    O      196,176  08-05-97   1:26p R45H04F.O
R45H06F            10,131  08-05-97   1:26p R45H06F
R45H06F    O      196,677  08-05-97   1:26p R45H06F.O
R45H08F            10,137  08-05-97   1:26p R45H08F
R45H08F    O      196,383  08-05-97   1:26p R45H08F.O
R45H10F            10,133  08-05-97   1:26p R45H10F
R45H10F    O      196,530  08-05-97   1:26p R45H10F.O
R45H13F            10,135  08-05-97   1:26p R45H13F
R45H13F    O      196,473  08-05-97   1:26p R45H13F.O
R45L08F            10,131  08-05-97   1:26p R45L08F
R45L08F    O      196,530  08-05-97   1:26p R45L08F.O
R45L10F            10,134  08-05-97   1:26p R45L10F
R45L10F    O      196,778  08-05-97   1:26p R45L10F.O
R45L13F            10,136  08-05-97   1:26p R45L13F
R45L13F    O      196,530  08-05-97   1:26p R45L13F.O
R45M04F            10,134  08-05-97   1:26p R45M04F
R45M04F    O      196,530  08-05-97   1:26p R45M04F.O
R45M06F            10,134  08-05-97   1:26p R45M06F
R45M06F    O      196,530  08-05-97   1:26p R45M06F.O
```

```
R45M08F          10,138  08-05-97   1:26p R45M08F
R45M08F   O     196,481  08-05-97   1:26p R45M08F.O
R45M10F          10,132  08-05-97   1:26p R45M10F
R45M10F   O     196,260  08-05-97   1:26p R45M10F.O
R45M13F          10,133  08-05-97   1:26p R45M13F
R45M13F   O     196,530  08-05-97   1:26p R45M13F.O
R4CR1F           10,133  08-05-97   1:26p R4CR1F
R4CR1F    O     196,327  08-05-97   1:26p R4CR1F.O
R4CR2F           10,133  08-05-97   1:26p R4CR2F
R4CR2F    O     196,447  08-05-97   1:26p R4CR2F.O
R4H04F           10,130  08-05-97   1:26p R4H04F
R4H04F    O     196,591  08-05-97   1:26p R4H04F.O
R4H06F           10,130  08-05-97   1:26p R4H06F
R4H06F    O     196,628  08-05-97   1:26p R4H06F.O
R4H08F           10,136  08-05-97   1:26p R4H08F
R4H08F    O     196,583  08-05-97   1:26p R4H08F.O
R4H10F           10,132  08-05-97   1:26p R4H10F
R4H10F    O     196,436  08-05-97   1:26p R4H10F.O
R4H13F           10,134  08-05-97   1:26p R4H13F
R4H13F    O     196,606  08-05-97   1:26p R4H13F.O
R4L08F           10,130  08-05-97   1:26p R4L08F
R4L08F    O     196,447  08-05-97   1:26p R4L08F.O
R4L10F           10,133  08-05-97   1:26p R4L10F
R4L10F    O     196,760  08-05-97   1:26p R4L10F.O
R4L13F           10,135  08-05-97   1:26p R4L13F
R4L13F    O     196,756  08-05-97   1:26p R4L13F.O
R4M04F           10,133  08-05-97   1:26p R4M04F
R4M04F    O     196,728  08-05-97   1:26p R4M04F.O
R4M06F           10,133  08-05-97   1:26p R4M06F
R4M06F    O     196,304  08-05-97   1:26p R4M06F.O
R4M08F           10,137  08-05-97   1:26p R4M08F
R4M08F    O     196,564  08-05-97   1:26p R4M08F.O
R4M10F           10,131  08-05-97   1:26p R4M10F
R4M10F    O     196,576  08-05-97   1:26p R4M10F.O
R4M13F           10,132  08-05-97   1:26p R4M13F
R4M13F    O     196,392  08-05-97   1:26p R4M13F.O

..\MCNPcases\Sect7-4\Tab74-12
R58C1A           10,223  07-10-97   5:01p R58c1a
R58C1A    O     199,744  07-10-97   5:01p R58c1a.O
R58C1B           10,227  07-10-97   5:01p R58c1b
R58C1B    O     199,401  07-10-97   5:01p R58c1b.O
R58C1C           10,194  07-10-97   5:01p R58c1c
R58C1C    O     199,141  07-10-97   5:01p R58c1c.O
R58C1D           10,193  07-10-97   5:01p R58c1d
R58C1D    O     198,976  07-10-97   5:01p R58c1d.O
R58C1E           10,128  07-10-97   5:01p R58c1e
R58C1E    O     197,507  07-10-97   5:01p R58c1e.O
R58C1F           10,129  07-10-97   5:01p R58c1f
R58C1F    O     197,636  07-15-97  11:14a R58c1f.O
R58C1G           10,131  07-10-97   5:01p R58c1g
R58C1G    O     197,593  07-10-97   5:01p R58c1g.O
R58C1H           10,129  07-10-97   5:01p R58c1h
R58C1H    O     197,654  07-10-97   5:01p R58c1h.O
R58C1I           10,130  07-10-97   5:01p R58c1i
R58C1I    O     197,470  07-10-97   5:01p R58c1i.O
R58C2A           10,221  07-10-97   5:01p R58c2a
R58C2A    O     199,612  07-10-97   5:01p R58c2a.O
R58C2B           10,222  07-10-97   5:01p R58c2b
R58C2B    O     199,556  07-10-97   5:01p R58c2b.O
R58C2C           10,189  07-10-97   5:01p R58c2c
R58C2C    O     198,874  07-10-97   5:01p R58c2c.O
R58C2D           10,191  07-10-97   5:01p R58c2d
R58C2D    O     199,146  07-10-97   5:01p R58c2d.O
R58C2E           10,129  07-10-97   5:01p R58c2e
R58C2E    O     197,681  07-10-97   5:01p R58c2e.O
R58C2F           10,129  07-10-97   5:01p R58c2f
R58C2F    O     197,674  07-10-97   5:01p R58c2f.O
R58C2G           10,129  07-10-97   5:01p R58c2g
R58C2G    O     197,828  07-10-97   5:01p R58c2g.O
R58C2H           10,127  07-10-97   5:01p R58c2h
R58C2H    O     197,828  07-10-97   5:01p R58c2h.O
R58C2I           10,122  07-10-97   5:01p R58c2i
R58C2I    O     197,877  07-10-97   5:01p R58c2i.O
R58CR1A          10,372  07-15-97  10:29a R58CR1A
R58CR1A   O     200,322  07-15-97  10:29a R58CR1A.O
R58CR1B          10,376  07-15-97  10:29a R58CR1B
R58CR1B   O     199,937  07-15-97  10:29a R58CR1B.O
R58CR1C          10,343  07-15-97  10:29a R58CR1C
R58CR1C   O     199,373  07-15-97  10:29a R58CR1C.O
R58CR1D          10,342  07-15-97  10:29a R58CR1D
```

R58CR1D	O	199,625	07-15-97	10:29a	R58CR1D.O
R58CR1E		10,277	07-15-97	10:29a	R58CR1E
R58CR1E	O	198,036	07-15-97	10:29a	R58CR1E.O
R58CR1F		10,278	07-15-97	10:29a	R58CR1F
R58CR1F	O	198,210	07-15-97	10:29a	R58CR1F.O
R58CR1G		10,280	07-15-97	10:29a	R58CR1G
R58CR1G	O	198,153	07-15-97	10:29a	R58CR1G.O
R58CR1H		10,278	07-15-97	10:29a	R58CR1H
R58CR1H	O	198,033	07-15-97	10:29a	R58CR1H.O
R58CR1I		10,279	07-15-97	10:29a	R58CR1I
R58CR1I	O	198,315	07-15-97	10:29a	R58CR1I.O
R58CR2A		10,370	07-15-97	10:29a	R58CR2A
R58CR2A	O	199,937	07-15-97	10:29a	R58CR2A.O
R58CR2B		10,371	07-15-97	10:29a	R58CR2B
R58CR2B	O	200,107	07-15-97	10:29a	R58CR2B.O
R58CR2C		10,338	07-15-97	10:29a	R58CR2C
R58CR2C	O	199,376	07-15-97	10:29a	R58CR2C.O
R58CR2D		10,340	07-15-97	10:29a	R58CR2D
R58CR2D	O	199,373	07-15-97	10:29a	R58CR2D.O
R58CR2E		10,278	07-15-97	10:29a	R58CR2E
R58CR2E	O	198,033	07-15-97	10:29a	R58CR2E.O
R58CR2F		10,278	07-15-97	10:29a	R58CR2F
R58CR2F	O	199,451	08-05-97	1:42p	R58CR2F.O
R58CR2G		10,278	07-15-97	10:29a	R58CR2G
R58CR2G	O	198,006	07-15-97	10:29a	R58CR2G.O
R58CR2H		10,276	07-15-97	10:29a	R58CR2H
R58CR2H	O	198,183	07-15-97	10:29a	R58CR2H.O
R58CR2I		10,271	07-15-97	10:29a	R58CR2I
R58CR2I	O	198,153	07-15-97	10:29a	R58CR2I.O
C33CR1A		9,532	08-05-97	9:46a	C33CR1A
C33CR1A	O	179,071	08-05-97	9:46a	C33CR1A.o
C33CR1B		9,536	08-05-97	9:46a	C33CR1B
C33CR1B	O	179,072	08-05-97	9:46a	C33CR1B.o
C33CR1C		9,503	08-05-97	9:46a	C33CR1C
C33CR1C	O	176,201	08-05-97	9:46a	C33CR1C.o
C33CR1D		9,502	08-05-97	9:46a	C33CR1D
C33CR1D	O	176,359	08-05-97	9:46a	C33CR1D.o
C33CR1E		9,437	08-05-97	9:46a	C33CR1E
C33CR1E	O	176,336	08-05-97	9:46a	C33CR1E.o
C33CR1F		9,438	08-05-97	9:46a	C33CR1F
C33CR1F	O	176,189	08-05-97	9:46a	C33CR1F.o
C33CR1G		9,440	08-05-97	9:46a	C33CR1G
C33CR1G	O	176,159	08-05-97	9:46a	C33CR1G.o
C33CR1H		9,438	08-05-97	9:46a	C33CR1H
C33CR1H	O	174,863	08-05-97	9:46a	C33CR1H.o
C33CR1I		9,439	08-05-97	9:46a	C33CR1I
C33CR1I	O	175,025	08-05-97	9:46a	C33CR1I.o
C33CR2A		9,530	08-05-97	9:46a	C33CR2A
C33CR2A	O	178,134	08-05-97	9:46a	C33CR2A.o
C33CR2B		9,531	08-05-97	9:46a	C33CR2B
C33CR2B	O	178,164	08-05-97	9:46a	C33CR2B.o
C33CR2C		9,498	08-05-97	9:46a	C33CR2C
C33CR2C	O	175,841	08-05-97	9:46a	C33CR2C.o
C33CR2D		9,500	08-05-97	9:46a	C33CR2D
C33CR2D	O	176,110	08-05-97	9:46a	C33CR2D.o
C33CR2E		9,438	08-05-97	9:46a	C33CR2E
C33CR2E	O	175,173	08-05-97	9:46a	C33CR2E.o
C33CR2F		9,438	08-05-97	9:46a	C33CR2F
C33CR2F	O	174,893	08-05-97	9:46a	C33CR2F.o
C33CR2G		9,438	08-05-97	9:46a	C33CR2G
C33CR2G	O	176,335	08-05-97	9:46a	C33CR2G.o
C33CR2H		9,436	08-05-97	9:46a	C33CR2H
C33CR2H	O	176,321	08-05-97	9:46a	C33CR2H.o
C33CR2I		9,435	08-05-97	9:46a	C33CR2I
C33CR2I	O	176,409	08-05-97	9:46a	C33CR2I.o
U33CR1A		9,312	08-05-97	9:49a	U33CR1A
U33CR1A	O	177,901	08-05-97	9:49a	U33CR1A.o
U33CR1B		9,316	08-05-97	9:49a	U33CR1B
U33CR1B	O	177,781	08-05-97	9:49a	U33CR1B.o
U33CR1C		9,283	08-05-97	9:49a	U33CR1C
U33CR1C	O	176,304	08-05-97	9:49a	U33CR1C.o
U33CR1D		9,282	08-05-97	9:49a	U33CR1D
U33CR1D	O	176,305	08-05-97	9:49a	U33CR1D.o
U33CR1E		9,217	08-05-97	9:49a	U33CR1E
U33CR1E	O	175,334	08-05-97	9:49a	U33CR1E.o
U33CR1F		9,218	08-05-97	9:49a	U33CR1F
U33CR1F	O	175,439	08-05-97	9:49a	U33CR1F.o
U33CR1G		9,220	08-05-97	9:49a	U33CR1G
U33CR1G	O	173,945	08-05-97	9:49a	U33CR1G.o
U33CR1H		9,218	08-05-97	9:49a	U33CR1H
U33CR1H	O	175,307	08-05-97	9:49a	U33CR1H.o

U33CR1I		9,219	08-05-97	9:49a	U33CR1I
U33CR1I	O	176,139	08-05-97	9:49a	U33CR1I.o
U33CR2A		9,310	08-05-97	9:49a	U33CR2A
U33CR2A	O	177,754	08-05-97	9:49a	U33CR2A.o
U33CR2B		9,311	08-05-97	9:49a	U33CR2B
U33CR2B	O	176,917	08-05-97	9:49a	U33CR2B.o
U33CR2C		9,278	08-05-97	9:49a	U33CR2C
U33CR2C	O	176,277	08-05-97	9:49a	U33CR2C.o
U33CR2D		9,280	08-05-97	9:49a	U33CR2D
U33CR2D	O	174,767	08-05-97	9:49a	U33CR2D.o
U33CR2E		9,218	08-05-97	9:49a	U33CR2E
U33CR2E	O	175,210	08-05-97	9:49a	U33CR2E.o
U33CR2F		9,218	08-05-97	9:49a	U33CR2F
U33CR2F	O	175,307	08-05-97	9:49a	U33CR2F.o
U33CR2G		9,218	08-05-97	9:49a	U33CR2G
U33CR2G	O	173,750	08-05-97	9:49a	U33CR2G.o
U33CR2H		9,216	08-05-97	9:49a	U33CR2H
U33CR2H	O	175,450	08-05-97	9:49a	U33CR2H.o
U33CR2I		9,215	08-05-97	9:49a	U33CR2I
U33CR2I	O	175,160	08-05-97	9:49a	U33CR2I.o

..\MCNPcases\Sect7-4\Tab74-13

C33CR1B		9,536	08-05-97	10:52a	C33CR1B
C33CR1B	O	179,072	08-05-97	10:52a	C33CR1B.o
C3C1B05		9,567	08-05-97	10:52a	c3c1b05
C3C1B05	O	176,680	08-05-97	10:52a	c3c1b05.o
C3C1B10		9,563	08-05-97	10:52a	c3c1b10
C3C1B10	O	176,526	08-05-97	10:52a	c3c1b10.o
C3C1B15		9,571	08-05-97	10:52a	c3c1b15
C3C1B15	O	177,828	08-05-97	10:52a	c3c1b15.o
C3C1B20		9,564	08-05-97	10:52a	c3c1b20
C3C1B20	O	177,967	08-05-97	10:52a	c3c1b20.o

..\MCNPcases\Sect7-4\Tab74-2

U30H06H		9,215	08-05-97	8:40a	u30h06h
U30H08A		9,309	08-05-97	8:59a	u30h08a
U30H04C	O	174,818	08-05-97	8:38a	u30h04c.o
U30H04A	O	175,367	08-05-97	8:38a	u30h04a.o
U30H04B		9,313	08-05-97	8:38a	u30h04b
U30H04B	O	174,909	08-05-97	8:38a	u30h04b.o
U30H04C		9,280	08-05-97	8:38a	u30h04c
U30H04A		9,313	08-05-97	8:38a	u30h04a
U30H04D		9,281	08-05-97	8:38a	u30h04d
U30H04D	O	176,362	08-05-97	8:38a	u30h04d.o
U30H04E		9,218	08-05-97	8:38a	u30h04e
U30H04E	O	175,096	08-05-97	8:38a	u30h04e.o
U30H04F		9,215	08-05-97	8:38a	u30h04f
U30H04F	O	173,832	08-05-97	8:38a	u30h04f.o
U30H04G		9,213	08-05-97	8:38a	u30h04g
U30H04G	O	173,700	08-05-97	8:38a	u30h04g.o
U30H04H		9,216	08-05-97	8:38a	u30h04h
U30H04H	O	175,154	08-05-97	8:38a	u30h04h.o
U30H04I		9,218	08-05-97	8:39a	u30h04i
U30H04I	O	175,154	08-05-97	8:39a	u30h04i.o
U30H04J		9,219	08-05-97	8:39a	u30h04j
U30H04J	O	175,256	08-05-97	8:39a	u30h04j.o
U30H10A		9,310	08-05-97	8:59a	u30h10a
U30H10A	O	175,209	08-05-97	8:59a	u30h10a.o
U30H06A	O	175,284	08-05-97	8:40a	u30h06a.o
U30H06B		9,311	08-05-97	8:40a	u30h06b
U30H06B	O	175,292	08-05-97	8:40a	u30h06b.o
U30H06C		9,276	08-05-97	8:40a	u30h06c
U30H06C	O	176,382	08-05-97	8:40a	u30h06c.o
U30H06D		9,279	08-05-97	8:40a	u30h06d
U30H06D	O	176,215	08-05-97	8:40a	u30h06d.o
U30H06E		9,212	08-05-97	8:40a	u30h06e
U30H06E	O	175,124	08-05-97	8:40a	u30h06e.o
U30H06F		9,215	08-05-97	8:40a	u30h06f
U30H06F	O	175,097	08-05-97	8:40a	u30h06f.o
U30H06G		9,215	08-05-97	8:40a	u30h06g
U30H06G	O	175,244	08-05-97	8:40a	u30h06g.o
U30H06A		9,308	08-05-97	8:40a	u30h06a
U30H06H	O	176,589	08-05-97	8:40a	u30h06h.o
U30H06I		9,215	08-05-97	8:40a	u30h06i
U30H06I	O	176,602	08-05-97	8:40a	u30h06i.o
U30H06J		9,217	08-05-97	8:40a	u30h06j
U30H06J	O	173,567	08-05-97	8:40a	u30h06j.o
U30H08A	O	176,868	08-05-97	8:59a	u30h08a.o
U30H08B		9,313	08-05-97	8:59a	u30h08b
U30H08B	O	175,298	08-05-97	8:59a	u30h08b.o
U30H08C		9,283	08-05-97	8:59a	u30h08c

```
U30H08C  O    177,370  08-05-97  8:59a u30h08c.o
U30H08D         9,281  08-05-97  8:59a u30h08d
U30H08D  O    174,701  08-05-97  8:59a u30h08d.o
U30H08E         9,218  08-05-97  8:59a u30h08e
U30H08E  O    175,124  08-05-97  8:59a u30h08e.o
U30H08F         9,219  08-05-97  8:59a u30h08f
U30H08F  O    175,244  08-05-97  8:59a u30h08f.o
U30H08G         9,219  08-05-97  8:59a u30h08g
U30H08G  O    173,701  08-05-97  8:59a u30h08g.o
U30H08H         9,220  08-05-97  8:59a u30h08h
U30H08H  O    173,728  08-05-97  8:59a u30h08h.o
U30H08I         9,220  08-05-97  8:59a u30h08i
U30H08I  O    173,791  08-05-97  8:59a u30h08i.o
U30H08J         9,220  08-05-97  8:59a u30h08j
U30H08J  O    173,728  08-05-97  8:59a u30h08j.o
U30H10B         9,313  08-05-97  8:59a u30h10b
U30H10B  O    175,208  08-05-97  8:59a u30h10b.o
U30H10C         9,281  08-05-97  8:59a u30h10c
U30H10C  O    176,271  08-05-97  8:59a u30h10c.o
U30H10D         9,280  08-05-97  8:59a u30h10d
U30H10D  O    176,403  08-05-97  8:59a u30h10d.o
U30H10E         9,214  08-05-97  8:59a u30h10e
U30H10E  O    176,420  08-05-97  8:59a u30h10e.o
U30H10F         9,215  08-05-97  8:59a u30h10f
U30H10F  O    173,611  08-05-97  8:59a u30h10f.o
U30H10G         9,217  08-05-97  8:59a u30h10g
U30H10G  O    173,610  08-05-97  8:59a u30h10g.o
U30H10H         9,217  08-05-97  8:59a u30h10h
U30H10H  O    173,604  08-05-97  8:59a u30h10h.o
U30H10I         9,219  08-05-97  8:59a u30h10i
U30H10I  O    173,581  08-05-97  8:59a u30h10i.o
U30H10J         9,217  08-05-97  8:59a u30h10j
U30H10J  O    173,685  08-05-97  8:59a u30h10j.o
U30H13A         9,311  08-05-97  9:00a u30h13a
U30H13A  O    175,211  08-05-97  9:00a u30h13a.o
U30H13B         9,312  08-05-97  9:00a u30h13b
U30H13B  O    176,827  08-05-97  9:00a u30h13b.o
U30H13C         9,281  08-05-97  9:00a u30h13c
U30H13C  O    176,271  08-05-97  9:00a u30h13c.o
U30H13D         9,280  08-05-97  9:00a u30h13d
U30H13D  O    174,731  08-05-97  9:00a u30h13d.o
U30H13E         9,217  08-05-97  9:00a u30h13e
U30H13E  O    173,553  08-05-97  9:00a u30h13e.o
U30H13F         9,217  08-05-97  9:00a u30h13f
U30H13F  O    173,713  08-05-97  9:00a u30h13f.o
U30H13G         9,216  08-05-97  9:00a u30h13g
U30H13G  O    176,241  08-05-97  9:00a u30h13g.o
U30H13H         9,217  08-05-97  9:00a u30h13h
U30H13H  O    173,700  08-05-97  9:00a u30h13h.o
U30H13I         9,215  08-05-97  9:00a u30h13i
U30H13I  O    173,728  08-05-97  9:00a u30h13i.o
U30H13J         9,218  08-05-97  9:00a u30h13j
U30H13J  O    175,244  08-05-97  9:00a u30h13j.o
U30M04A         9,315  08-05-97  9:00a u30m04a
U30M04A  O    175,180  08-05-97  9:00a u30m04a.o
U30M04B         9,315  08-05-97  9:00a u30m04b
U30M04B  O    175,285  08-05-97  9:00a u30m04b.o
U30M04C         9,285  08-05-97  9:00a u30m04c
U30M04C  O    176,272  08-05-97  9:00a u30m04c.o
U30M04D         9,285  08-05-97  9:00a u30m04d
U30M04D  O    176,246  08-05-97  9:00a u30m04d.o
U30M04E         9,221  08-05-97  9:00a u30m04e
U30M04E  O    175,230  08-05-97  9:00a u30m04e.o
U30M04F         9,218  08-05-97  9:00a u30m04f
U30M04F  O    175,096  08-05-97  9:00a u30m04f.o
U30M04G         9,222  08-05-97  9:00a u30m04g
U30M04G  O    175,154  08-05-97  9:00a u30m04g.o
U30M04H         9,217  08-05-97  9:00a u30m04h
U30M04H  O    176,398  08-05-97  9:00a u30m04h.o
U30M04I         9,222  08-05-97  9:00a u30m04i
U30M04I  O    176,398  08-05-97  9:00a u30m04i.o
U30M04J         9,222  08-05-97  9:00a u30m04j
U30M04J  O    173,751  08-05-97  9:00a u30m04j.o
U30M06A         9,315  08-05-97  9:00a u30m06a
U30M06A  O    175,314  08-05-97  9:00a u30m06a.o
U30M06B         9,313  08-05-97  9:00a u30m06b
U30M06B  O    176,715  08-05-97  9:00a u30m06b.o
U30M06C         9,284  08-05-97  9:00a u30m06c
U30M06C  O    176,242  08-05-97  9:00a u30m06c.o
U30M06D         9,284  08-05-97  9:00a u30m06d
U30M06D  O    174,831  08-05-97  9:00a u30m06d.o
```

U30M06E		9,221	08-05-97	9:00a	u30m06e
U30M06E	O	173,701	08-05-97	9:00a	u30m06e.o
U30M06F		9,218	08-05-97	9:00a	u30m06f
U30M06F	O	173,909	08-05-97	9:00a	u30m06f.o
U30M06G		9,220	08-05-97	9:00a	u30m06g
U30M06G	O	173,832	08-05-97	9:00a	u30m06g.o
U30M06H		9,218	08-05-97	9:00a	u30m06h
U30M06H	O	175,286	08-05-97	9:00a	u30m06h.o
U30M06I		9,220	08-05-97	9:00a	u30m06i
U30M06I	O	175,123	08-05-97	9:00a	u30m06i.o
U30M06J		9,219	08-05-97	9:00a	u30m06j
U30M06J	O	175,152	08-05-97	9:00a	u30m06j.o
U30M08A		9,316	08-05-97	9:01a	u30m08a
U30M08A	O	175,152	08-05-97	9:01a	u30m08a.o
U30M08B		9,316	08-05-97	9:01a	u30m08b
U30M08B	O	175,031	08-05-97	9:01a	u30m08b.o
U30M08C		9,284	08-05-97	9:01a	u30m08c
U30M08C	O	176,241	08-05-97	9:01a	u30m08c.o
U30M08D		9,280	08-05-97	9:01a	u30m08d
U30M08D	O	176,392	08-05-97	9:01a	u30m08d.o
U30M08E		9,221	08-05-97	9:01a	u30m08e
U30M08E	O	175,065	08-05-97	9:01a	u30m08e.o
U30M08F		9,220	08-05-97	9:01a	u30m08f
U30M08F	O	173,554	08-05-97	9:01a	u30m08f.o
U30M08G		9,221	08-05-97	9:01a	u30m08g
U30M08G	O	176,646	08-05-97	9:01a	u30m08g.o
U30M08H		9,219	08-05-97	9:01a	u30m08h
U30M08H	O	173,731	08-05-97	9:01a	u30m08h.o
U30M08I		9,216	08-05-97	9:01a	u30m08i
U30M08I	O	173,583	08-05-97	9:01a	u30m08i.o
U30M08J		9,219	08-05-97	9:01a	u30m08j
U30M08J	O	173,580	08-05-97	9:01a	u30m08j.o
U30M10A		9,312	08-05-97	9:01a	u30m10a
U30M10A	O	175,356	08-05-97	9:01a	u30m10a.o
U30M10B		9,311	08-05-97	9:01a	u30m10b
U30M10B	O	175,326	08-05-97	9:01a	u30m10b.o
U30M10C		9,282	08-05-97	9:01a	u30m10c
U30M10C	O	176,392	08-05-97	9:01a	u30m10c.o
U30M10D		9,282	08-05-97	9:01a	u30m10d
U30M10D	O	176,389	08-05-97	9:01a	u30m10d.o
U30M10E		9,218	08-05-97	9:01a	u30m10e
U30M10E	O	175,097	08-05-97	9:01a	u30m10e.o
U30M10F		9,214	08-05-97	9:01a	u30m10f
U30M10F	O	176,518	08-05-97	9:01a	u30m10f.o
U30M10G		9,217	08-05-97	9:01a	u30m10g
U30M10G	O	173,257	08-05-97	9:01a	u30m10g.o
U30M10H		9,216	08-05-97	9:01a	u30m10h
U30M10H	O	176,618	08-05-97	9:01a	u30m10h.o
U30M10I		9,217	08-05-97	9:01a	u30m10i
U30M10I	O	173,576	08-05-97	9:01a	u30m10i.o
U30M10J		9,218	08-05-97	9:01a	u30m10j
U30M10J	O	173,553	08-05-97	9:01a	u30m10j.o
U30M13A		9,309	08-05-97	9:02a	u30m13a
U30M13A	O	175,356	08-05-97	9:02a	u30m13a.o
U30M13B		9,309	08-05-97	9:02a	u30m13b
U30M13B	O	175,460	08-05-97	9:02a	u30m13b.o
U30M13C		9,276	08-05-97	9:02a	u30m13c
U30M13C	O	174,694	08-05-97	9:02a	u30m13c.o
U30M13D		9,277	08-05-97	9:02a	u30m13d
U30M13D	O	176,214	08-05-97	9:02a	u30m13d.o
U30M13E		9,214	08-05-97	9:02a	u30m13e
U30M13E	O	176,116	08-05-97	9:02a	u30m13e.o
U30M13F		9,215	08-05-97	9:02a	u30m13f
U30M13F	O	175,270	08-05-97	9:02a	u30m13f.o
U30M13G		9,214	08-05-97	9:02a	u30m13g
U30M13G	O	173,701	08-05-97	9:02a	u30m13g.o
U30M13H		9,215	08-05-97	9:02a	u30m13h
U30M13H	O	173,604	08-05-97	9:02a	u30m13h.o
U30M13I		9,216	08-05-97	9:02a	u30m13i
U30M13I	O	175,153	08-05-97	9:02a	u30m13i.o
U30M13J		9,217	08-05-97	9:02a	u30m13j
U30M13J	O	176,792	08-05-97	9:02a	u30m13j.o

..\MCNPcases\Sect7-4\Tab74-3

U33H04A		9,313	08-05-97	9:03a	u33h04a
U33H04A	O	175,244	08-05-97	9:03a	u33h04a.o
U33H04B		9,313	08-05-97	9:03a	u33h04b
U33H04B	O	175,210	08-05-97	9:03a	u33h04b.o
U33H04C		9,280	08-05-97	9:03a	u33h04c
U33H04C	O	176,306	08-05-97	9:03a	u33h04c.o
U33H04D		9,281	08-05-97	9:03a	u33h04d

```
U33H04D  O    176,336  08-05-97  9:03a u33h04d.o
U33H04E         9,218  08-05-97  9:03a u33h04e
U33H04E  O    175,307  08-05-97  9:03a u33h04e.o
U33H04F         9,215  08-05-97  9:03a u33h04f
U33H04F  O    175,319  08-05-97  9:03a u33h04f.o
U33H04G         9,213  08-05-97  9:03a u33h04g
U33H04G  O    175,335  08-05-97  9:03a u33h04g.o
U33H04H         9,216  08-05-97  9:03a u33h04h
U33H04H  O    176,827  08-05-97  9:03a u33h04h.o
U33H04I         9,218  08-05-97  9:03a u33h04i
U33H04I  O    173,676  08-05-97  9:03a u33h04i.o
U33H04J         9,219  08-05-97  9:03a u33h04j
U33H04J  O    173,823  08-05-97  9:03a u33h04j.o
U33H06A         9,308  08-05-97  9:04a u33h06a
U33H06A  O    175,362  08-05-97  9:04a u33h06a.o
U33H06B         9,311  08-05-97  9:04a u33h06b
U33H06B  O    178,413  08-05-97  9:04a u33h06b.o
U33H06C         9,276  08-05-97  9:04a u33h06c
U33H06C  O    176,302  08-05-97  9:04a u33h06c.o
U33H06D         9,279  08-05-97  9:04a u33h06d
U33H06D  O    174,941  08-05-97  9:04a u33h06d.o
U33H06E         9,212  08-05-97  9:04a u33h06e
U33H06E  O    175,293  08-05-97  9:04a u33h06e.o
U33H06F         9,215  08-05-97  9:04a u33h06f
U33H06F  O    175,187  08-05-97  9:04a u33h06f.o
U33H06G         9,215  08-05-97  9:04a u33h06g
U33H06G  O    173,648  08-05-97  9:04a u33h06g.o
U33H06H         9,215  08-05-97  9:04a u33h06h
U33H06H  O    173,740  08-05-97  9:04a u33h06h.o
U33H06I         9,215  08-05-97  9:04a u33h06i
U33H06I  O    173,674  08-05-97  9:04a u33h06i.o
U33H06J         9,217  08-05-97  9:04a u33h06j
U33H06J  O    176,386  08-05-97  9:04a u33h06j.o
U33H08A         9,311  08-05-97  9:04a u33h08a
U33H08A  O    175,242  08-05-97  9:04a u33h08a.o
U33H08B         9,315  08-05-97  9:04a u33h08b
U33H08B  O    175,215  08-05-97  9:04a u33h08b.o
U33H08C         9,285  08-05-97  9:04a u33h08c
U33H08C  O    177,945  08-05-97  9:04a u33h08c.o
U33H08D         9,283  08-05-97  9:04a u33h08d
U33H08D  O    176,270  08-05-97  9:04a u33h08d.o
U33H08E         9,220  08-05-97  9:04a u33h08e
U33H08E  O    175,319  08-05-97  9:04a u33h08e.o
U33H08F         9,221  08-05-97  9:04a u33h08f
U33H08F  O    173,610  08-05-97  9:04a u33h08f.o
U33H08G         9,221  08-05-97  9:04a u33h08g
U33H08G  O    173,674  08-05-97  9:04a u33h08g.o
U33H08H         9,222  08-05-97  9:04a u33h08h
U33H08H  O    173,617  08-05-97  9:04a u33h08h.o
U33H08I         9,222  08-05-97  9:04a u33h08i
U33H08I  O    173,749  08-05-97  9:04a u33h08i.o
U33H08J         9,222  08-05-97  9:04a u33h08j
U33H08J  O    175,187  08-05-97  9:04a u33h08j.o
U33H10A         9,312  08-05-97  9:05a u33h10a
U33H10A  O    175,368  08-05-97  9:05a u33h10a.o
U33H10B         9,315  08-05-97  9:05a u33h10b
U33H10B  O    175,361  08-05-97  9:05a u33h10b.o
U33H10C         9,283  08-05-97  9:05a u33h10c
U33H10C  O    176,278  08-05-97  9:05a u33h10c.o
U33H10D         9,282  08-05-97  9:05a u33h10d
U33H10D  O    174,762  08-05-97  9:05a u33h10d.o
U33H10E         9,216  08-05-97  9:05a u33h10e
U33H10E  O    175,217  08-05-97  9:05a u33h10e.o
U33H10F         9,217  08-05-97  9:05a u33h10f
U33H10F  O    176,856  08-05-97  9:05a u33h10f.o
U33H10G         9,219  08-05-97  9:05a u33h10g
U33H10G  O    173,673  08-05-97  9:05a u33h10g.o
U33H10H         9,219  08-05-97  9:05a u33h10h
U33H10H  O    173,674  08-05-97  9:05a u33h10h.o
U33H10I         9,221  08-05-97  9:05a u33h10i
U33H10I  O    173,617  08-05-97  9:05a u33h10i.o
U33H10J         9,219  08-05-97  9:05a u33h10j
U33H10J  O    173,673  08-05-97  9:05a u33h10j.o
U33H13A         9,313  08-05-97  9:06a u33h13a
U33H13A  O    175,550  08-05-97  9:06a u33h13a.o
U33H13B         9,314  08-05-97  9:06a u33h13b
U33H13B  O    175,406  08-05-97  9:06a u33h13b.o
U33H13C         9,283  08-05-97  9:06a u33h13c
U33H13C  O    174,909  08-05-97  9:06a u33h13c.o
U33H13D         9,282  08-05-97  9:06a u33h13d
U33H13D  O    176,277  08-05-97  9:06a u33h13d.o
```

```
U33H13E          9,219  08-05-97  9:06a u33h13e
U33H13E   O    175,307  08-05-97  9:06a u33h13e.o
U33H13F          9,219  08-05-97  9:06a u33h13f
U33H13F   O    176,156  08-05-97  9:06a u33h13f.o
U33H13G          9,218  08-05-97  9:06a u33h13g
U33H13G   O    173,619  08-05-97  9:06a u33h13g.o
U33H13H          9,219  08-05-97  9:06a u33h13h
U33H13H   O    173,646  08-05-97  9:06a u33h13h.o
U33H13I          9,217  08-05-97  9:06a u33h13i
U33H13I   O    176,841  08-05-97  9:06a u33h13i.o
U33H13J          9,220  08-05-97  9:06a u33h13j
U33H13J   O    175,217  08-05-97  9:06a u33h13j.o
U3H3G05          9,242  08-05-97  9:06a u3h3g05
U3H3G05   O    173,793  08-05-97  9:06a u3h3g05.o
U3H3G11          9,275  08-05-97  9:06a u3h3g11
U3H3G11   O    173,647  08-05-97  9:06a u3h3g11.o
U3H3G11I  O    173,806  08-05-97  9:06a u3h3g11i.o
U3H3G15          9,246  08-05-97  9:06a u3h3g15
U3H3G15   O    173,764  08-05-97  9:06a u3h3g15.o
U3H3G22          9,250  08-05-97  9:06a u3h3g22
U3H3G22   O    173,764  08-05-97  9:06a u3h3g22.o
U33L08A          9,314  08-05-97  9:12a u33l08a
U33L08A   O    175,361  08-05-97  9:12a u33l08a.o
U33L08B          9,314  08-05-97  9:12a u33l08b
U33L08B   O    175,235  08-05-97  9:12a u33l08b.o
U33L08C          9,281  08-05-97  9:12a u33l08c
U33L08C   O    174,735  08-05-97  9:12a u33l08c.o
U33L08D          9,282  08-05-97  9:12a u33l08d
U33L08D   O    176,482  08-05-97  9:12a u33l08d.o
U33L08E          9,217  08-05-97  9:12a u33l08e
U33L08E   O    175,319  08-05-97  9:12a u33l08e.o
U33L08F          9,215  08-05-97  9:12a u33l08f
U33L08F   O    173,806  08-05-97  9:12a u33l08f.o
U33L08G          9,214  08-05-97  9:12a u33l08g
U33L08G   O    173,732  08-05-97  9:12a u33l08g.o
U33L08H          9,218  08-05-97  9:12a u33l08h
U33L08H   O    173,646  08-05-97  9:12a u33l08h.o
U33L08I          9,220  08-05-97  9:12a u33l08i
U33L08I   O    176,926  08-05-97  9:12a u33l08i.o
U33L08J          9,213  08-05-97  9:12a u33l08j
U33L08J   O    173,748  08-05-97  9:12a u33l08j.o
U33L10A          9,312  08-05-97  9:13a u33l10a
U33L10A   O    176,813  08-05-97  9:13a u33l10a.o
U33L10B          9,312  08-05-97  9:13a u33l10b
U33L10B   O    175,246  08-05-97  9:13a u33l10b.o
U33L10C          9,281  08-05-97  9:13a u33l10c
U33L10C   O    174,736  08-05-97  9:13a u33l10c.o
U33L10D          9,284  08-05-97  9:13a u33l10d
U33L10D   O    174,601  08-05-97  9:13a u33l10d.o
U33L10E          9,220  08-05-97  9:13a u33l10e
U33L10E   O    175,217  08-05-97  9:13a u33l10e.o
U33L10F          9,218  08-05-97  9:13a u33l10f
U33L10F   O    177,337  08-05-97  9:13a u33l10f.o
U33L10G          9,220  08-05-97  9:13a u33l10g
U33L10G   O    173,648  08-05-97  9:13a u33l10g.o
U33L10H          9,219  08-05-97  9:13a u33l10h
U33L10H   O    173,674  08-05-97  9:13a u33l10h.o
U33L10I          9,220  08-05-97  9:13a u33l10i
U33L10I   O    175,564  08-05-97  9:13a u33l10i.o
U33L10J          9,216  08-05-97  9:13a u33l10j
U33L10J   O    173,400  08-05-97  9:13a u33l10j.o
U33L13A          9,316  08-05-97  9:13a u33l13a
U33L13A   O    175,215  08-05-97  9:13a u33l13a.o
U33L13B          9,317  08-05-97  9:13a u33l13b
U33L13B   O    175,272  08-05-97  9:13a u33l13b.o
U33L13C          9,283  08-05-97  9:13a u33l13c
U33L13C   O    174,763  08-05-97  9:13a u33l13c.o
U33L13D          9,284  08-05-97  9:13a u33l13d
U33L13D   O    176,656  08-05-97  9:13a u33l13d.o
U33L13E          9,221  08-05-97  9:13a u33l13e
U33L13E   O    173,616  08-05-97  9:13a u33l13e.o
U33L13F          9,220  08-05-97  9:13a u33l13f
U33L13F   O    173,551  08-05-97  9:13a u33l13f.o
U33L13G          9,221  08-05-97  9:13a u33l13g
U33L13G   O    177,528  08-05-97  9:13a u33l13g.o
U33L13H          9,221  08-05-97  9:13a u33l13h
U33L13H   O    175,307  08-05-97  9:13a u33l13h.o
U33L13I          9,221  08-05-97  9:13a u33l13i
U33L13I   O    173,674  08-05-97  9:13a u33l13i.o
U33L13J          9,221  08-05-97  9:13a u33l13j
U33L13J   O    173,820  08-05-97  9:13a u33l13j.o
```

U33M04A		9,315	08-05-97	9:13a	u33m04a
U33M04A	O	176,781	08-05-97	9:13a	u33m04a.o
U33M04B		9,315	08-05-97	9:13a	u33m04b
U33M04B	O	176,962	08-05-97	9:13a	u33m04b.o
U33M04C		9,285	08-05-97	9:13a	u33m04c
U33M04C	O	174,639	08-05-97	9:13a	u33m04c.o
U33M04D		9,285	08-05-97	9:13a	u33m04d
U33M04D	O	174,762	08-05-97	9:13a	u33m04d.o
U33M04E		9,221	08-05-97	9:13a	u33m04e
U33M04E	O	176,709	08-05-97	9:13a	u33m04e.o
U33M04F		9,218	08-05-97	9:13a	u33m04f
U33M04F	O	176,652	08-05-97	9:13a	u33m04f.o
U33M04G		9,222	08-05-97	9:13a	u33m04g
U33M04G	O	173,896	08-05-97	9:13a	u33m04g.o
U33M04H		9,217	08-05-97	9:13a	u33m04h
U33M04H	O	173,674	08-05-97	9:13a	u33m04h.o
U33M04I		9,222	08-05-97	9:13a	u33m04i
U33M04J		9,222	08-05-97	9:13a	u33m04j
U33M06A		9,315	08-05-97	9:14a	u33m06a
U33M06A	O	175,242	08-05-97	9:14a	u33m06a.o
U33M06B		9,313	08-05-97	9:14a	u33m06b
U33M06B	O	175,242	08-05-97	9:14a	u33m06b.o
U33M06C		9,284	08-05-97	9:14a	u33m06c
U33M06C	O	174,792	08-05-97	9:14a	u33m06c.o
U33M06D		9,284	08-05-97	9:14a	u33m06d
U33M06D	O	175,044	08-05-97	9:14a	u33m06d.o
U33M06E		9,221	08-05-97	9:14a	u33m06e
U33M06E	O	175,159	08-05-97	9:14a	u33m06e.o
U33M06F		9,218	08-05-97	9:14a	u33m06f
U33M06F	O	175,336	08-05-97	9:14a	u33m06f.o
U33M06G		9,220	08-05-97	9:14a	u33m06g
U33M06G	O	175,338	08-05-97	9:14a	u33m06g.o
U33M06H		9,218	08-05-97	9:14a	u33m06h
U33M06H	O	175,150	08-05-97	9:14a	u33m06h.o
U33M06I		9,220	08-05-97	9:14a	u33m06i
U33M06J		9,219	08-05-97	9:14a	u33m06j
U33M08A		9,318	08-05-97	9:16a	u33m08a
U33M08A	O	175,340	08-05-97	9:16a	u33m08a.o
U33M08B		9,318	08-05-97	9:16a	u33m08b
U33M08B	O	175,215	08-05-97	9:16a	u33m08b.o
U33M08C		9,286	08-05-97	9:16a	u33m08c
U33M08C	O	177,910	08-05-97	9:16a	u33m08c.o
U33M08D		9,282	08-05-97	9:16a	u33m08d
U33M08D	O	176,278	08-05-97	9:16a	u33m08d.o
U33M08E		9,223	08-05-97	9:16a	u33m08e
U33M08E	O	173,403	08-05-97	9:16a	u33m08e.o
U33M08F		9,222	08-05-97	9:16a	u33m08f
U33M08F	O	173,644	08-05-97	9:16a	u33m08f.o
U33M08G		9,223	08-05-97	9:16a	u33m08g
U33M08G	O	175,160	08-05-97	9:16a	u33m08g.o
U33M08H		9,221	08-05-97	9:16a	u33m08h
U33M08H	O	175,306	08-05-97	9:16a	u33m08h.o
U33M08I		9,218	08-05-97	9:16a	u33m08i
U33M08I	O	173,617	08-05-97	9:16a	u33m08i.o
U33M08J		9,221	08-05-97	9:16a	u33m08j
U33M08J	O	173,647	08-05-97	9:16a	u33m08j.o
U33M10A		9,314	08-05-97	9:17a	u33m10a
U33M10A	O	174,971	08-05-97	9:17a	u33m10a.o
U33M10B		9,313	08-05-97	9:17a	u33m10b
U33M10B	O	175,242	08-05-97	9:17a	u33m10b.o
U33M10C		9,284	08-05-97	9:17a	u33m10c
U33M10C	O	176,335	08-05-97	9:17a	u33m10c.o
U33M10D		9,284	08-05-97	9:17a	u33m10d
U33M10D	O	175,041	08-05-97	9:17a	u33m10d.o
U33M10E		9,220	08-05-97	9:17a	u33m10e
U33M10E	O	176,707	08-05-97	9:17a	u33m10e.o
U33M10F		9,216	08-05-97	9:17a	u33m10f
U33M10F	O	173,784	08-05-97	9:17a	u33m10f.o
U33M10G		9,219	08-05-97	9:17a	u33m10g
U33M10G	O	173,757	08-05-97	9:17a	u33m10g.o
U33M10H		9,218	08-05-97	9:17a	u33m10h
U33M10H	O	175,160	08-05-97	9:17a	u33m10h.o
U33M10I		9,219	08-05-97	9:17a	u33m10i
U33M10I	O	175,462	08-05-97	9:17a	u33m10i.o
U33M10J		9,220	08-05-97	9:17a	u33m10j
U33M10J	O	173,643	08-05-97	9:17a	u33m10j.o
U33M13A		9,311	08-05-97	9:17a	u33m13a
U33M13A	O	175,342	08-05-97	9:17a	u33m13a.o
U33M13B		9,313	08-05-97	9:17a	u33m13b
U33M13B	O	175,272	08-05-97	9:17a	u33m13b.o
U33M13C		9,278	08-05-97	9:17a	u33m13c

U33M13C	O	174,939	08-05-97	9:17a	u33m13c.o
U33M13D		9,279	08-05-97	9:17a	u33m13d
U33M13D	O	174,784	08-05-97	9:17a	u33m13d.o
U33M13E		9,216	08-05-97	9:17a	u33m13e
U33M13E	O	175,216	08-05-97	9:17a	u33m13e.o
U33M13F		9,217	08-05-97	9:17a	u33m13f
U33M13F	O	175,217	08-05-97	9:17a	u33m13f.o
U33M13G		9,216	08-05-97	9:17a	u33m13g
U33M13G	O	176,709	08-05-97	9:17a	u33m13g.o
U33M13H		9,217	08-05-97	9:17a	u33m13h
U33M13H	O	173,805	08-05-97	9:17a	u33m13h.o
U33M13I		9,218	08-05-97	9:17a	u33m13i
U33M13I	O	173,643	08-05-97	9:17a	u33m13i.o
U33M13J		9,219	08-05-97	9:17a	u33m13j
U33M13J	O	173,749	08-05-97	9:17a	u33m13j.o

..\MCNPcases\Sect7-4\Tab74-4

U40H06A		9,304	08-05-97	9:20a	u40h06a
U40H06A	O	175,214	08-05-97	9:20a	u40h06a.o
U40H06B		9,307	08-05-97	9:20a	u40h06b
U40H06B	O	176,772	08-05-97	9:20a	u40h06b.o
U40H06C		9,272	08-05-97	9:20a	u40h06c
U40H06C	O	176,588	08-05-97	9:20a	u40h06c.o
U40H06D		9,275	08-05-97	9:20a	u40h06d
U40H06D	O	176,306	08-05-97	9:20a	u40h06d.o
U40H06E		9,208	08-05-97	9:20a	u40h06e
U40H06E	O	175,186	08-05-97	9:20a	u40h06e.o
U40H06F		9,211	08-05-97	9:20a	u40h06f
U40H06F	O	175,189	08-05-97	9:20a	u40h06f.o
U40H06G		9,211	08-05-97	9:20a	u40h06g
U40H06G	O	176,652	08-05-97	9:20a	u40h06g.o
U40H06H		9,211	08-05-97	9:20a	u40h06h
U40H06H	O	176,857	08-05-97	9:20a	u40h06h.o
U40H06I		9,211	08-05-97	9:20a	u40h06i
U40H06J		9,213	08-05-97	9:20a	u40h06j
U40H08A		9,307	08-05-97	9:21a	u40h08a
U40H08A	O	175,404	08-05-97	9:21a	u40h08a.o
U40H08B		9,311	08-05-97	9:21a	u40h08b
U40H08B	O	175,373	08-05-97	9:21a	u40h08b.o
U40H08C		9,281	08-05-97	9:21a	u40h08c
U40H08C	O	174,791	08-05-97	9:21a	u40h08c.o
U40H08D		9,279	08-05-97	9:21a	u40h08d
U40H08D	O	174,438	08-05-97	9:21a	u40h08d.o
U40H08E		9,216	08-05-97	9:21a	u40h08e
U40H08E	O	173,506	08-05-97	9:21a	u40h08e.o
U40H08F		9,217	08-05-97	9:21a	u40h08f
U40H08F	O	176,708	08-05-97	9:21a	u40h08f.o
U40H08G		9,217	08-05-97	9:21a	u40h08g
U40H08G	O	175,183	08-05-97	9:21a	u40h08g.o
U40H08H		9,218	08-05-97	9:21a	u40h08h
U40H08H	O	173,791	08-05-97	9:21a	u40h08h.o
U40H08I		9,218	08-05-97	9:21a	u40h08i
U40H08I	O	173,617	08-05-97	9:21a	u40h08i.o
U40H08J		9,218	08-05-97	9:21a	u40h08j
U40H08J	O	175,160	08-05-97	9:21a	u40h08j.o
U40H10A		9,308	08-05-97	9:22a	u40h10a
U40H10A	O	175,242	08-05-97	9:22a	u40h10a.o
U40H10B		9,311	08-05-97	9:22a	u40h10b
U40H10B	O	175,214	08-05-97	9:22a	u40h10b.o
U40H10C		9,279	08-05-97	9:22a	u40h10c
U40H10C	O	174,912	08-05-97	9:22a	u40h10c.o
U40H10D		9,278	08-05-97	9:22a	u40h10d
U40H10D	O	174,896	08-05-97	9:22a	u40h10d.o
U40H10E		9,212	08-05-97	9:22a	u40h10e
U40H10E	O	173,814	08-05-97	9:22a	u40h10e.o
U40H10F		9,213	08-05-97	9:22a	u40h10f
U40H10F	O	175,187	08-05-97	9:22a	u40h10f.o
U40H10G		9,215	08-05-97	9:22a	u40h10g
U40H10G	O	175,258	08-05-97	9:22a	u40h10g.o
U40H10H		9,215	08-05-97	9:22a	u40h10h
U40H10H	O	175,266	08-05-97	9:22a	u40h10h.o
U40H10I		9,217	08-05-97	9:22a	u40h10i
U40H10I	O	173,776	08-05-97	9:22a	u40h10i.o
U40H10J		9,215	08-05-97	9:22a	u40h10j
U40H10J	O	173,673	08-05-97	9:22a	u40h10j.o
U40H13A		9,309	08-05-97	9:22a	u40h13a
U40H13A	O	178,307	08-05-97	9:22a	u40h13a.o
U40H13B		9,310	08-05-97	9:22a	u40h13b
U40H13B	O	175,207	08-05-97	9:22a	u40h13b.o
U40H13C		9,279	08-05-97	9:22a	u40h13c
U40H13C	O	174,762	08-05-97	9:22a	u40h13c.o

U40H13D		9,278	08-05-97	9:22a	u40h13d
U40H13D	O	176,305	08-05-97	9:22a	u40h13d.o
U40H13E		9,215	08-05-97	9:22a	u40h13e
U40H13E	O	175,217	08-05-97	9:22a	u40h13e.o
U40H13F		9,215	08-05-97	9:22a	u40h13f
U40H13F	O	175,217	08-05-97	9:22a	u40h13f.o
U40H13G		9,214	08-05-97	9:22a	u40h13g
U40H13G	O	173,762	08-05-97	9:22a	u40h13g.o
U40H13H		9,215	08-05-97	9:22a	u40h13h
U40H13H	O	173,820	08-05-97	9:22a	u40h13h.o
U40H13I		9,213	08-05-97	9:22a	u40h13i
U40H13I	O	173,612	08-05-97	9:22a	u40h13i.o
U40H13J		9,216	08-05-97	9:22a	u40h13j
U40H13J	O	173,644	08-05-97	9:22a	u40h13j.o
U40M08A		9,314	08-05-97	9:22a	u40m08a
U40M08A	O	175,272	08-05-97	9:22a	u40m08a.o
U40M08B		9,314	08-05-97	9:22a	u40m08b
U40M08B	O	175,271	08-05-97	9:22a	u40m08b.o
U40M08C		9,282	08-05-97	9:22a	u40m08c
U40M08C	O	176,482	08-05-97	9:22a	u40m08c.o
U40M08D		9,278	08-05-97	9:22a	u40m08d
U40M08D	O	176,328	08-05-97	9:22a	u40m08d.o
U40M08E		9,219	08-05-97	9:22a	u40m08e
U40M08E	O	173,615	08-05-97	9:22a	u40m08e.o
U40M08F		9,218	08-05-97	9:22a	u40m08f
U40M08F	O	175,192	08-05-97	9:22a	u40m08f.o
U40M08G		9,219	08-05-97	9:22a	u40m08g
U40M08G	O	173,350	08-05-97	9:22a	u40m08g.o
U40M08H		9,217	08-05-97	9:22a	u40m08h
U40M08H	O	173,806	08-05-97	9:22a	u40m08h.o
U40M08I		9,214	08-05-97	9:22a	u40m08i
U40M08I	O	173,643	08-05-97	9:22a	u40m08i.o
U40M08J		9,217	08-05-97	9:22a	u40m08j
U40M08J	O	173,644	08-05-97	9:22a	u40m08j.o
U40M10A		9,310	08-05-97	9:23a	u40m10a
U40M10A	O	175,215	08-05-97	9:23a	u40m10a.o
U40M10B		9,309	08-05-97	9:23a	u40m10b
U40M10B	O	176,759	08-05-97	9:23a	u40m10b.o
U40M10C		9,280	08-05-97	9:23a	u40m10c
U40M10C	O	174,908	08-05-97	9:23a	u40m10c.o
U40M10D		9,280	08-05-97	9:23a	u40m10d
U40M10D	O	174,730	08-05-97	9:23a	u40m10d.o
U40M10E		9,216	08-05-97	9:23a	u40m10e
U40M10E	O	175,188	08-05-97	9:23a	u40m10e.o
U40M10F		9,212	08-05-97	9:23a	u40m10f
U40M10F	O	176,526	08-05-97	9:23a	u40m10f.o
U40M10G		9,215	08-05-97	9:23a	u40m10g
U40M10G	O	173,790	08-05-97	9:23a	u40m10g.o
U40M10H		9,214	08-05-97	9:23a	u40m10h
U40M10H	O	173,617	08-05-97	9:23a	u40m10h.o
U40M10I		9,215	08-05-97	9:23a	u40m10i
U40M10I	O	173,658	08-05-97	9:23a	u40m10i.o
U40M10J		9,216	08-05-97	9:23a	u40m10j
U40M10J	O	176,842	08-05-97	9:23a	u40m10j.o
U40M13A		9,307	08-05-97	9:23a	u40m13a
U40M13A	O	175,215	08-05-97	9:23a	u40m13a.o
U40M13B		9,309	08-05-97	9:23a	u40m13b
U40M13B	O	175,242	08-05-97	9:23a	u40m13b.o
U40M13C		9,274	08-05-97	9:23a	u40m13c
U40M13C	O	176,278	08-05-97	9:23a	u40m13c.o
U40M13D		9,275	08-05-97	9:23a	u40m13d
U40M13D	O	174,745	08-05-97	9:23a	u40m13d.o
U40M13E		9,212	08-05-97	9:23a	u40m13e
U40M13E	O	176,960	08-05-97	9:23a	u40m13e.o
U40M13F		9,213	08-05-97	9:23a	u40m13f
U40M13F	O	173,647	08-05-97	9:23a	u40m13f.o
U40M13G		9,212	08-05-97	9:23a	u40m13g
U40M13G	O	173,644	08-05-97	9:24a	u40m13g.o
U40M13H		9,213	08-05-97	9:24a	u40m13h
U40M13H	O	173,617	08-05-97	9:24a	u40m13h.o
U40M13I		9,214	08-05-97	9:24a	u40m13i
U40M13I	O	173,644	08-05-97	9:24a	u40m13i.o
U40M13J		9,215	08-05-97	9:24a	u40m13j
U40M13J	O	175,308	08-05-97	9:24a	u40m13j.o

..\MCNPcases\Sect7-4\Tab74-5

R58H04A		10,224	07-07-97	10:22a	R58H04A
R58H04A	O	198,446	07-07-97	10:22a	R58H04A.O
R58H04B		10,224	07-07-97	10:22a	R58H04B
R58H04B	O	198,140	07-07-97	10:22a	R58H04B.O
R58H04C		10,191	07-07-97	10:22a	R58H04C

R58H04C	O	197,825	07-07-97	10:22a	R58H04C.O
R58H04D		10,192	07-07-97	10:22a	R58H04D
R58H04D	O	197,666	07-07-97	10:22a	R58H04D.O
R58H04E		10,129	07-07-97	10:22a	R58H04E
R58H04E	O	196,326	07-07-97	10:22a	R58H04E.O
R58H04F		10,126	07-07-97	10:22a	R58H04F
R58H04F	O	196,383	07-07-97	10:22a	R58H04F.O
R58H04G		10,120	07-07-97	10:22a	R58H04G
R58H04G	O	196,206	07-07-97	10:22a	R58H04G.O
R58H04H		10,127	07-07-97	10:22a	R58H04H
R58H04H	O	196,326	07-07-97	10:22a	R58H04H.O
R58H04I		10,129	07-07-97	10:22a	R58H04I
R58H04I	O	196,478	07-07-97	10:22a	R58H04I.O
R58H04J		10,130	07-07-97	10:22a	R58H04J
R58H04J	O	196,115	07-07-97	10:22a	R58H04J.O
R58H06A		10,219	07-07-97	10:22a	R58H06A
R58H06A	O	198,137	07-07-97	10:22a	R58H06A.O
R58H06B		10,222	07-07-97	10:22a	R58H06B
R58H06B	O	198,314	07-07-97	10:22a	R58H06B.O
R58H06C		10,187	07-07-97	10:22a	R58H06C
R58H06C	O	197,519	07-07-97	10:22a	R58H06C.O
R58H06D		10,190	07-07-97	10:22a	R58H06D
R58H06D	O	197,519	07-07-97	10:22a	R58H06D.O
R58H06E		10,119	07-07-97	10:22a	R58H06E
R58H06E	O	196,349	07-07-97	10:22a	R58H06E.O
R58H06F		10,126	07-07-97	10:22a	R58H06F
R58H06F	O	196,503	07-07-97	10:22a	R58H06F.O
R58H06G		10,126	07-07-97	10:22a	R58H06G
R58H06G	O	196,481	07-07-97	10:22a	R58H06G.O
R58H06H		10,126	07-07-97	10:22a	R58H06H
R58H06H	O	196,331	07-07-97	10:22a	R58H06H.O
R58H06I		10,126	07-07-97	10:22a	R58H06I
R58H06I	O	196,353	07-07-97	10:22a	R58H06I.O
R58H06J		10,128	07-07-97	10:22a	R58H06J
R58H06J	O	196,500	07-07-97	10:22a	R58H06J.O
R58H08A		10,218	07-07-97	10:22a	R58H08A
R58H08A	O	198,314	07-07-97	10:22a	R58H08A.O
R58H08B		10,226	07-07-97	10:22a	R58H08B
R58H08B	O	198,550	07-07-97	10:22a	R58H08B.O
R58H08C		10,196	07-07-97	10:22a	R58H08C
R58H08C	O	197,723	07-07-97	10:22a	R58H08C.O
R58H08D		10,194	07-07-97	10:22a	R58H08D
R58H08D	O	197,870	07-07-97	10:22a	R58H08D.O
R58H08E		10,131	07-10-97	5:20p	R58H08E
R58H08E	O	197,779	07-10-97	5:20p	R58H08E.O
R58H08F		10,132	07-07-97	10:22a	R58H08F
R58H08F	O	196,236	07-07-97	10:22a	R58H08F.O
R58H08G		10,132	07-07-97	10:22a	R58H08G
R58H08G	O	196,383	07-07-97	10:22a	R58H08G.O
R58H08H		10,133	07-07-97	10:22a	R58H08H
R58H08H	O	196,530	07-07-97	10:22a	R58H08H.O
R58H08I		10,133	07-07-97	10:22a	R58H08I
R58H08I	O	196,473	07-07-97	10:22a	R58H08I.O
R58H08J		10,133	07-07-97	10:22a	R58H08J
R58H08J	O	196,179	07-07-97	10:22a	R58H08J.O
R58H10A		10,223	07-07-97	10:22a	R58H10A
R58H10A	O	198,167	07-07-97	10:22a	R58H10A.O
R58H10B		10,226	07-07-97	10:22a	R58H10B
R58H10B	O	198,431	07-07-97	10:22a	R58H10B.O
R58H10C		10,194	07-07-97	10:22a	R58H10C
R58H10C	O	197,824	07-07-97	10:22a	R58H10C.O
R58H10D		10,193	07-07-97	10:22a	R58H10D
R58H10D	O	197,693	07-07-97	10:22a	R58H10D.O
R58H10E		10,127	07-07-97	10:22a	R58H10E
R58H10E	O	196,236	07-07-97	10:22a	R58H10E.O
R58H10F		10,128	07-07-97	10:22a	R58H10F
R58H10F	O	196,466	07-07-97	10:23a	R58H10F.O
R58H10G		10,130	07-07-97	10:23a	R58H10G
R58H10G	O	196,485	07-07-97	10:23a	R58H10G.O
R58H10H		10,130	07-07-97	10:23a	R58H10H
R58H10H	O	196,542	07-07-97	10:23a	R58H10H.O
R58H10I		10,132	07-07-97	10:23a	R58H10I
R58H10I	O	196,383	07-07-97	10:23a	R58H10I.O
R58H10J		10,130	07-07-97	10:23a	R58H10J
R58H10J	O	196,229	07-07-97	10:23a	R58H10J.O
R58H13A		10,224	07-07-97	10:23a	R58H13A
R58H13A	O	198,556	07-07-97	10:23a	R58H13A.O
R58H13B		10,225	07-07-97	10:23a	R58H13B
R58H13B	O	198,431	07-07-97	10:23a	R58H13B.O
R58H13C		10,194	07-07-97	10:23a	R58H13C
R58H13C	O	197,919	07-07-97	10:23a	R58H13C.O

R58H13D		10,193	07-07-97	10:23a	R58H13D
R58H13D	O	197,546	07-07-97	10:23a	R58H13D.O
R58H13E		10,130	07-07-97	10:23a	R58H13E
R58H13E	O	196,444	07-07-97	10:23a	R58H13E.O
R58H13F		10,130	07-07-97	10:23a	R58H13F
R58H13F	O	196,500	07-07-97	10:23a	R58H13F.O
R58H13G		10,129	07-07-97	10:23a	R58H13G
R58H13G	O	196,503	07-07-97	10:23a	R58H13G.O
R58H13H		10,130	07-07-97	10:23a	R58H13H
R58H13H	O	196,395	07-07-97	10:23a	R58H13H.O
R58H13I		10,128	07-10-97	5:20p	R58H13I
R58H13I	O	197,651	07-10-97	5:20p	R58H13I.O
R58H13J		10,131	07-07-97	10:23a	R58H13J
R58H13J	O	196,549	07-07-97	10:23a	R58H13J.O
R58L08A		10,225	07-07-97	10:23a	R58L08A
R58L08A	O	198,277	07-07-97	10:23a	R58L08A.O
R58L08B		10,225	07-07-97	10:23a	R58L08B
R58L08B	O	198,397	07-07-97	10:23a	R58L08B.O
R58L08C		10,192	07-07-97	10:23a	R58L08C
R58L08C	O	197,840	07-07-97	10:23a	R58L08C.O
R58L08D		10,193	07-07-97	10:23a	R58L08D
R58L08D	O	197,862	07-07-97	10:23a	R58L08D.O
R58L08E		10,128	07-07-97	10:23a	R58L08E
R58L08E	O	196,503	07-07-97	10:23a	R58L08E.O
R58L08F		10,126	07-07-97	10:23a	R58L08F
R58L08F	O	196,606	07-07-97	10:23a	R58L08F.O
R58L08G		10,121	07-07-97	10:23a	R58L08G
R58L08G	O	196,236	07-07-97	10:23a	R58L08G.O
R58L08H		10,129	07-07-97	10:23a	R58L08H
R58L08H	O	196,229	07-07-97	10:23a	R58L08H.O
R58L08I		10,131	07-07-97	10:23a	R58L08I
R58L08I	O	196,236	07-07-97	10:23a	R58L08I.O
R58L08J		10,120	07-07-97	10:23a	R58L08J
R58L08J	O	196,179	07-07-97	10:23a	R58L08J.O
R58L10A		10,223	07-07-97	10:23a	R58L10A
R58L10A	O	198,566	07-07-97	10:23a	R58L10A.O
R58L10B		10,223	07-07-97	10:23a	R58L10B
R58L10B	O	198,404	07-07-97	10:23a	R58L10B.O
R58L10C		10,192	07-07-97	10:23a	R58L10C
R58L10C	O	197,870	07-07-97	10:23a	R58L10C.O
R58L10D		10,195	07-07-97	10:23a	R58L10D
R58L10D	O	197,723	07-07-97	10:23a	R58L10D.O
R58L10E		10,131	07-07-97	10:23a	R58L10E
R58L10E	O	196,665	07-07-97	10:23a	R58L10E.O
R58L10F		10,129	07-07-97	10:23a	R58L10F
R58L10F	O	196,405	07-07-97	10:23a	R58L10F.O
R58L10G		10,131	07-07-97	10:23a	R58L10G
R58L10G	O	196,326	07-07-97	10:23a	R58L10G.O
R58L10H		10,130	07-07-97	10:23a	R58L10H
R58L10H	O	196,478	07-07-97	10:23a	R58L10H.O
R58L10I		10,131	07-07-97	10:23a	R58L10I
R58L10I	O	196,855	07-07-97	10:23a	R58L10I.O
R58L10J		10,127	07-07-97	10:23a	R58L10J
R58L10J	O	196,302	07-07-97	10:23a	R58L10J.O
R58L13A		10,227	07-07-97	10:23a	R58L13A
R58L13A	O	198,431	07-07-97	10:23a	R58L13A.O
R58L13B		10,228	07-07-97	10:23a	R58L13B
R58L13B	O	198,137	07-07-97	10:23a	R58L13B.O
R58L13C		10,194	07-07-97	10:23a	R58L13C
R58L13C	O	197,806	07-07-97	10:23a	R58L13C.O
R58L13D		10,195	07-07-97	10:23a	R58L13D
R58L13D	O	197,666	07-07-97	10:23a	R58L13D.O
R58L13E		10,132	07-07-97	10:23a	R58L13E
R58L13E	O	196,605	07-07-97	10:23a	R58L13E.O
R58L13EP		43,769	07-07-97	10:23a	R58L13EP
R58L13F		10,131	07-07-97	10:23a	R58L13F
R58L13F	O	196,500	07-07-97	10:23a	R58L13F.O
R58L13G		10,132	07-07-97	10:23a	R58L13G
R58L13G	O	196,549	07-07-97	10:23a	R58L13G.O
R58L13H		10,132	07-07-97	10:23a	R58L13H
R58L13H	O	196,473	07-07-97	10:23a	R58L13H.O
R58L13I		10,132	07-07-97	10:23a	R58L13I
R58L13I	O	196,628	07-07-97	10:23a	R58L13I.O
R58L13J		10,132	07-07-97	10:23a	R58L13J
R58L13J	O	196,457	07-07-97	10:23a	R58L13J.O
R58M04A		10,226	07-07-97	10:23a	R58M04A
R58M04A	O	198,103	07-07-97	10:23a	R58M04A.O
R58M04B		10,226	07-07-97	10:23a	R58M04B
R58M04B	O	198,397	07-07-97	10:23a	R58M04B.O
R58M04C		10,196	07-07-97	10:23a	R58M04C
R58M04C	O	197,843	07-07-97	10:23a	R58M04C.O

R58M04D		10,196	07-07-97	10:23a	R58M04D
R58M04D	O	197,693	07-07-97	10:23a	R58M04D.O
R58M04E		10,132	07-07-97	10:23a	R58M04E
R58M04E	O	196,598	07-07-97	10:23a	R58M04E.O
R58M04F		10,129	07-07-97	10:23a	R58M04F
R58M04F	O	196,522	07-07-97	10:23a	R58M04F.O
R58M04G		10,133	07-07-97	10:23a	R58M04G
R58M04G	O	196,605	07-07-97	10:23a	R58M04G.O
R58M04H		10,124	07-07-97	10:23a	R58M04H
R58M04H	O	196,500	07-07-97	10:23a	R58M04H.O
R58M04I		10,133	07-07-97	10:23a	R58M04I
R58M04I	O	196,326	07-07-97	10:23a	R58M04I.O
R58M04J		10,133	07-07-97	10:23a	R58M04J
R58M04J	O	196,338	07-07-97	10:23a	R58M04J.O
R58M06A		10,226	07-07-97	10:23a	R58M06A
R58M06A	O	198,678	07-07-97	10:23a	R58M06A.O
R58M06B		10,220	07-07-97	10:23a	R58M06B
R58M06B	O	198,404	07-07-97	10:23a	R58M06B.O
R58M06C		10,195	07-07-97	10:23a	R58M06C
R58M06C	O	197,813	07-07-97	10:23a	R58M06C.O
R58M06D		10,195	07-07-97	10:23a	R58M06D
R58M06D	O	197,813	07-07-97	10:23a	R58M06D.O
R58M06E		10,132	07-07-97	10:23a	R58M06E
R58M06E	O	196,356	07-07-97	10:23a	R58M06E.O
R58M06F		10,129	07-07-97	10:23a	R58M06F
R58M06F	O	196,172	07-07-97	10:23a	R58M06F.O
R58M06G		10,131	07-07-97	10:23a	R58M06G
R58M06G	O	196,311	07-07-97	10:23a	R58M06G.O
R58M06H		10,129	07-07-97	10:23a	R58M06H
R58M06H	O	196,466	07-07-97	10:23a	R58M06H.O
R58M06I		10,131	07-07-97	10:23a	R58M06I
R58M06I	O	196,571	07-07-97	10:23a	R58M06I.O
R58M06J		10,130	07-07-97	10:23a	R58M06J
R58M06J	O	196,493	07-07-97	10:23a	R58M06J.O
R58M08A		10,229	07-07-97	10:23a	R58M08A
R58M08A	O	198,461	07-07-97	10:23a	R58M08A.O
R58M08B		10,229	07-07-97	10:23a	R58M08B
R58M08B	O	198,250	07-07-97	10:23a	R58M08B.O
R58M08C		10,197	07-07-97	10:23a	R58M08C
R58M08C	O	197,539	07-07-97	10:23a	R58M08C.O
R58M08D		10,189	07-07-97	10:23a	R58M08D
R58M08D	O	197,666	07-07-97	10:23a	R58M08D.O
R58M08E		10,134	07-07-97	10:23a	R58M08E
R58M08E	O	196,503	07-07-97	10:23a	R58M08E.O
R58M08F		10,133	07-07-97	10:23a	R58M08F
R58M08F	O	196,601	07-07-97	10:23a	R58M08F.O
R58M08G		10,134	07-07-97	10:23a	R58M08G
R58M08G	O	196,605	07-07-97	10:23a	R58M08G.O
R58M08H		10,132	07-07-97	10:23a	R58M08H
R58M08H	O	196,549	07-07-97	10:23a	R58M08H.O
R58M08I		10,125	07-07-97	10:23a	R58M08I
R58M08I	O	196,202	07-07-97	10:23a	R58M08I.O
R58M08J		10,132	07-07-97	10:23a	R58M08J
R58M08J	O	196,319	07-07-97	10:23a	R58M08J.O
R58M10A		10,225	07-07-97	10:23a	R58M10A
R58M10A	O	198,532	07-07-97	10:23a	R58M10A.O
R58M10B		10,224	07-07-97	10:23a	R58M10B
R58M10B	O	198,404	07-07-97	10:23a	R58M10B.O
R58M10C		10,195	07-07-97	10:23a	R58M10C
R58M10C	O	197,576	07-07-97	10:23a	R58M10C.O
R58M10D		10,195	07-07-97	10:23a	R58M10D
R58M10D	O	197,892	07-07-97	10:23a	R58M10D.O
R58M10E		10,131	07-07-97	10:23a	R58M10E
R58M10E	O	196,368	07-07-97	10:23a	R58M10E.O
R58M10F		10,127	07-07-97	10:23a	R58M10F
R58M10F	O	196,579	07-07-97	10:23a	R58M10F.O
R58M10G		10,130	07-07-97	10:23a	R58M10G
R58M10G	O	196,488	07-07-97	10:23a	R58M10G.O
R58M10H		10,129	07-07-97	10:23a	R58M10H
R58M10H	O	196,473	07-07-97	10:23a	R58M10H.O
R58M10I		10,130	07-07-97	10:23a	R58M10I
R58M10I	O	196,524	07-07-97	10:23a	R58M10I.O
R58M10J		10,131	07-07-97	10:23a	R58M10J
R58M10J	O	196,473	07-07-97	10:23a	R58M10J.O
R58M13A		10,222	07-07-97	10:23a	R58M13A
R58M13A	O	198,427	07-07-97	10:23a	R58M13A.O
R58M13B		10,224	07-07-97	10:23a	R58M13B
R58M13B	O	198,110	07-07-97	10:23a	R58M13B.O
R58M13C		10,189	07-07-97	10:23a	R58M13C
R58M13C	O	197,938	07-07-97	10:23a	R58M13C.O
R58M13D		10,190	07-07-97	10:23a	R58M13D

R58M13D	O	197,693	07-07-97	10:23a	R58M13D.O
R58M13E		10,127	07-07-97	10:23a	R58M13E
R58M13E	O	196,172	07-07-97	10:23a	R58M13E.O
R58M13F		10,128	07-07-97	10:23a	R58M13F
R58M13F	O	196,338	07-07-97	10:23a	R58M13F.O
R58M13G		10,127	07-07-97	10:23a	R58M13G
R58M13G	O	196,530	07-07-97	10:23a	R58M13G.O
R58M13H		10,128	07-07-97	10:23a	R58M13H
R58M13H	O	196,356	07-07-97	10:23a	R58M13H.O
R58M13I		10,129	07-07-97	10:23a	R58M13I
R58M13I	O	196,522	07-07-97	10:23a	R58M13I.O
R58M13J		10,130	07-07-97	10:23a	R58M13J
R58M13J	O	196,693	07-07-97	10:23a	R58M13J.O
RESULTS	OUT	27,994	07-07-97	10:24a	results.out

..\MCNPcases\Sect7-4\Tab74-6

BR58L13	O	200,873	07-10-97	4:57p	BR58L13.O
BR58H13	O	199,481	07-10-97	4:57p	BR58H13.O
BR58L13		10,421	07-10-97	4:57p	BR58L13
BR58H13		10,356	07-10-97	4:57p	BR58H13
BR58M13		10,353	07-10-97	4:57p	BR58M13
BR58M13	O	199,515	08-05-97	1:41p	BR58M13.O
BU33H13		12,438	07-10-97	4:57p	BU33H13
BU33H13	O	227,144	07-10-97	4:57p	BU33H13.O
BU33L13		12,503	07-10-97	4:57p	BU33L13
BU33L13	O	228,415	07-10-97	4:57p	BU33L13.O
BU33M13		12,435	07-10-97	4:57p	BU33M13
BU33M13	O	227,444	08-05-97	1:43p	BU33M13.O

..\MCNPcases\Sect7-4\Tab74-7

RB2M13		10,193	07-10-97	4:58p	RB2M13
RBP5L13	O	203,675	07-10-97	4:58p	RBP5L13.O
RBP5M13		10,195	07-10-97	4:58p	RBP5M13
RBP5M13	O	201,909	07-10-97	4:58p	RBP5M13.O
RBP1M13		10,196	07-10-97	4:58p	RBP1M13
RBP1M13	O	202,206	07-10-97	4:58p	RBP1M13.O
RBP2H13		10,198	07-10-97	4:58p	RBP2H13
RBP2H13	O	202,225	07-10-97	4:58p	RBP2H13.O
RBP2L13		10,263	07-10-97	4:58p	RBP2L13
RBP2L13	O	203,543	07-10-97	4:58p	RBP2L13.O
RBP2M13		10,195	07-10-97	4:58p	RBP2M13
RBP2M13	O	202,071	07-10-97	4:58p	RBP2M13.O
RBP5H13		10,198	07-10-97	4:58p	RBP5H13
RBP5H13	O	202,176	07-10-97	4:58p	RBP5H13.O
RB5M13		10,193	07-10-97	4:58p	RB5M13
RB5M13	O	202,002	07-10-97	4:58p	RB5M13.O
RBCH13		10,257	07-10-97	4:58p	RBCH13
RBCH13	O	202,217	07-10-97	4:58p	RBCH13.O
RBCL13		10,322	07-10-97	4:58p	RBCL13
RBCL13	O	203,584	07-10-97	4:58p	RBCL13.O
RBCM13		10,254	07-10-97	4:58p	RBCM13
RBCM13	O	201,996	07-10-97	4:58p	RBCM13.O
RBP1H13		10,199	07-10-97	4:58p	RBP1H13
RBP1H13	O	202,059	07-10-97	4:58p	RBP1H13.O
RBP1L13		10,264	07-10-97	4:58p	RBP1L13
RBP1L13	O	203,617	07-10-97	4:58p	RBP1L13.O
RB1M13		10,193	07-10-97	4:58p	RB1M13
RB1M13	O	202,203	07-10-97	4:58p	RB1M13.O
RB2H13		10,196	07-10-97	4:58p	RB2H13
RB2H13	O	201,596	07-10-97	4:58p	RB2H13.O
RB2L13		10,261	07-10-97	4:58p	RB2L13
RB2L13	O	202,712	07-10-97	4:58p	RB2L13.O
RBP5L13		10,263	07-10-97	4:58p	RBP5L13
RB2M13	O	202,087	07-10-97	4:58p	RB2M13.O
RB5H13		10,196	07-10-97	4:58p	RB5H13
RB5H13	O	201,986	07-10-97	4:58p	RB5H13.O
RB5L13		10,261	07-10-97	4:58p	RB5L13
RB5L13	O	203,072	07-10-97	4:58p	RB5L13.O
RB10H13		10,198	07-10-97	4:58p	RB10H13
RB10H13	O	202,149	07-10-97	4:58p	RB10H13.O
RB10L13		10,263	07-10-97	4:58p	RB10L13
RB10M13		10,195	07-10-97	4:58p	RB10M13
RB10M13	O	202,149	07-10-97	4:58p	RB10M13.O
RB1H13		10,196	07-10-97	4:58p	RB1H13
RB1H13	O	201,935	07-10-97	4:58p	RB1H13.O
RB1L13		10,261	07-10-97	4:58p	RB1L13
RB1L13	O	203,419	07-10-97	4:58p	RB1L13.O
RB10L13	O	203,129	08-05-97	1:40p	RB10L13.O

..\MCNPcases\Sect7-4\Tab74-8

U33H13G		9,218	08-05-97	9:53a	u33h13g

```
U33H13G  O      173,619  08-05-97   9:53a u33h13g.o
U3H3G05           9,242  08-05-97   9:53a u3h3g05
U3H3G05  O      173,793  08-05-97   9:53a u3h3g05.o
U3H3G11           9,275  08-05-97   9:53a u3h3g11
U3H3G11  O      173,647  08-05-97   9:53a u3h3g11.o
U3H3G15           9,246  08-05-97   9:53a u3h3g15
U3H3G15  O      173,764  08-05-97   9:53a u3h3g15.o
U3H3G22           9,250  08-05-97   9:53a u3h3g22
U3H3G22  O      173,764  08-05-97   9:53a u3h3g22.o
```

..\MCNPcases\Sect7-4\Tab74-9\h13

```
R33H13G          10,431  08-05-97   9:51a r33h13g
R33H13G  O      204,377  08-05-97   9:51a r33h13g.o
R36H13G          10,431  08-05-97   9:51a r36h13g
R36H13G  O      201,477  08-05-97   9:51a r36h13g.o
R38H13G          10,431  08-05-97   9:51a r38h13g
R38H13G  O      201,330  08-05-97   9:51a r38h13g.o
R41H13G          10,431  08-05-97   9:51a r41h13g
R41H13G  O      201,329  08-05-97   9:51a r41h13g.o
R43H13G          10,431  08-05-97   9:51a r43h13g
R43H13G  O      202,808  08-05-97   9:51a r43h13g.o
R46H13G          10,431  08-05-97   9:51a r46h13g
R46H13G  O      202,726  08-05-97   9:51a r46h13g.o
R48H13G          10,429  08-05-97   9:51a r48h13g
R48H13G  O      202,612  08-05-97   9:51a r48h13g.o
R51H13G          10,430  08-05-97   9:51a r51h13g
R51H13G  O      201,156  08-05-97   9:51a r51h13g.o
R53H13G          10,430  08-05-97   9:51a r53h13g
R53H13G  O      201,329  08-05-97   9:51a r53h13g.o
R56H13G          10,430  08-05-97   9:51a r56h13g
R56H13G  O      204,700  08-05-97   9:51a r56h13g.o
R58H13G          10,385  08-05-97   9:51a r58h13g
R58H13G  O      199,854  08-05-97   9:51a r58h13g.o
U33H13G           9,343  08-05-97   9:51a u33h13g
U33H13G  O      175,804  08-05-97   9:51a u33h13g.o
```

..\MCNPcases\Sect7-4\Tab74-9\m13

```
R33M13F          10,435  08-05-97   9:51a r33m13f
R33M13F  O      204,282  08-05-97   9:51a r33m13f.o
R36M13F          10,435  08-05-97   9:51a r36m13f
R36M13F  O      201,349  08-05-97   9:51a r36m13f.o
R38M13F          10,435  08-05-97   9:51a r38m13f
R38M13F  O      201,152  08-05-97   9:51a r38m13f.o
R41M13F          10,435  08-05-97   9:51a r41m13f
R41M13F  O      201,288  08-05-97   9:51a r41m13f.o
R43M13F          10,435  08-05-97   9:51a r43m13f
R43M13F  O      200,829  08-05-97   9:51a r43m13f.o
R46M13F          10,435  08-05-97   9:51a r46m13f
R46M13F  O      203,682  08-05-97   9:51a r46m13f.o
R48M13F          10,433  08-05-97   9:51a r48m13f
R48M13F  O      201,392  08-05-97   9:51a r48m13f.o
R51M13F          10,434  08-05-97   9:51a r51m13f
R51M13F  O      203,020  08-05-97   9:51a r51m13f.o
R53M13F          10,434  08-05-97   9:51a r53m13f
R53M13F  O      203,083  08-05-97   9:51a r53m13f.o
R56M13F          10,434  08-05-97   9:51a r56m13f
R56M13F  O      201,476  08-05-97   9:51a r56m13f.o
R58M13F          10,389  08-05-97   9:51a r58m13f
R58M13F  O      201,394  08-05-97   9:51a r58m13f.o
U33M13F           9,329  08-05-97   9:51a u33m13f
U33M13F  O      175,684  08-05-97   9:51a u33m13f.o
```

..\MCNPcases\Sect7-5

```
UP0A0             9,271  08-05-97  11:01a up0a0
UP0A0    O      173,804  08-05-97  11:01a up0a0.O
UP0A50            9,527  08-05-97  11:01a up0a50
UP0A50   O      173,874  08-05-97  11:01a up0a50.O
UP0AC             9,527  08-05-97  11:01a up0aC
UP0AC    O      174,145  08-05-97  11:01a up0aC.O
UP73A0            9,221  08-05-97  11:01a up73a0
UP73A0   O      173,348  08-05-97  11:01a up73a0.O
UP73AC            9,213  08-05-97  11:01a up73aC
UP73AC   O      173,318  08-05-97  11:01a up73aC.O
UPV0A0            9,273  08-05-97  11:01a upv0a0
UPV0A0   O      173,416  08-05-97  11:01a upv0a0.O
UPV73A0           9,225  08-05-97  11:01a upv73a0
UPV73A0  O      173,438  08-05-97  11:01a upv73a0.O
UPILE    O      168,054  08-06-97   8:50a upile.O
UPILE             8,314  08-06-97   8:50a upile
```

..\MCNPcases\Sect7-7\Tab771-1\r58cr

```
.                 <DIR>        08-05-97   9:43a .
..                <DIR>        08-05-97   9:43a ..
R58CR19H              10,332   08-05-97   9:43a r58cr19h
R58CR19H O           198,425   08-05-97   9:43a r58cr19h.o
R58CR1H               10,298   08-05-97   9:43a r58cr1h
R58CR1H  O           198,397   08-05-97   9:43a r58cr1h.o

..\MCNPcases\Sect7-7\Tab771-1\r58h13
R58H132C              10,295   08-05-97   9:43a r58h132c
R58H132C O           196,721   08-05-97   9:43a r58h132c.o
R58H133C              10,296   08-05-97   9:43a r58h133c
R58H133C O           197,046   08-05-97   9:43a r58h133c.o
R58H1342              10,296   08-05-97   9:43a r58h1342
R58H1342 O           197,046   08-05-97   9:43a r58h1342.o
R58H1343              10,296   08-05-97   9:43a r58h1343
R58H1343 O           198,582   08-05-97   9:43a r58h1343.o
R58H1345              10,286   08-05-97   9:43a r58h1345
R58H1345 O           198,559   08-05-97   9:43a r58h1345.o
R58H135C              10,285   08-05-97   9:43a r58h135c
R58H135C O           198,386   08-05-97   9:43a r58h135c.o
U39H13F                9,313   08-05-97   9:43a u39h13f
U39H13F  O           176,143   08-05-97   9:43a u39h13f.o
U43H13F                9,315   08-05-97   9:43a u43h13f
U43H13F  O           176,404   08-05-97   9:43a u43h13f.o
U45H13F                9,317   08-05-97   9:43a u45h13f
U45H13F  O           173,616   08-05-97   9:43a u45h13f.o
U45H13G                9,333   08-05-97   9:43a u45h13g
U45H13G  O           177,407   08-05-97   9:43a u45h13g.o

..\MCNPcases\Sect7-7\Tab771-1\r58l13
R58L130C              10,357   08-05-97   9:43a r58l130c
R58L130C O           201,391   08-05-97   9:43a r58l130c.o
R58L1310              10,358   08-05-97   9:43a r58l1310
R58L1310 O           198,405   08-05-97   9:43a r58l1310.o
R58L131C              10,358   08-05-97   9:43a r58l131c
R58L131C O           201,546   08-05-97   9:43a r58l131c.o
R58L133C              10,358   08-05-97   9:43a r58l133c
R58L133C O           199,731   08-05-97   9:43a r58l133c.o
R58L1370              10,358   08-05-97   9:43a r58l1370
R58L1370 O           198,356   08-05-97   9:43a r58l1370.o
R58L138               10,358   08-05-97   9:43a r58l138
R58L138  O           198,070   08-05-97   9:43a r58l138.o
R58L13D               10,195   08-05-97   9:43a r58l13d

..\MCNPcases\Sect7-7\Tab771-1\r58m13
R58M131C              10,292   08-05-97   9:43a r58m131c
R58M131C O           198,806   08-05-97   9:43a r58m131c.o
R58M132C              10,292   08-05-97   9:43a r58m132c
R58M132C O           198,463   08-05-97   9:43a r58m132c.o
R58M134               10,280   08-05-97   9:43a r58m134
R58M134  O           196,753   08-05-97   9:43a r58m134.o
R58M1341              10,292   08-05-97   9:43a r58m1341
R58M1341 O           196,977   08-05-97   9:43a r58m1341.o
R58M1342              10,292   08-05-97   9:43a r58m1342
R58M1343              10,292   08-05-97   9:43a r58m1343
R58M1343 O           196,933   08-05-97   9:43a r58m1343.o
R58M13C               10,280   08-05-97   9:43a r58m13c
R58M13C  O           198,845   08-05-97   9:43a r58m13c.o
R58M13G               10,292   08-05-97   9:43a r58m13g
U33M13G                9,211   08-05-97   9:43a u33m13g
U33M13G  O           174,992   08-05-97   9:43a u33m13g.o
U38M13G                9,345   08-05-97   9:43a u38m13g
U38M13G  O           175,372   08-05-97   9:43a u38m13g.o
U40M13G                9,212   08-05-97   9:43a u40m13g
U42M13G                9,350   08-05-97   9:43a u42m13g
U42M13G  O           173,712   08-05-97   9:43a u42m13g.o
U44M13G                9,350   08-05-97   9:43a u44m13g
U44M13G  O           175,428   08-05-97   9:43a u44m13g.o

..\MCNPcases\Sect7-7\Tab772-2
R58LC1B  O           198,280   08-05-97  10:54a R58LC1B.O
R58LC1C               10,193   08-05-97  10:54a R58LC1C
R58LC1C  O           197,696   08-05-97  10:54a R58LC1C.O
R58LC1D               10,196   08-05-97  10:54a R58LC1D
R58LC1D  O           197,843   08-05-97  10:54a R58LC1D.O
R58LC1E               10,132   08-05-97  10:54a R58LC1E
R58LC1E  O           196,179   08-05-97  10:54a R58LC1E.O
R58LC1F               10,124   08-05-97  10:54a R58LC1F
R58LC1F  O           196,295   08-05-97  10:54a R58LC1F.O
R58LC1G               10,132   08-05-97  10:54a R58LC1G
R58LC1G  O           196,331   08-05-97  10:54a R58LC1G.O
```

R58LC2B		10,226	08-05-97	10:54a	R58LC2B
R58LC2B	O	198,461	08-05-97	10:54a	R58LC2B.O
R58LC2C		10,196	08-05-97	10:54a	R58LC2C
R58LC2C	O	197,617	08-05-97	10:54a	R58LC2C.O
R58LC2D		10,196	08-05-97	10:54a	R58LC2D
R58LC2D	O	197,666	08-05-97	10:54a	R58LC2D.O
R58LC2E		10,131	08-05-97	10:54a	R58LC2E
R58LC2E	O	196,326	08-05-97	10:54a	R58LC2E.O
R58LC2F		10,132	08-05-97	10:54a	R58LC2F
R58LC2F	O	196,179	08-05-97	10:54a	R58LC2F.O
R58LC2G		10,129	08-05-97	10:54a	R58LC2G
R58LC2G	O	196,500	08-05-97	10:54a	R58LC2G.O
R58LC3B		10,228	08-05-97	10:54a	R58LC3B
R58LC3B	O	198,314	08-05-97	10:54a	R58LC3B.O
R58LC3C		10,194	08-05-97	10:54a	R58LC3C
R58LC3C	O	197,813	08-05-97	10:54a	R58LC3C.O
R58LC3D		10,194	08-05-97	10:54a	R58LC3D
R58LC3D	O	197,689	08-05-97	10:54a	R58LC3D.O
R58LC3E		10,124	08-05-97	10:54a	R58LC3E
R58LC3E	O	196,454	08-05-97	10:54a	R58LC3E.O
R58LC3F		10,132	08-05-97	10:54a	R58LC3F
R58LC3F	O	196,236	08-05-97	10:54a	R58LC3F.O
R58LC3G		10,131	08-05-97	10:54a	R58LC3G
R58LC3G	O	196,356	08-05-97	10:54a	R58LC3G.O
R58LC4B		10,223	08-05-97	10:54a	R58LC4B
R58LC4B	O	198,416	08-05-97	10:54a	R58LC4B.O
R58LC4C		10,195	08-05-97	10:54a	R58LC4C
R58LC4C	O	197,845	08-05-97	10:54a	R58LC4C.O
R58LC4D		10,197	08-05-97	10:54a	R58LC4D
R58LC4D	O	197,546	08-05-97	10:54a	R58LC4D.O
R58LC4E		10,132	08-05-97	10:54a	R58LC4E
R58LC4E	O	196,353	08-05-97	10:54a	R58LC4E.O
R58LC4F		10,132	08-05-97	10:54a	R58LC4F
R58LC4F	O	196,493	08-05-97	10:54a	R58LC4F.O
R58LC4G		10,133	08-05-97	10:54a	R58LC4G
R58LC4G	O	196,326	08-05-97	10:54a	R58LC4G.O
R58LD1B		10,224	08-05-97	10:54a	R58LD1B
R58LD1B	O	198,404	08-05-97	10:54a	R58LD1B.O
R58LD1C		10,191	08-05-97	10:54a	R58LD1C
R58LD1C	O	197,889	08-05-97	10:54a	R58LD1C.O
R58LD1D		10,189	08-05-97	10:54a	R58LD1D
R58LD1D	O	197,843	08-05-97	10:54a	R58LD1D.O
R58LD1E		10,127	08-05-97	10:54a	R58LD1E
R58LD1E	O	196,172	08-05-97	10:54a	R58LD1E.O
R58LD1F		10,127	08-05-97	10:54a	R58LD1F
R58LD1F	O	196,632	08-05-97	10:54a	R58LD1F.O
R58LD1G		10,118	08-05-97	10:54a	R58LD1G
R58LD1G	O	196,591	08-05-97	10:54a	R58LD1G.O
R58LD2B		10,225	08-05-97	10:54a	R58LD2B
R58LD2B	O	198,269	08-05-97	10:54a	R58LD2B.O
R58LD2C		10,195	08-05-97	10:54a	R58LD2C
R58LD2C	O	197,549	08-05-97	10:54a	R58LD2C.O
R58LD2D		10,195	08-05-97	10:54a	R58LD2D
R58LD2D	O	197,677	08-05-97	10:54a	R58LD2D.O
R58LD2E		10,130	08-05-97	10:55a	R58LD2E
R58LD2E	O	196,326	08-05-97	10:55a	R58LD2E.O
R58LD2F		10,131	08-05-97	10:55a	R58LD2F
R58LD2F	O	196,605	08-05-97	10:55a	R58LD2F.O
R58LD2G		10,129	08-05-97	10:55a	R58LD2G
R58LD2G	O	196,522	08-05-97	10:55a	R58LD2G.O
R58LD3B		10,229	08-05-97	10:55a	R58LD3B
R58LD3B	O	198,299	08-05-97	10:55a	R58LD3B.O
R58LD3C		10,195	08-05-97	10:55a	R58LD3C
R58LD3C	O	197,708	08-05-97	10:55a	R58LD3C.O
R58LD3D		10,196	08-05-97	10:55a	R58LD3D
R58LD3D	O	197,576	08-05-97	10:55a	R58LD3D.O
R58LD3E		10,134	08-05-97	10:55a	R58LD3E
R58LD3E	O	196,040	08-05-97	10:55a	R58LD3E.O
R58LD3F		10,133	08-05-97	10:55a	R58LD3F
R58LD3F	O	196,236	08-05-97	10:55a	R58LD3F.O
R58LD3G		10,133	08-05-97	10:55a	R58LD3G
R58LD3G	O	196,493	08-05-97	10:55a	R58LD3G.O
R58LA1B		10,227	08-05-97	1:06p	R58LA1B
R58LA1B	O	198,532	08-05-97	1:06p	R58LA1B.O
R58LA1C		10,196	08-05-97	1:06p	R58LA1C
R58LA1C	O	197,794	08-05-97	1:06p	R58LA1C.O
R58LA1D		10,187	08-05-97	1:06p	R58LA1D
R58LA1D	O	198,061	08-05-97	1:06p	R58LA1D.O
R58LA1E		10,133	08-05-97	1:06p	R58LA1E
R58LA1E	O	196,206	08-05-97	1:06p	R58LA1E.O
R58LA1F		10,133	08-05-97	1:06p	R58LA1F

R58LA1F	O	197,813	08-05-97	1:44p	R58LA1F.O
R58LA1G		10,132	08-05-97	1:06p	R58LA1G
R58LA1G	O	196,574	08-05-97	1:06p	R58LA1G.O
R58LA2B		10,225	08-05-97	1:06p	R58LA2B
R58LA2B	O	198,461	08-05-97	1:06p	R58LA2B.O
R58LA2C		10,195	08-05-97	1:06p	R58LA2C
R58LA2C	O	197,911	08-05-97	1:06p	R58LA2C.O
R58LA2D		10,182	08-05-97	1:06p	R58LA2D
R58LA2D	O	197,659	08-05-97	1:06p	R58LA2D.O
R58LA2E		10,127	08-05-97	1:06p	R58LA2E
R58LA2E	O	196,473	08-05-97	1:06p	R58LA2E.O
R58LA2F		10,129	08-05-97	1:06p	R58LA2F
R58LA2F	O	196,353	08-05-97	1:06p	R58LA2F.O
R58LA2G		10,130	08-05-97	1:06p	R58LA2G
R58LA2G	O	196,300	08-05-97	1:06p	R58LA2G.O
R58LA3B		10,228	08-05-97	1:06p	R58LA3B
R58LA3B	O	198,137	08-05-97	1:06p	R58LA3B.O
R58LA3C		10,195	08-05-97	1:06p	R58LA3C
R58LA3C	O	197,742	08-05-97	1:06p	R58LA3C.O
R58LA3D		10,196	08-05-97	1:06p	R58LA3D
R58LA3D	O	197,862	08-05-97	1:06p	R58LA3D.O
R58LA3E		10,133	08-05-97	1:06p	R58LA3E
R58LA3E	O	196,307	08-05-97	1:06p	R58LA3E.O
R58LA3F		10,132	08-05-97	1:06p	R58LA3F
R58LA3F	O	196,485	08-05-97	1:06p	R58LA3F.O
R58LA3G		10,131	08-05-97	1:06p	R58LA3G
R58LA3G	O	196,206	08-05-97	1:06p	R58LA3G.O
R58LA4B		10,224	08-05-97	1:06p	R58LA4B
R58LA4B	O	198,576	08-05-97	1:06p	R58LA4B.O
R58LA4C		10,192	08-05-97	1:06p	R58LA4C
R58LA4C	O	197,678	08-05-97	1:06p	R58LA4C.O
R58LA4D		10,190	08-05-97	1:06p	R58LA4D
R58LA4D	O	197,666	08-05-97	1:06p	R58LA4D.O
R58LA4E		10,130	08-05-97	1:06p	R58LA4E
R58LA4E	O	196,500	08-05-97	1:06p	R58LA4E.O
R58LA4F		10,130	08-05-97	1:06p	R58LA4F
R58LA4F	O	196,206	08-05-97	1:06p	R58LA4F.O
R58LA4G		10,129	08-05-97	1:06p	R58LA4G
R58LA4G	O	196,451	08-05-97	1:06p	R58LA4G.O
R58LB1B		10,228	08-05-97	1:06p	R58LB1B
R58LB1B	O	198,728	08-05-97	1:06p	R58LB1B.O
R58LB1C		10,196	08-05-97	1:06p	R58LB1C
R58LB1C	O	197,870	08-05-97	1:06p	R58LB1C.O
R58LB1D		10,195	08-05-97	1:06p	R58LB1D
R58LB1D	O	198,193	08-05-97	1:06p	R58LB1D.O
R58LB1E		10,132	08-05-97	1:06p	R58LB1E
R58LB1E	O	196,836	08-05-97	1:06p	R58LB1E.O
R58LB1F		10,129	08-05-97	1:06p	R58LB1F
R58LB1F	O	196,604	08-05-97	1:06p	R58LB1F.O
R58LB1G		10,133	08-05-97	1:06p	R58LB1G
R58LB1G	O	196,748	08-05-97	1:06p	R58LB1G.O
R58LB2B		10,225	08-05-97	1:06p	R58LB2B
R58LB2B	O	198,627	08-05-97	1:06p	R58LB2B.O
R58LB2C		10,192	08-05-97	1:06p	R58LB2C
R58LB2C	O	197,546	08-05-97	1:06p	R58LB2C.O
R58LB2D		10,192	08-05-97	1:06p	R58LB2D
R58LB2D	O	197,941	08-05-97	1:06p	R58LB2D.O
R58LB2E		10,126	08-05-97	1:06p	R58LB2E
R58LB2E	O	196,711	08-05-97	1:06p	R58LB2E.O
R58LB2F		10,130	08-05-97	1:06p	R58LB2F
R58LB2F	O	196,485	08-05-97	1:06p	R58LB2F.O
R58LB2G		10,130	08-05-97	1:06p	R58LB2G
R58LB2G	O	196,473	08-05-97	1:06p	R58LB2G.O
R58LB3B		10,226	08-05-97	1:06p	R58LB3B
R58LB3B	O	198,397	08-05-97	1:06p	R58LB3B.O
R58LB3C		10,195	08-05-97	1:06p	R58LB3C
R58LB3C	O	197,965	08-05-97	1:06p	R58LB3C.O
R58LB3D		10,197	08-05-97	1:06p	R58LB3D
R58LB3D	O	197,696	08-05-97	1:06p	R58LB3D.O
R58LB3E		10,131	08-05-97	1:07p	R58LB3E
R58LB3E	O	196,515	08-05-97	1:07p	R58LB3E.O
R58LB3F		10,132	08-05-97	1:07p	R58LB3F
R58LB3F	O	196,503	08-05-97	1:07p	R58LB3F.O
R58LB3G		10,132	08-05-97	1:07p	R58LB3G
R58LB3G	O	196,684	08-05-97	1:07p	R58LB3G.O
R58LB4B		10,225	08-05-97	1:07p	R58LB4B
R58LB4B	O	198,232	08-05-97	1:07p	R58LB4B.O
R58LB4C		10,194	08-05-97	1:07p	R58LB4C
R58LB4C	O	197,546	08-05-97	1:07p	R58LB4C.O
R58LB4D		10,193	08-05-97	1:07p	R58LB4D
R58LB4D	O	197,843	08-05-97	1:07p	R58LB4D.O

```
R58LB4E            10,122  08-05-97   1:07p R58LB4E
R58LB4E   O       196,500  08-05-97   1:07p R58LB4E.O
R58LB4F            10,128  08-05-97   1:07p R58LB4F
R58LB4F   O       196,353  08-05-97   1:07p R58LB4F.O
R58LB4G            10,119  08-05-97   1:07p R58LB4G
R58LB4G   O       196,503  08-05-97   1:07p R58LB4G.O

..\MCNPcases\Sect7-7\Tab772-5
C58M10B            10,373  07-15-97  10:26a C58M10B
C58H08B            10,375  07-15-97  10:26a C58H08B
C58H08C            10,345  07-15-97  10:26a C58H08C
C58H08D            10,343  07-15-97  10:26a C58H08D
C58H08E            10,280  07-15-97  10:26a C58H08E
C58H08F            10,281  07-15-97  10:26a C58H08F
C58H08G            10,281  07-15-97  10:26a C58H08G
C58H08H            10,282  07-15-97  10:26a C58H08H
C58H08I            10,282  07-15-97  10:26a C58H08I
C58H10A            10,372  08-05-97   1:24p C58H10A
C58H10B            10,375  08-05-97   1:24p C58H10B
C58H10C            10,343  08-05-97   1:24p C58H10C
C58H10D            10,342  08-05-97   1:24p C58H10D
C58H10E            10,276  08-05-97   1:24p C58H10E
C58H10F            10,277  08-05-97   1:24p C58H10F
C58H10G            10,279  08-05-97   1:24p C58H10G
C58H10H            10,279  08-05-97   1:24p C58H10H
C58H10I            10,281  08-05-97   1:24p C58H10I
C58H13A            10,373  07-15-97  10:29a C58H13A
C58H13B            10,374  07-15-97  10:29a C58H13B
C58H13C            10,343  07-15-97  10:29a C58H13C
C58H13D            10,342  07-15-97  10:29a C58H13D
C58H13E            10,279  07-15-97  10:29a C58H13E
C58H13F            10,279  07-15-97  10:29a C58H13F
C58H13G            10,278  07-15-97  10:29a C58H13G
C58H13H            10,279  07-15-97  10:29a C58H13H
C58H13I            10,277  07-15-97  10:29a C58H13I
C58L13A            10,376  08-05-97   1:24p C58L13A
C58L13B            10,377  08-05-97   1:24p C58L13B
C58L13C            10,343  08-05-97   1:24p C58L13C
C58L13D            10,344  08-05-97   1:24p C58L13D
C58L13E            10,281  08-05-97   1:24p C58L13E
C58L13F            10,280  08-05-97   1:24p C58L13F
C58L13G            10,281  08-05-97   1:24p C58L13G
C58L13H            10,281  08-05-97   1:24p C58L13H
C58L13I            10,281  08-05-97   1:24p C58L13I
C58M08A            10,378  07-15-97  10:26a C58M08A
C58M08B            10,378  07-15-97  10:26a C58M08B
C58M08C            10,346  07-15-97  10:26a C58M08C
C58M08D            10,338  07-15-97  10:26a C58M08D
C58M08E            10,283  07-15-97  10:26a C58M08E
C58M08F            10,282  07-15-97  10:26a C58M08F
C58M08G            10,283  07-15-97  10:26a C58M08G
C58M08H            10,281  07-15-97  10:26a C58M08H
C58M08I            10,274  07-15-97  10:26a C58M08I
C58M10A            10,374  07-15-97  10:26a C58M10A
C58H08A            10,367  07-15-97  10:26a C58H08A
C58M10C            10,344  07-15-97  10:26a C58M10C
C58M10D            10,344  07-15-97  10:26a C58M10D
C58M10E            10,280  07-15-97  10:26a C58M10E
C58M10F            10,276  07-15-97  10:26a C58M10F
C58M10G            10,279  07-15-97  10:26a C58M10G
C58M10H            10,278  07-15-97  10:26a C58M10H
C58M10I            10,279  07-15-97  10:26a C58M10I
C58M13A            10,371  08-05-97   1:24p C58M13A
C58M13B            10,373  08-05-97   1:24p C58M13B
C58M13C            10,338  08-05-97   1:24p C58M13C
C58M13D            10,339  08-05-97   1:24p C58M13D
C58M13E            10,276  08-05-97   1:24p C58M13E
C58M13F            10,277  08-05-97   1:24p C58M13F
C58M13G            10,276  08-05-97   1:24p C58M13G
C58M13H            10,277  08-05-97   1:24p C58M13H
C58M13I            10,278  08-05-97   1:24p C58M13I
C58H08I   O       198,232  07-15-97  10:26a C58H08I.O
C58M13H   O       198,006  08-05-97   1:24p C58M13H.O
C58M13G   O       198,273  08-05-97   1:24p C58M13G.O
C58M13F   O       198,315  08-05-97   1:24p C58M13F.O
C58M13E   O       198,146  08-05-97   1:24p C58M13E.O
C58M13D   O       200,897  08-05-97   1:42p C58M13D.O
C58M13C   O       199,373  08-05-97   1:24p C58M13C.O
C58M13B   O       200,095  08-05-97   1:24p C58M13B.O
C58M13A   O       200,114  08-05-97   1:24p C58M13A.O
C58M10I   O       198,202  07-15-97  10:26a C58M10I.O
```

C58M10H	O	198,180	07-15-97	10:26a	C58M10H.O
C58M10G	O	198,183	07-15-97	10:26a	C58M10G.O
C58M10F	O	198,180	07-15-97	10:26a	C58M10F.O
C58M10E	O	197,950	07-15-97	10:26a	C58M10E.O
C58M10D	O	199,346	07-15-97	10:26a	C58M10D.O
C58M10C	O	199,346	07-15-97	10:26a	C58M10C.O
C58M10B	O	200,069	07-15-97	10:26a	C58M10B.O
C58M10A	O	200,160	07-15-97	10:26a	C58M10A.O
C58M08I	O	198,006	07-15-97	10:26a	C58M08I.O
C58M08H	O	198,153	07-15-97	10:26a	C58M08H.O
C58M08G	O	198,210	07-15-97	10:26a	C58M08G.O
C58M08F	O	198,033	07-15-97	10:26a	C58M08F.O
C58M08E	O	198,180	07-15-97	10:26a	C58M08E.O
C58M08D	O	199,377	07-15-97	10:26a	C58M08D.O
C58M08C	O	199,219	07-15-97	10:26a	C58M08C.O
C58M08B	O	200,111	07-15-97	10:26a	C58M08B.O
C58M08A	O	199,964	07-15-97	10:26a	C58M08A.O
C58L13I	O	198,082	08-05-97	1:24p	C58L13I.O
C58L13H	O	198,006	08-05-97	1:24p	C58L13H.O
C58L13G	O	198,036	08-05-97	1:24p	C58L13G.O
C58L13F	O	199,549	08-05-97	1:42p	C58L13F.O
C58L13E	O	197,859	08-05-97	1:24p	C58L13E.O
C58L13D	O	199,376	08-05-97	1:24p	C58L13D.O
C58L13C	O	199,704	08-05-97	1:24p	C58L13C.O
C58L13B	O	199,964	08-05-97	1:24p	C58L13B.O
C58L13A	O	200,163	08-05-97	1:24p	C58L13A.O
C58H13I	O	198,180	07-15-97	10:29a	C58H13I.O
C58H13H	O	198,168	07-15-97	10:29a	C58H13H.O
C58H13G	O	198,153	07-15-97	10:29a	C58H13G.O
C58H13F	O	198,006	07-15-97	10:29a	C58H13F.O
C58H13E	O	197,859	07-15-97	10:29a	C58H13E.O
C58H13D	O	199,625	07-15-97	10:29a	C58H13D.O
C58H13C	O	199,373	07-15-97	10:29a	C58H13C.O
C58H13B	O	200,084	07-15-97	10:29a	C58H13B.O
C58H13A	O	200,107	07-15-97	10:29a	C58H13A.O
C58H10I	O	198,112	08-05-97	1:24p	C58H10I.O
C58H10H	O	198,342	08-05-97	1:24p	C58H10H.O
C58H10G	O	198,281	08-05-97	1:24p	C58H10G.O
C58H10F	O	198,280	08-05-97	1:24p	C58H10F.O
C58H10E	O	197,886	08-05-97	1:24p	C58H10E.O
C58H10D	O	199,618	08-05-97	1:24p	C58H10D.O
C58H10C	O	199,366	08-05-97	1:24p	C58H10C.O
C58H10B	O	200,111	08-05-97	1:24p	C58H10B.O
C58H10A	O	199,994	08-05-97	1:24p	C58H10A.O
C58M13I	O	198,342	08-05-97	1:24p	C58M13I.O
C58H08H	O	198,056	07-15-97	10:26a	C58H08H.O
C58H08G	O	198,351	07-15-97	10:26a	C58H08G.O
C58H08F	O	198,391	07-15-97	10:26a	C58H08F.O
C58H08E	O	198,259	07-15-97	10:26a	C58H08E.O
C58H08D	O	199,535	07-15-97	10:26a	C58H08D.O
C58H08C	O	199,648	07-15-97	10:26a	C58H08C.O
C58H08B	O	200,239	07-15-97	10:26a	C58H08B.O
C58H08A	O	200,141	07-15-97	10:26a	C58H08A.O

..\MCNPcases\Sect7-7\Tab772-6

C33M10C	9,504	08-05-97	9:46a	C33M10C
C33H08B	9,535	08-05-97	9:46a	C33H08B
C33H08C	9,505	08-05-97	9:46a	C33H08C
C33H08D	9,503	08-05-97	9:46a	C33H08D
C33H08E	9,440	08-05-97	9:46a	C33H08E
C33H08F	9,441	08-05-97	9:46a	C33H08F
C33H08G	9,441	08-05-97	9:46a	C33H08G
C33H08H	9,442	08-05-97	9:46a	C33H08H
C33H08I	9,442	08-05-97	9:46a	C33H08I
C33H10A	9,532	08-05-97	9:46a	C33H10A
C33H10B	9,535	08-05-97	9:46a	C33H10B
C33H10C	9,503	08-05-97	9:46a	C33H10C
C33H10D	9,502	08-05-97	9:46a	C33H10D
C33H10E	9,436	08-05-97	9:46a	C33H10E
C33H10F	9,437	08-05-97	9:46a	C33H10F
C33H10G	9,439	08-05-97	9:46a	C33H10G
C33H10H	9,439	08-05-97	9:46a	C33H10H
C33H10I	9,441	08-05-97	9:46a	C33H10I
C33H13A	9,533	08-05-97	9:46a	C33H13A
C33H13B	9,534	08-05-97	9:46a	C33H13B
C33H13C	9,503	08-05-97	9:46a	C33H13C
C33H13D	9,502	08-05-97	9:46a	C33H13D
C33H13E	9,439	08-05-97	9:46a	C33H13E
C33H13F	9,439	08-05-97	9:46a	C33H13F
C33H13G	9,438	08-05-97	9:46a	C33H13G
C33H13H	9,439	08-05-97	9:46a	C33H13H

```
C33H13I               9,437  08-05-97   9:46a C33H13I
C33L13A               9,536  08-05-97   9:46a C33L13A
C33L13B               9,537  08-05-97   9:46a C33L13B
C33L13C               9,503  08-05-97   9:46a C33L13C
C33L13D               9,504  08-05-97   9:46a C33L13D
C33L13E               9,441  08-05-97   9:46a C33L13E
C33L13F               9,440  08-05-97   9:46a C33L13F
C33L13G               9,441  08-05-97   9:46a C33L13G
C33L13H               9,441  08-05-97   9:46a C33L13H
C33L13I               9,441  08-05-97   9:46a C33L13I
C33M08A               9,538  08-05-97   9:46a C33M08A
C33M08B               9,538  08-05-97   9:46a C33M08B
C33M08C               9,506  08-05-97   9:46a C33M08C
C33M08D               9,502  08-05-97   9:46a C33M08D
C33M08E               9,443  08-05-97   9:46a C33M08E
C33M08F               9,442  08-05-97   9:46a C33M08F
C33M08G               9,443  08-05-97   9:46a C33M08G
C33M08H               9,441  08-05-97   9:46a C33M08H
C33M08I               9,438  08-05-97   9:46a C33M08I
C33M10A               9,534  08-05-97   9:46a C33M10A
C33M10B               9,533  08-05-97   9:46a C33M10B
C33H08A               9,531  08-05-97   9:46a C33H08A
C33M10D               9,504  08-05-97   9:46a C33M10D
C33M10E               9,440  08-05-97   9:46a C33M10E
C33M10F               9,436  08-05-97   9:46a C33M10F
C33M10G               9,439  08-05-97   9:46a C33M10G
C33M10H               9,438  08-05-97   9:46a C33M10H
C33M10I               9,439  08-05-97   9:46a C33M10I
C33M13A               9,531  08-05-97   9:46a C33M13A
C33M13B               9,533  08-05-97   9:46a C33M13B
C33M13C               9,498  08-05-97   9:46a C33M13C
C33M13D               9,499  08-05-97   9:46a C33M13D
C33M13E               9,436  08-05-97   9:46a C33M13E
C33M13F               9,437  08-05-97   9:46a C33M13F
C33M13G               9,436  08-05-97   9:46a C33M13G
C33M13H               9,437  08-05-97   9:46a C33M13H
C33M13I               9,438  08-05-97   9:46a C33M13I
C33H10B  O          179,098  08-05-97   9:46a C33H10B.o
C33M13H  O          176,132  08-05-97   9:46a C33M13H.o
C33M13G  O          174,668  08-05-97   9:46a C33M13G.o
C33M13F  O          175,041  08-05-97   9:46a C33M13F.o
C33M13E  O          176,321  08-05-97   9:46a C33M13E.o
C33M13D  O          177,508  08-05-97   9:46a C33M13D.o
C33M13C  O          177,404  08-05-97   9:46a C33M13C.o
C33M13B  O          176,534  08-05-97   9:46a C33M13B.o
C33M13A  O          176,560  08-05-97   9:46a C33M13A.o
C33M10I  O          176,335  08-05-97   9:46a C33M10I.o
C33M10H  O          176,406  08-05-97   9:46a C33M10H.o
C33M10G  O          175,014  08-05-97   9:46a C33M10G.o
C33M10F  O          176,410  08-05-97   9:46a C33M10F.o
C33M10E  O          175,143  08-05-97   9:46a C33M10E.o
C33M10D  O          178,759  08-05-97   9:46a C33M10D.o
C33M10C  O          178,619  08-05-97   9:46a C33M10C.o
C33M10B  O          178,413  08-05-97   9:46a C33M10B.o
C33M10A  O          176,591  08-05-97   9:46a C33M10A.o
C33M08I  O          175,014  08-05-97   9:46a C33M08I.o
C33M08H  O          174,867  08-05-97   9:46a C33M08H.o
C33M08G  O          176,292  08-05-97   9:46a C33M08G.o
C33M08F  O          175,040  08-05-97   9:46a C33M08F.o
C33M08E  O          176,528  08-05-97   9:46a C33M08E.o
C33M08D  O          177,774  08-05-97   9:46a C33M08D.o
C33M08C  O          177,309  08-05-97   9:46a C33M08C.o
C33M08B  O          176,323  08-05-97   9:46a C33M08B.o
C33M08A  O          176,548  08-05-97   9:46a C33M08A.o
C33L13I  O          176,437  08-05-97   9:46a C33L13I.o
C33L13H  O          176,583  08-05-97   9:46a C33L13H.o
C33L13G  O          174,769  08-05-97   9:46a C33L13G.o
C33L13F  O          175,014  08-05-97   9:46a C33L13F.o
C33L13E  O          176,407  08-05-97   9:46a C33L13E.o
C33L13D  O          177,801  08-05-97   9:46a C33L13D.o
C33L13C  O          177,800  08-05-97   9:46a C33L13C.o
C33L13B  O          176,712  08-05-97   9:46a C33L13B.o
C33L13A  O          176,560  08-05-97   9:46a C33L13A.o
C33H13I  O          174,865  08-05-97   9:46a C33H13I.o
C33H13H  O          174,894  08-05-97   9:46a C33H13H.o
C33H13G  O          177,430  08-05-97   9:46a C33H13G.o
C33H13F  O          176,187  08-05-97   9:46a C33H13F.o
C33H13E  O          176,189  08-05-97   9:46a C33H13E.o
C33H13D  O          177,654  08-05-97   9:46a C33H13D.o
C33H13C  O          177,703  08-05-97   9:46a C33H13C.o
C33H13B  O          176,591  08-05-97   9:46a C33H13B.o
```

```
C33H13A   O       176,706  08-05-97   9:46a C33H13A.o
C33H10I   O       176,295  08-05-97   9:46a C33H10I.o
C33H10H   O       176,159  08-05-97   9:46a C33H10H.o
C33H10G   O       176,188  08-05-97   9:46a C33H10G.o
C33H10F   O       174,863  08-05-97   9:46a C33H10F.o
C33H10E   O       174,894  08-05-97   9:46a C33H10E.o
C33H10D   O       177,654  08-05-97   9:46a C33H10D.o
C33H10C   O       177,743  08-05-97   9:46a C33H10C.o
C33M13I   O       174,969  08-05-97   9:46a C33M13I.o
C33H10A   O       177,827  08-05-97   9:46a C33H10A.o
C33H08I   O       176,162  08-05-97   9:46a C33H08I.o
C33H08H   O       174,893  08-05-97   9:46a C33H08H.o
C33H08G   O       174,996  08-05-97   9:46a C33H08G.o
C33H08F   O       176,257  08-05-97   9:46a C33H08F.o
C33H08E   O       174,998  08-05-97   9:46a C33H08E.o
C33H08D   O       176,323  08-05-97   9:46a C33H08D.o
C33H08C   O       177,552  08-05-97   9:46a C33H08C.o
C33H08B   O       179,248  08-05-97   9:46a C33H08B.o
C33H08A   O       179,249  08-05-97   9:46a C33H08A.o

..\Scale43cases
E325B28    SUM        65,416  07-03-97   9:47a e325b28.sum
E49B48     SUM        65,416  07-03-97   9:46a e49b48.sum
E49B44     SUM        65,416  07-03-97   9:46a e49b44.sum
E49B34     SUM        65,416  07-03-97   9:46a e49b34.sum
E46B39     SUM        65,416  07-03-97   9:46a e46b39.sum
E45B35     SUM        65,416  07-03-97   9:47a e45b35.sum
E3B235     SUM        65,343  07-03-97   9:46a e3b235.sum
E39B27     SUM        65,416  07-03-97   9:46a e39b27.sum
E385B385   SUM        65,416  07-03-97   9:46a e385b385.sum
E35B325    SUM        65,416  07-03-97   9:46a e35b325.sum
EP8B3      SUM        65,343  07-03-97   9:46a ep8b3.sum
E17B9      SUM        65,416  07-03-97   9:46a e17b9.sum
E15B12     SUM        65,416  07-03-97   9:46a e15b12.sum
E499B45    SUM        65,416  07-09-97  10:01a e499b45.sum
E479B45    SUM        65,416  07-09-97  10:01a e479b45.sum
E545B45    SUM        65,416  07-09-97  10:01a e545b45.sum
E457B45    SUM        65,416  07-09-97  10:01a e457b45.sum
E172B10    SUM        65,343  07-09-97  10:01a e172b10.sum
E228B20    SUM        65,343  07-09-97  10:01a e228b20.sum
E219B10    SUM        65,343  07-09-97  10:01a e219b10.sum
E184B10    SUM        65,343  07-09-97  10:01a e184b10.sum
E244B20    SUM        65,343  07-09-97  10:01a e244b20.sum
E309B20    SUM        65,343  07-09-97  10:01a e309b20.sum
E336B30    SUM        65,343  07-09-97  10:01a e336b30.sum
E4B4       SUM        65,343  07-09-97  10:01a e4b4.sum
E47B13     SUM        65,343  07-09-97  10:01a e47b13.sum
E43B3      SUM        65,343  07-09-97  10:01a e43b3.sum
E36B30     SUM        65,343  07-09-97  10:01a e36b30.sum
E314B30    SUM        65,343  07-09-97  10:01a e314b30.sum
E261B20    SUM        65,343  07-09-97  10:01a e261b20.sum
E16B10     SUM        65,343  07-09-97  10:01a e16b10.sum
E545B4~1   OUT    24,875,395  07-09-97  10:02a e545b45.output
E479B4~1   OUT    24,875,107  07-09-97  10:03a e479b45.output
E36B30~1   OUT    24,863,041  07-09-97  10:05a e36b30.output
E457B4~1   OUT    24,874,903  07-09-97  10:03a e457b45.output
E499B4~1   OUT    24,874,894  07-09-97  10:04a e499b45.output
E314B3~1   OUT    24,866,486  07-09-97  10:04a e314b30.output
E336B3~1   OUT    24,865,120  07-09-97  10:04a e336b30.output
E228B2~1   OUT    24,851,825  07-09-97  10:05a e228b20.output
E261B2~1   OUT    24,850,735  07-09-97  10:06a e261b20.output
E244B2~1   OUT    24,850,175  07-09-97  10:06a e244b20.output
E309B2~1   OUT    24,849,014  07-09-97  10:06a e309b20.output
E47B13~1   OUT    24,819,900  07-09-97  10:07a e47b13.output
E16B10~1   OUT    24,816,265  07-09-97  10:07a e16b10.output
E219B1~1   OUT    24,815,349  07-09-97  10:07a e219b10.output
E184B1~1   OUT    24,814,552  07-09-97  10:08a e184b10.output
E172B1~1   OUT    24,813,919  07-09-97  10:08a e172b10.output
E4B4~1     OUT    24,779,202  07-09-97  10:09a e4b4.output
E43B3~1    OUT    24,774,561  07-09-97  10:09a e43b3.output
GETPI                  1,256  07-17-97   6:09p getPI
BATCH43                  714  07-17-97   6:09p batch43
RUN                      120  07-17-97   6:09p run
E49B48~1   OUT    25,125,997  07-17-97   6:49p e49b48.output
E49B44~1   OUT    25,123,888  07-17-97   6:50p e49b44.output
E385B3~1   OUT    25,121,289  07-17-97   6:50p e385b385.output
E46B39~1   OUT    25,121,114  07-17-97   6:51p e46b39.output
E35B32~1   OUT    25,118,238  07-17-97   6:51p e35b325.output
E49B34~1   OUT    25,115,490  07-17-97   6:52p e49b34.output
E325B2~1   OUT    25,111,042  07-17-97   6:52p e325b28.output
E39B27~1   OUT    25,109,973  07-17-97   6:53p e39b27.output
```

```
E3B235~1 OUT     25,105,112  07-17-97   6:53p e3b235.output
E15B12~1 OUT     25,082,891  07-17-97   6:53p e15b12.output
E17B9~1  OUT     25,061,061  07-17-97   6:54p e17b9.output
EP8B3~1  OUT     25,032,232  07-17-97   6:54p ep8b3.output
```

Disk 1

```
A00CR1F  O          265,038  09-03-97 10:59a A00CR1F.O
A00CR2F              15,357  09-03-97 10:59a A00CR2F
A00CR2F  O          265,126  09-03-97 10:59a A00CR2F.O
A08CR1F              18,546  09-03-97 10:59a A08CR1F
A08CR1F  O          318,291  09-03-97 10:59a A08CR1F.O
A08CR2F              18,544  09-03-97 10:59a A08CR2F
A08CR2F  O          318,632  09-03-97 10:59a A08CR2F.O
A00CR1F              15,359  09-03-97 11:00a A00CR1F
```

Disk 2

```
A30CR1F              15,300  09-03-97 11:03a A30CR1F
A30CR1F  O          270,593  09-03-97 11:03a A30CR1F.O
A30CR2F              15,298  09-03-97 11:03a A30CR2F
A30CR2F  O          270,872  09-03-97 11:03a A30CR2F.O
B08CR1D              18,542  09-03-97 11:04a B08CR1D
B08CR1D  O          318,264  09-03-97 11:04a B08CR1D.O
```

```
/*burnrich.c program to tabulate enrichment-burnup statistics for a
* range of kinf. This requires a calculation of kinf as a function of age,
* burnup, and initial enrichment. In particular, this version prints a table for
* each kinf bin above some limit The values in each kinf table are the number of
* assemblies for the enrichment corresponding to the column and the burnup
* corresponding to the row. In this version the kinf bin width is 0.01;
* the enrichment bin width is 0.1; and the burnup bin width is 1 GWd/MTU.
* Since there is no regression for kinf developed yet for BWR SNF, This evaluation
* methodology is presently applicable to PWR only. */

#include <string.h>
#include <stdlib.h>
#include <stdio.h>
#include <math.h>
#include <malloc.h>
#include <string.h>
#include <ctype.h>
#define KINFS 30      /*number of kinf intervals       */
#define RICHS 70      /*number of enrichment intervals */
#define BURNS 70      /*number of burnup intervals     */

float getfloat();
int getint();
FILE *ferr;
long int numassy=0,/*Counts total assemblies processed (PWR, 1st repository)*/
  richcount[RICHS],/*Counts assemblies in each enrichment bin      */
  burncount[BURNS],/*Counts assemblies in each burnup bin          */
  burnrichcount[BURNS][RICHS],/*Counts assy in each combined burnup-enrichment bin*/
  allcount[BURNS][RICHS][KINFS];/*Assy in each combined burnup-kinf-enrich bin*/

void main()
{int i,j,k=0,ndyr,/*Yr of discharge from reactor; not used*/
  npyr,     /*Yr delivered to the repository; not used*/
  na,       /*number of assy in this batch      */
  nb,       /*index for burnup bin         */
  nk,       /*index for kinf bin       */
  nr;       /*index for enrichment bin     */
float b,    /*burnup for this batch of SNF    */
  w,        /*total MTU in this batch        */
  a,        /*Enrichment for this batch      */
  c,        /*Age since dschg, set to 10 yrs   */
  kinf,/*Neutron multiplication factor for an infinite lattice of this assy type*/
  wtotal=0; /*Total mass of this batch; Not used in this version*/
FILE *fout,  /*Output for this run*/
  *fin;     /*Input: EIA commercial SNF history and forecast;
              processing by WSM for format only*/
char buffer[300],  /*temporary for reading input file */
  type,         /* B or P               */
  rname[30];       /* Name of reactor site (not used this version)*/
if ((fin=fopen("data.in","r"))==NULL)
  {printf("Can't open input file\n");exit(0);}
fout=fopen("burnrich.out","w");
ferr=fopen("junk.out","w"); /*To record anomalous assemblies*/
c=10;                /*arbitrary age for all SNF    */
while(fgets(buffer,300,fin)!=NULL)
  {w=getfloat(buffer,21,10); /*Total MTU in this batch      */
  b=getfloat(buffer,51,10); /*Burnup in MWd/MTU          */
  ndyr=getint(buffer,71,8); /*Year of discharge from reactor (not used)*/
  npyr=getint(buffer,215,4); /*Year of delivery to repository (not used)*/
  type=buffer[123];        /*BWR or PWR (1st character)   */
  na=getint(buffer,31,10); /*number of assemblies this batch */
  a=getfloat(buffer,41,10); /*initial enrichment         */
  strncpy(rname,buffer+1,20); /*reactor name (not used)      */
```

```
 rname[20]='\0';
 if(type=='P')            /*Process PWR only            */
  {wtotal+=w;              /*Increment total MTU processed */
  numassy+=na;              /*Increment number of assemblies processed */
  b/=1000;         /*Burnup reduced to GWd/MTU (for use in regression)*/
   kinf=1.06-.01*b-.002*c+.114*a+.00007081*b*b+.00007565*c*c
       -.007*a*a-.0002671*b*a-.0001145*b*c+.0002318*c*a+
        .000009366*b*c*a; /*Regression from ORNL study */
   if (kinf>=1.00)        /*Tabulate only for 10 yr age kinf>1      */
    {nr=a*10;            /*Group enrichment in 0.1% bins  */
    nb=b;               /*Group burnup in 1 GWd/MTU bins */
    nk=100*(kinf-1.00);/*Group kinf in 0.01 bins, and shift min value to 0.01*/
    if(nk>=KINFS-1)nk=KINFS-1;/*Truncate kinf values at 1.30*/
    if((nr<0)||(nb<0)||(nk<0)) /*no negative bin indices allowed*/
     {fprintf(ferr,"assay=%f burnup=%f kinf=%f\n",a,b,kinf);
     printf("Negative parameter index\n");
     exit(0);}
    else
     {if(nr<10) nr=10; /*floor on enrichment = 1.0  */
     if(nr>50) nr=50;  /*ceiling on enrichment = 5.0 */
     richcount[nr]+=na; /*Increment bin counts, also next 3 statements */
     burncount[nb]+=na;
     burnrichcount[nb][nr]+=na;
     allcount[nb][nr][nk]+=na;}}}}
for(i=0;i<KINFS;i++)      /*One table for each kinf bin */
 {fprintf(fout,"\n\nKinf=%f\n\n",1.00+(float)i/100); /*table header*/
 fprintf(fout,"%3s"," ");/*blank in col header row to leave room for row label*/
 for(k=10;k<=50;k++) fprintf(fout,"%5d",k); /*column labels*/
 fprintf(fout,"\n");    /*start table, after row of column headers */
 for(j=0;j<BURNS;j++)
  {fprintf(fout,"%3d",j); /*label for each row of this table*/
  for(k=10;k<=50;k++)fprintf(fout,"%5ld",allcount[j][k][i]);/*Element values for
                       each column of this row*/
  fprintf(fout,"\n");}}}  /*End row            */

float getfloat(string, start, length) /*Extract floating point from buffer */
char string[300];
int start,length;
{char temp[20];
int i;
for(i=start;i<start+length;i++) temp[i-start]=string[i];
temp[length]='\0';
return(atof(temp));}

int getint(string, start, length)   /*Extract integer from buffer  */
char string[300];
int start,length;
{char temp[20];
int i;
for(i=start;i<start+length;i++) temp[i-start]=string[i];
temp[length]='\0';
return(atoi(temp));}
```

```
50  CLS
    CLEAR
    '
    'AMIGO - This program gets nuclide concentrations in grams
    'from summarized origin-s output for 30 principal isotopes
    'and creates desired MCNP input files using a user created
    'MCNP template file.  The template file must have a FUELTOT
    'in the cell card where the total number density for the fuel
    'region is to be located, and a FUELNUM in the material card
    'where the number densities for the 30 isotopes are to be placed.
    '
    '
    'dimension variables
    DIM iso$(30)          '29 principl isotopes + oxygen
    DIM grams(30, 100)    'gram concentraions of 30 isotopes at 100 different decay times
    DIM numden(30, 100)   'number densities of 30 isotopes at 100 different decay times
    DIM total(100)        'total number density of 30 isotopes at 100 different deay times
    DIM MW(30)            'atomic weights of the 30 isotopes
    DIM time(100)         '100 decay times
    DIM MCNPID$(30)       'MCNP IDs for 30 principal isotopes
    '
    '30 principal isotopes, their atomic weights, and MCNP IDs
    '
    iso$(1) = "  o 16 ": MW(1) = 15.994915#: MCNPID$(1) = "8016.50C"
    iso$(2) = "  mo 95 ": MW(2) = 94.905839#: MCNPID$(2) = "42095.50C"
    iso$(3) = "  ru101 ": MW(3) = 100.905576#: MCNPID$(3) = "44101.50C"
    iso$(4) = "  tc 99 ": MW(4) = 98.9062749#: MCNPID$(4) = "43099.50C"
    iso$(5) = "  rh103 ": MW(5) = 102.905511#: MCNPID$(5) = "45103.50C"
    iso$(6) = "  ag109 ": MW(6) = 108.904756#: MCNPID$(6) = "47109.50C"
    iso$(7) = "  nd143 ": MW(7) = 142.909779#: MCNPID$(7) = "60143.50C"
    iso$(8) = "  nd145 ": MW(8) = 144.912538#: MCNPID$(8) = "60145.50C"
    iso$(9) = "  sm147 ": MW(9) = 146.914867#: MCNPID$(9) = "62147.50C"
    iso$(10) = "  sm149 ": MW(10) = 148.91718#: MCNPID$(10) = "62149.50C"
    iso$(11) = "  sm150 ": MW(11) = 149.917276#: MCNPID$(11) = "62150.50C"
    iso$(12) = "  sm151 ": MW(12) = 150.919919#: MCNPID$(12) = "62151.50C"
    iso$(13) = "  sm152 ": MW(13) = 151.919756#: MCNPID$(13) = "62152.50C"
    iso$(14) = "  eu151 ": MW(14) = 150.919838#: MCNPID$(14) = "63151.55C"
    iso$(15) = "  eu153 ": MW(15) = 152.921242#: MCNPID$(15) = "63153.55C"
    iso$(16) = "  gd155 ": MW(16) = 154.922662#: MCNPID$(16) = "64155.50C"
    iso$(17) = "  u233 ": MW(17) = 233.039522#: MCNPID$(17) = "92233.50C"
    iso$(18) = "  u234 ": MW(18) = 234.040904#: MCNPID$(18) = "92234.50C"
    iso$(19) = "  u235 ": MW(19) = 235.043915#: MCNPID$(19) = "92235.50C"
    iso$(20) = "  u236 ": MW(20) = 236.045637#: MCNPID$(20) = "92236.50C"
    iso$(21) = "  u238 ": MW(21) = 238.05077#: MCNPID$(21) = "92238.50C"
    iso$(22) = "  np237 ": MW(22) = 237.048056#: MCNPID$(22) = "93237.55C"
    iso$(23) = "  pu238 ": MW(23) = 238.049511#: MCNPID$(23) = "94238.50C"
    iso$(24) = "  pu239 ": MW(24) = 239.052146#: MCNPID$(24) = "94239.55C"
    iso$(25) = "  pu240 ": MW(25) = 240.053882#: MCNPID$(25) = "94240.50C"
    iso$(26) = "  pu241 ": MW(26) = 241.056737#: MCNPID$(26) = "94241.50C"
    iso$(27) = "  pu242 ": MW(27) = 242.058725#: MCNPID$(27) = "94242.50C"
    iso$(28) = "  am241 ": MW(28) = 241.056714#: MCNPID$(28) = "95241.50C"
    iso$(29) = "  am242m": MW(29) = 242.059502#: MCNPID$(29) = "95242.50C"
    iso$(30) = "  am243 ": MW(30) = 243.061367#: MCNPID$(30) = "95243.50C"
    '
    ' other variables used
    '
    n = 30                 'total number of principal isotopes
    tcount = 1             'counter for number of times read
    UO2mass = 526380       'mass of UO2 per B&W15x15 fuel assembly
    Na = .602252           'Avagadro's number
    UO2dens = .96 * 10.96  '96% theoretical UO2 density in grams/cm^3
    '
    ' Enter name of input and output files
```

```
'
INPUT "Enter ORIGEN-S output summary file name"; file$
OPEN file$ FOR INPUT ACCESS READ AS #1
'
'locate start of isotope list
'
'Find start of a ORIGEN-S grams table in summary output and get first set of times
'
DO UNTIL LEFT$(start$, 20) = "          charge"
    LINE INPUT #1, start$
LOOP
columns = (LEN(start$) / 10)    'determine number of columns in table
FOR i = 3 TO (columns - 1)      'get times starting at fourth column
    time(tcount) = VAL(MID$(start$, i * 10 + 2, 7))
    IF MID$(start$, i * 10 + 10, 1) = "d" THEN
        time(tcount) = time(tcount) / 365.25    'convert days to years
    END IF
    tcount = tcount + 1
NEXT i
'
'Get isotope grams from first table
'
DO UNTIL LEFT$(Line$, 21) = "          initial"
    LINE INPUT #1, Line$
    FOR i = 1 TO n      ' Check to see if line has isotope that is on the list
        IF iso$(i) = LEFT$(Line$, 11) THEN
            FOR j = 3 TO (columns - 1)     'get grams starting at fourth column
                grams(i, j - 2) = VAL(MID$(Line$, j * 10 + 2, 10))
            NEXT j
        END IF
    NEXT i
LOOP
'
' Load in times and gram concentrations from remaining tables in output
DO UNTIL EOF(1)
    columns = (LEN(Line$) / 10)    'determine number of columns in table
    itcount = tcount
    Newtable$ = LEFT$(Line$, 31)
    FOR i = 2 TO (columns - 1)     'get times starting at third column
        time(tcount) = VAL(MID$(Line$, i * 10 + 2, 7))
        IF MID$(Line$, i * 10 + 10, 1) = "d" THEN
            time(tcount) = time(count) / 365.25    'convert days to years
        END IF
        tcount = tcount + 1
    NEXT i
    DO UNTIL (LEFT$(Line$, 21) = "          initial" AND LEFT$(Line$, 31) <> Newtable$) OR EOF(1)
        LINE INPUT #1, Line$
        FOR i = 1 TO n      ' Check to see if line has isotope that is on the list
            IF iso$(i) = LEFT$(Line$, 11) THEN
                FOR j = 2 TO (columns - 1)     'get grams starting at third column
                    grams(i, itcount + j - 2) = VAL(MID$(Line$, j * 10 + 2, 10))
                NEXT j
            END IF
        NEXT i
    LOOP
LOOP
CLOSE #1
'
'Calculate number densities (in atoms/b-cm) for each isotope at each time
'
PRINT "Enter mass of material in fuel region in grams ["; UO2mass; "]";
INPUT z$
IF z$ <> "" THEN
```

```
        z = VAL(z$)
        IF z <> 0 THEN UO2mass = z
    END IF
    FOR i = 1 TO tcount - 1
        numden(1, i) = .046947   'O-16 has constant number density at all times
        total(i) = numden(1, i)
        FOR j = 2 TO n
            numden(j, i) = (grams(j, i) / UO2mass) * UO2dens * Na / MW(j)
            total(i) = total(i) + numden(j, i)     'add number density to total
        NEXT j
    NEXT i
    PRINT "Number Densities are available for the following times (#'s 1 to "; (tcount - 1); "):"
    PRINT
    FOR i = 1 TO tcount - 1
        PRINT "    "; i; " - "; time(i); "years",
    NEXT i
100 PRINT "Enter time range for MCNP inputs using the format start#,end#"
    INPUT "(enter same # twice for a single time)"; startnum, endnum
    IF (startnum > (tcount - 1)) OR (endnum > (tcount - 1)) OR (startnum < 1) OR (endnum < 1) THEN
        PRINT "Starting or ending number outside of range! Select again."
        GOTO 100
    END IF
    '
    ' Build MCNP input files
    '
150 INPUT "Enter MCNP input template file name"; tempfile$
    INPUT "Enter first 5 characters of MCNP input files to be created"; outfile$
    FOR i = startnum TO endnum
        OPEN tempfile$ FOR INPUT ACCESS READ AS #1
        '
        'Set file name decay time designator
        '
        SELECT CASE i
            CASE 20
                x$ = "a"
            CASE 21
                x$ = "b"
            CASE 23
                x$ = "c"
            CASE 24
                x$ = "d"
            CASE 25
                x$ = "e"
            CASE 26
                x$ = "f"
            CASE 30
                x$ = "g"
            CASE 37
                x$ = "h"
            CASE 39
                x$ = "i"
            CASE 45
                x$ = "j"
            CASE ELSE
                x$ = LTRIM$(STR$(i))
        END SELECT
        z$ = outfile$ + x$
        OPEN z$ FOR OUTPUT ACCESS WRITE AS #2
        DO UNTIL EOF(1)
            LINE INPUT #1, Line$
            IF VAL(LEFT$(Line$, 1)) <> 0 THEN
                outline$ = Line$
                linelen = LEN(Line$)
```

```
                FOR j = 1 TO (linelen - 7)
                    chunk$ = MID$(Line$, j, 7)
                    IF chunk$ = "FUELTOT" THEN
                        PRINT Line$
                        leftline$ = LEFT$(Line$, j - 1)
                        rightline$ = RIGHT$(Line$, (linelen - 7 - j))
                        outline$ = leftline$ + STR$(total(i)) + rightline$
                    END IF
                NEXT j
                PRINT #2, outline$
            ELSEIF LEFT$(Line$, 1) = "M" THEN
                flag = 0
                outline$ = Line$
                linelen = LEN(Line$)
                FOR j = 1 TO (linelen)
                    chunk$ = MID$(Line$, j, 7)
                    IF chunk$ = "FUELNUM" THEN
                        PRINT Line$
                        leftline$ = LEFT$(Line$, j - 1)
                        rightline$ = MID$(Line$, j + 7)
                        outline$ = leftline$ + MCNPID$(1) + "  " + STR$(numden(1, i)) + rightline$
                        flag = 1
                        PRINT #2, "C     "; file$; "  "; time(i); " years decay"
                    END IF
                NEXT j
                PRINT #2, outline$
                IF flag = 1 THEN
                    FOR j = 2 TO n
                        IF numden(j, i) <> 0 THEN
                            PRINT #2, "     "; MCNPID$(j); "  "; numden(j, i)
                        END IF
                    NEXT j
                END IF
            ELSE
                PRINT #2, Line$
            END IF
        LOOP
        CLOSE #1
        CLOSE #2
    NEXT i
    PRINT "MCNP input files created. Process another template file(y/n)?"
    DO
        z$ = INKEY$
    LOOP UNTIL z$ <> ""
    IF z$ = "y" OR z$ = "Y" THEN
        CLS
        GOTO 150
    END IF
    PRINT "Process another ORIGEN-S file(y/n)?"
    DO
        z$ = INKEY$
    LOOP UNTIL z$ <> ""
    IF z$ = "y" OR z$ = "Y" THEN
        CLS
        GOTO 50
    END IF
    END
```

VOL

JM 9/18/97

Volumes of Basket Components from BBA000000-01717-0200-00037 REV00 Att. VI

Carbon Steel Components	Volume	Mass (kg)	Mass Fe (kg)	moles Fe	moles Fe2O3	Mass Fe2O3 (kg)	Complete Oxidation Fe2O3 Volume
Single Carbon Steel Tube	0.02117 m^3	165.8034	163.374	2.925E+03	1.463E+03	233.581	0.045
21 Carbon Steel Tube	0.44457 m^3	3481.872	3430.863	6.143E+04	3.072E+04	4905.206	0.936 m^3
Carbon Steel Guides & Supports	0.259 m^3	2028.488	1998.771	3.579E+04	1.790E+04	2857.701	0.545 m^3
Total CS Component Vol. (21 tubes + guides & supports)	0.70357 m^3	5510.36	5429.633	9.722E+04	4.861E+04	7762.907	1.481 m^3
Extra CS added for criticality control		0	0.000	0.000E+00	0.000E+00	0.000	0.000 m^3
Borated SS plates	0.243 m^3	1882.035	1137.596	2.037E+04	1.018E+04	1626.455	0.310 m^3
Total Basket Volume	0.947 m^3	TOTALS	6567.230	1.176E+05	5.880E+04	9389.361377	1.792 m^3

WP Empty Volume	
21 PWR WP Inner diameter	1.4099 m
21 PWR WP Inner length	4.585 m
Empty 21 PWR WP Int. Volume	7.158 m^3
PWR Fuel Assembly Volume	0.081 m^3
21 PWR Assembly Volume	1.701 m^3
Void Space in full 21 PWR minus basket volume	5.457 m^3
Void Space in full 21 PWR WP w/ intact basket	4.511 m^3

Surface Areas for Basket Components	
B-SS Plates	69.43 m^2
21 CS Tubes	177.83 m^2
CS Guides & Supports	51.80 m^2

Quick conversion from kg of iron to uniform vol%
0.0049998

Densities		Reference
Carbon Steel (A516)	7832 kg/m^3	BBA00000-01717-0200-00002 REV00
SS316B6A	7745 kg/m^3	BBA00000-01717-0200-00002 REV00
Iron Oxide (Fe2O3)	5240 kg/m^3	CRC, 66th edition
Weight Fraction Iron in A516	0.98535	BBA00000-01717-0200-00002 REV00
Weight Fraction Iron in SS316B6A	0.60445	BBA00000-01717-0200-00002 REV00
Atomic Weight of Iron	55.847 g/mole	Chart of Nuclides, 14th Edition
Atomic Weight of Oxygen	15.9994 g/mole	Chart of Nuclides, 14th Edition
Molecular Weight of Iron Oxide (Fe2O3)	159.6922 g/mole	=2*Fe+3*O
Atomic Weight of Boron	10.811 g/mole	Chart of Nuclides, 14th Edition

Amount of Fe2O3 for single assembly		Reference
CS Tube Length	4.575 m	BBA000000-01717-0200-00037 REV00 Att. I
CS Tube OD	0.236 m	BBA000000-01717-0200-00037 REV00 Att. I
Length of 4 B-SS Plates	4.5352 m	BBA000000-01717-0200-00037 REV00 Att. I
Thickness of B-SS Plates	0.007 m	BBA000000-01717-0200-00037 REV00 Att. I
BW 15x15 Assy. Length	4.207 m	BBA000000-01717-0200-00012 REV01
BW 15x15 Assy. Envelope	0.217 m	BBA000000-01717-0200-00012 REV01
Volume Occupied by Assy. Env.	0.216 m^3	
Void Space Available	0.135 m^3	
Mass Fe2O3 from one CS Tube	214.786 kg	
Mass Fe2O3 from B-SS for 1 assy.	71.843 kg	Assy. Vol%
Theoretical Fe2O3 Volume	0.0547 m^3	40.63%
Theoretical Fe2O3 Vol - Tube only	0.0410 m^3	30.45%
Theoretical Fe2O3 Vol - SS only	0.0137 m^3	10.18%
65% Packed Fe2O3 Volume	0.0842 m^3	62.51%
58% Packed Fe2O3 Volume	0.0943 m^3	70.06%
58% Packed Fe2O3 Vol - Tube only	0.0707 m^3	52.50%
58% Packed Fe2O3 Vol - SS only	0.0236 m^3	17.56%

% Full 21 PWR WP Void Space Occupied by Fe2O3				
Uniformly Distributed	Settled to Bottom of WP			
Theoretical Density	65% Theoretical	60% Theoretical	58% Theoretical	55% Theoretical
17.15%	26.39%	28.59%	29.58%	31.19%
9.99%	15.37%	16.66%	17.23%	18.17%
27.15%	41.76%	45.24%	46.81%	49.36%
0.00%	0.00%	0.00%	0.00%	0.00%
5.69%	8.75%	9.48%	9.81%	10.34%
32.83%	50.51%	54.72%	56.61%	59.70%
% of 4th row filled	24.26%	48.42%	59.25%	76.98%
% of 5th row filled	0.00%	0.00%	0.00%	0.00%
rods in 4th row covrd	3	7	8	11
rods in 5th row covrd	0	0	0	0

Note that a rod row is conservatively not considered covered unless it is fully covered

no. assys

5.5	1	water
15.5	2.818181818	oxide/water

	Void (m^3)	No. Assys.	% Void
Lower Half	2.526	13	46.29%
Upper Half	2.931	8	53.71%
Total	5.457		
Void Space in Row 5	0.977	3	17.90%
Void Space in Row 4	0.951	5	17.42%
Void Space at top	1.004		18.39%

Cylinder Segment Volume Calculation				Consolidated
Geometry Calculations		top of 4th row up	top of 5th row up	Rods
Cylinder Radius	cm	70.495	70.495	70.495
Cylinder Length	cm	458.5	458.5	458.5
Cylinder Volume	cm^3	7158233.196	7158233.196	7158233.196
Segment Volume	cm^3	2.22345E+06	1.00354E+06	1.70100E+06
Distance from Center	cm	21.3	42.6	29.98356188

Peak Boron Sorption on Fe2O3	2.00E-03	molesB/kg Fe2O3
	3.19E-04	molesB/mole Fe2O3
	1.60E-04	moles B/mole Fe
	3.18E-05	moles B-10/mole Fe
wt% Boron in SS	1.60%	
Mass of Boron in WP	30.11	kg
Moles of Boron in WP	2.79E+03	moles
Moles of Fe in WP	1.18E+05	moles
Peak Moles of B Adsorbed	18.78	moles
Percent of Original B Adsorbed	0.67%	

No. Fuel Rod Rows Covered	% of Assembly Covered
1	6.67%
2	13.33%
3	20.00%
4	26.67%
5	33.33%
6	40.00%
7	46.67%
8	53.33%
9	60.00%
10	66.67%
11	73.33%
12	80.00%
13	86.67%
14	93.33%
15	100.00%

Amount of Iron Removed By Flow		
Solubility of Iron - Oxidizing Acidic J-13 Conditions	2.47E-04	moles/liter
Solubility of Iron - Oxidizing Neutral J-13 Conditions	3.45E-10	moles/liter
Solubility of Iron - Reducing Acidic J-13 Conditions	5.05E-03	moles/liter
Solubility of Iron - Reducing Neutral J-13 Conditions	8.77E-05	moles/liter
Exchange Efficiency	10%	

Long Term Water Flow Assumption		
Fully Mediated (nominal)	0.5	m^3/yr
Steady Focused (1/40 yrs)	20	m^3/yr
Episodic Focused (1/40 yrs)	20	m^3/yr
Averaged over 40 years	1.475	m^3/yr

					Volume% Oxide	
Moles iron removed over time at average flow	10000	20000	50000	100000	100k vol%	2.5x 100k vol%
Oxidizing Acidic J-13 Conditions	364.325	728.65	1821.625	3643.25	1%	3%
Oxidizing Neutral J-13 Conditions	0.000509	0.001018	0.002544	0.005089	0%	0%
Reducing Acidic J-13 Conditions	7448.75	14897.5	37243.75	74487.5	21%	52%
Reducing Neutral J-13 Conditions	129.3575	258.715	646.7875	1293.575	0%	1%

Percent of total iron removed				
Oxidizing Acidic J-13 Conditions	0.31%	0.62%	1.55%	3.10%
Oxidizing Neutral J-13 Conditions	0.00%	0.00%	0.00%	0.00%
Reducing Acidic J-13 Conditions	6.33%	12.67%	31.67%	63.34%
Reducing Neutral J-13 Conditions	0.11%	0.22%	0.55%	1.10%

	A	C	D	E	F	G	H	I	J	K	L
1											
2	Volumes of Basket Components from BBA000000-01										
3											
4										Complete Oxidation	
5	Carbon Steel Components		Volume		Mass (kg)	Mass Fe (kg)	moles Fe	moles Fe2O3	Mass Fe2O3 (kg)	Fe2O3 Volume	
6	Single Carbon Steel Tube		0.02117	m^3	=D6*$E$27	=F6*$E$31	=G6*1000/$E$34	=H6/2	=I6*$E$36/1000	=J6/$E$29	
7	21 Carbon Steel Tube		=21*D6	m^3	=D7*$E$27	=F7*$E$31	=G7*1000/$E$34	=H7/2	=I7*$E$36/1000	=J7/$E$29	m^3
8	Carbon Steel Guides & Supports		0.259	m^3	=D8*$E$27	=F8*$E$31	=G8*1000/$E$34	=H8/2	=I8*$E$36/1000	=J8/$E$29	m^3
9	Total CS Component Vol. (21 tubes + guides & supports)		=D8+21*D6	m^3	=D9*$E$27	=F9*$E$31	=G9*1000/$E$34	=H9/2	=I9*$E$36/1000	=J9/$E$29	m^3
10	Extra CS added for criticality control ----------------				0	=F10*$E$31	=G10*1000/$E$34	=H10/2	=I10*$E$36/1000	=J10/$E$29	m^3
11	Borated SS plates		0.243	m^3	=D11*E28	=F11*E32	=G11*1000/$E$34	=H11/2	=I11*$E$36/1000	=J11/$E$29	m^3
12											
13	Total Basket Volume		=D11+D9	m^3	TOTALS	=G9+G11+G10	=H9+H11+H10	=H13/2	=I13*$E$36/1000	=J13/$E$29	m^3
14											
15	WP Empty Volume						Surface Areas for Bas				
16	21 PWR WP inner diameter		1.4099	m			B-SS Plates		=D11/0.007*2	m^2	
17	21 PWR WP inner length		4.585	m			21 CS Tubes		=D6/0.005*21*2	m^2	Quick cc
18	Empty 21 PWR WP Int. Volume		=PI()*D16^2/4*D17	m^3			CS Guides & Support		=D8/0.01*2	m^2	kg of iro
19											=O13/G
20	PWR Fuel Assembly Volume		0.081	m^3							
21	21 PWR Assembly Volume		=D20*21	m^3							
22	Void Space in full 21 PWR minus basket volume		=D18-D21	m^3							
23	Void Space in full 21 PWR WP w/ intact basket		=D18-D13-D21	m^3							
24											
25											
26	Densities					Reference					
27	Carbon Steel (A516)			7832	kg/m^3	BBA00000-0171					
28	SS316B6A			7745	kg/m^3	BBA00000-0171					
29	Iron Oxide (Fe2O3)			=5240	kg/m^3	CRC, 86th edition					
30											
31	Weight Fraction Iron in A516			0.98535		BBA00000-0171					
32	Weight Fraction Iron in SS316B6A			0.80445		BBA00000-0171					
33											
34	Atomic Weight of Iron			55.847	g/mole	Chart of Nuclides					
35	Atomic Weight of Oxygen			15.9994	g/mole	Chart of Nuclides					
36	Molecular Weight of Iron Oxide (Fe2O3)			=E34*2+E35*3	g/mole	=2*Fe+3*O					
37	Atomic Weight of Boron			10.811	g/mole	Chart of Nuclides					
38											
39	Amount of Fe2O3 for single assembly			Reference							
40	CS Tube Length	4.575	m	BBA000000-01							
41	CS Tube OD	0.2364	m	BBA000000-01							
42	Length of 4 B-SS Plates	=1.1336*4	m	BBA000000-01							
43	Thickness of B-SS Plates	0.007	m	BBA000000-01							
44	BW 15x15 Assy. Length	=165.625*2.54/100	m	BBA000000-01							
45	BW 15x15 Assy. Envelope	0.216814	m	BBA000000-01							
46	Volume Occupied by Assy. Env.	=C45*C41*C44	m^3								
47	Void Space Available	=C46-D20	m^3								
48	Mass Fe2O3 from one CS Tube	=J6*C44/C40	kg								
49	Mass Fe2O3 from B-SS for 1 assy.	=J11/21*C44/C42	kg	Assy. Vol%							
50	Theoretical Fe2O3 Volume	=(C48+C49)/E29	m^3	=C50/$C$47							
51	Theoretical Fe2O3 Vol - Tube only	=(C48)/E29	m^3	=C51/$C$47							
52	Theoretical Fe2O3 Vol - SS only	=C49/E29	m^3	=C52/$C$47							
53	65% Packed Fe2O3 Volume	=(C48+C49)/(E29*0.65)	m^3	=C53/$C$47							
54	58% Packed Fe2O3 Volume	=(C48+C49)/(E29*0.58)	m^3	=C54/$C$47							
55	58% Packed Fe2O3 Vol - Tube only	=C48/(E29*0.58)	m^3	=C55/$C$47							
56	58% Packed Fe2O3 Vol - SS only	=C49/(E29*0.58)	m^3	=C56/$C$47							
57											
58											
59											

	O	P	Q	R	S	T
1						
2						
3		% Full 21 PWR WP Void Space Occupied by Fe2O3				
4	Uniformly Distributed		Settled to Bottom of WP			
5	Theoretical Density	65% Theoretical	60% Theoretical	58% Theoretical	55% Theoretical	
6						
7	=K7/$D$22	=O7/0.65	=O7/0.6	=O7/0.58	=O7/0.55	
8	=K8/$D$22	=O8/0.65	=O8/0.6	=O8/0.58	=O8/0.55	
9	=K9/$D$22	=O9/0.65	=O9/0.6	=O9/0.58	=O9/0.55	
10	=K10/$D$22	=O10/0.65	=O10/0.6	=O10/0.58	=O10/0.55	
11	=K11/$D$22	=O11/0.65	=O11/0.6	=O11/0.58	=O11/0.55	
12						
13	=K13/$D$22	=O13/0.65	=O13/0.6	=O13/0.58	=O13/0.55	
14	% of 4th row filled	=IF((P13-$R$27)/$R$31>100%,100%,(P13-$R$27)/$R$31)	=IF((Q13-$R$27)/$R$31>100%,100%,(Q13-$R$27)/$R$31)	=IF((R13-$R$27)/$R$31>100%,100%,(R13-$R$27)/$R$31)	=IF((S13-$R$27)/$R$31>100%,10	
15	% of 5th row filled	=IF(P14<100%,0%,(P13-$R$27-$R$31)/$R$30)	=IF(Q14<100%,0%,(Q13-$R$27-$R$31)/$R$30)	=IF(R14<100%,0%,(R13-$R$27-$R$31)/$R$30)	=IF(S14<100%,0%,(S13-$R$27-$R	
16	rods in 4th row covrd	=FLOOR(P14*15,1)	=FLOOR(Q14*15,1)	=FLOOR(R14*15,1)	=FLOOR(S14*15,1)	
17	rods in 5th row covrd	=FLOOR(P15*15,1)	=FLOOR(Q15*15,1)	=FLOOR(R15*15,1)	=FLOOR(S15*15,1)	
18						
19	Note that a rod row is conservatively m					
20						
21	no. assys					
22	=3+0.5*5	=O22/$O$22	water			
23	=O27+0.5*5	=O23/$O$22	oxide/water			
24						
25						
26		Void (m^3)	No. Assys.	% Void		
27	Lower Half	=$D$18/2-13*$D$20	13	=P27/$P$29		
28	Upper Half	=$D$18/2-8*$D$20	8	=P28/$P$29		
29	Total	=SUM(P27:P28)				
30	Void Space in Row 5	=(Q40/1000000-3*D20)-R40/1000000	3	=P30/P29		
31	Void Space in Row 4	=P28-(Q40/1000000-3*D20)	5	=P31/P29		
32	Void Space at top	=R40/1000000		=P32/P29		
33						
34						
35	Cylinder Segment Volume Calculation				Consolidated	
36	Geometry Calculations		top of 4th row up	top of 5th row up	Rods	
37	Cylinder Radius	cm	=$D$16*100/2	=$D$16*100/2	=$D$16*100/2	
38	Cylinder Length	cm	=$D$17*100	=$D$17*100	=$D$17*100	
39	Cylinder Volume	cm^3	=PI()*Q37^2*Q38	=PI()*R37^2*R38	=PI()*S37^2*S38	
40	Segment Volume	cm^3	=Q38*(Q37^2*ACOS(Q41/Q37)-(Q41*SQRT(Q37^2-Q41^2)))	=R38*(R37^2*ACOS(R41/R37)-(R41*SQRT(R37^2-R41^2)))	=S38*(S37^2*ACOS(S41/S37)-(S4	
41	Distance from Center	cm	=42.6/2	=42.6	29.9835618818384	
42						
43						
44						
45	Peak Boron Sorption on Fe2O3		0.002	molesB/kg Fe2O3		
46			=E36*0.001*Q45	molesB/mole Fe2O3		
47			=Q46/2	moles B/mole Fe		
48			=Q47*0.199	moles B-10/mole Fe		
49						
50	wt% Boron in SS		0.016			
51	Mass of Boron in WP		=Q50*F11	kg		
52	Moles of Boron in WP		=Q51*1000/E37	moles		
53	Moles of Fe in WP		=H13	moles		
54	Peak Moles of B Adsorbed		=Q53*Q47	moles		
55	Percent of Original B Adsorbed		=Q54/(Q52)			
56						
57			moles B10/Fe	=Q48*5/(100*Q55)		
58			for 5% Boron			
59			Trapping in oxide			

		V	W	X	Y	Z	AA	AB	AC
1									
2									
3	No. Fuel Rod	% of Assembly							
4	Rows Covered	Covered							
5	1	=U5/$U$19							
6	2	=U6/$U$19							
7	3	=U7/$U$19							
8	4	=U8/$U$19							
9	5	=U9/$U$19							
10	6	=U10/$U$19							
11	7	=U11/$U$19							
12	8	=U12/$U$19							
13	9	=U13/$U$19							
14	10	=U14/$U$19							
15	11	=U15/$U$19							
16	12	=U16/$U$19							
17	13	=U17/$U$19							
18	14	=U18/$U$19							
19	15	=U19/$U$19							
20									
21	Amount of Iron Removed By Fl								
22	Solubility of Iron - Oxidizing Acidic				0.000247	moles/liter			
23	Solubility of Iron - Oxidizing Neutr				0.000000000345	moles/liter			
24	Solubility of Iron - Reducing Acidic				0.00506	moles/liter			
25	Solubility of Iron - Reducing Neutr				0.0000877	moles/liter			
26	Exchange Efficiency				0.1				
27									
28	Long Term Water Flow Assumptio								
29	Fully Mediated (nominal)		0.5	m^3/yr					
30	Steady Focused (1/40 yrs)		20	m^3/yr					
31	Episodic Focused (1/40 yrs)		20	m^3/yr					
32	Averaged over 40 years		=(W29*38+W30*2)/40	m^3/yr					
33								Volume% Oxide	
34	Moles iron removed over time at i			10000	20000	50000	100000	100k vol%	2.5x 100k vol%
35	Oxidizing Acidic J-13 Conditions			=$W$32*1000*X$34*$Y22*$Y$26	=$W$32*1000*Y$34*$Y22*$Y$26	=$W$32*1000*Z$34*$Y22*$Y$26	=$W$32*1000*AA$34*$Y22*$Y$26	=AA35/2*$E$36/1000/$E$29/$D$22	=AB35*2.5
36	Oxidizing Neutral J-13 Conditions			=$W$32*1000*X$34*$Y23*$Y$26	=$W$32*1000*Y$34*$Y23*$Y$26	=$W$32*1000*Z$34*$Y23*$Y$26	=$W$32*1000*AA$34*$Y23*$Y$26	=AA36/2*$E$36/1000/$E$29/$D$22	=AB36*2.5
37	Reducing Acidic J-13 Conditions			=$W$32*1000*X$34*$Y24*$Y$26	=$W$32*1000*Y$34*$Y24*$Y$26	=$W$32*1000*Z$34*$Y24*$Y$26	=$W$32*1000*AA$34*$Y24*$Y$26	=AA37/2*$E$36/1000/$E$29/$D$22	=AB37*2.5
38	Reducing Neutral J-13 Conditions			=$W$32*1000*X$34*$Y25*$Y$26	=$W$32*1000*Y$34*$Y25*$Y$26	=$W$32*1000*Z$34*$Y25*$Y$26	=$W$32*1000*AA$34*$Y25*$Y$26	=AA38/2*$E$36/1000/$E$29/$D$22	=AB38*2.5
39									
40	Percent of total iron removed								
41	Oxidizing Acidic J-13 Conditions			=X35/$H$13	=Y35/$H$13	=Z35/$H$13	=AA35/$H$13		
42	Oxidizing Neutral J-13 Conditions			=X36/$H$13	=Y36/$H$13	=Z36/$H$13	=AA36/$H$13		
43	Reducing Acidic J-13 Conditions			=X37/$H$13	=Y37/$H$13	=Z37/$H$13	=AA37/$H$13		
44	Reducing Neutral J-13 Conditions			=X38/$H$13	=Y38/$H$13	=Z38/$H$13	=AA38/$H$13		
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									

Number Densities of Uniform Fe2O3/Water Mixtures

Vol% FeO2	1001.50C	8016.50C	26000.55C	TOTAL	Density (g/cc)
100%	0.0000E+00	5.9285E-02	3.9524E-02	9.8809E-02	5.2400
95%	3.3439E-03	5.7993E-02	3.7547E-02	9.8884E-02	5.0280
90%	6.6878E-03	5.6701E-02	3.5571E-02	9.8960E-02	4.8160
85%	1.0032E-02	5.5408E-02	3.3595E-02	9.9035E-02	4.6040
80%	1.3376E-02	5.4116E-02	3.1619E-02	9.9110E-02	4.3920
75%	1.6720E-02	5.2824E-02	2.9643E-02	9.9186E-02	4.1800
70%	2.0063E-02	5.1531E-02	2.7666E-02	9.9261E-02	3.9680
65%	2.3407E-02	5.0239E-02	2.5690E-02	9.9337E-02	3.7560
60%	2.6751E-02	4.8947E-02	2.3714E-02	9.9412E-02	3.5440
58%	2.8089E-02	4.8430E-02	2.2924E-02	9.9442E-02	3.4592
55%	3.0095E-02	4.7654E-02	2.1738E-02	9.9488E-02	3.3320
50%	3.3439E-02	4.6362E-02	1.9762E-02	9.9563E-02	3.1200
45%	3.6783E-02	4.5070E-02	1.7786E-02	9.9638E-02	2.9080
40%	4.0127E-02	4.3778E-02	1.5809E-02	9.9714E-02	2.6960
38%	4.1464E-02	4.3261E-02	1.5019E-02	9.9744E-02	2.6112
36%	4.2802E-02	4.2744E-02	1.4228E-02	9.9774E-02	2.5264
35%	4.3471E-02	4.2485E-02	1.3833E-02	9.9789E-02	2.4840
34%	4.4139E-02	4.2227E-02	1.3438E-02	9.9804E-02	2.4416
33%	4.4808E-02	4.1968E-02	1.3043E-02	9.9819E-02	2.3992
32%	4.5477E-02	4.1710E-02	1.2648E-02	9.9834E-02	2.3568
30%	4.6815E-02	4.1193E-02	1.1857E-02	9.9865E-02	2.2720
25%	5.0159E-02	3.9901E-02	9.8809E-03	9.9940E-02	2.0600
20%	5.3502E-02	3.8608E-02	7.9047E-03	1.0002E-01	1.8480
15%	5.6846E-02	3.7316E-02	5.9285E-03	1.0009E-01	1.6360
10%	6.0190E-02	3.6024E-02	3.9524E-03	1.0017E-01	1.4240
5%	6.3534E-02	3.4731E-02	1.9762E-03	1.0024E-01	1.2120
0%	6.6878E-02	3.3439E-02	0.0000E+00	1.0032E-01	1.0000

Number Densities for Oxide with Maximum Boron Adsorbed (0.67% of orignal)

Vol% FeO2	1001.50C	8016.50C	26000.55C	5010.50C	TOTAL	Density (g/cc)
58%	2.8089E-02	4.8430E-02	2.2924E-02	7.28485E-07	9.9443E-02	3.4592
33%	4.4808E-02	4.1968E-02	1.3043E-02	4.14483E-07	9.9820E-02	2.3992

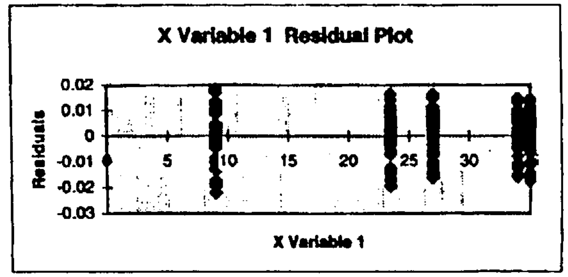
Number Densities for Oxide with Boron in Solution

Vol% FeO2	kg Orig. B in sol.	% Orig. B in sol.	1001.50C	8016.50C	26000.55C	5010.50C	TOTAL	Density (g/cc)
58%	30.113	100.000%	2.8089E-02	4.8430E-02	2.2924E-02	1.9222E-04	9.9634E-02	3.4592
58%	22.584	75.000%	2.8089E-02	4.8430E-02	2.2924E-02	1.4416E-04	9.9586E-02	3.4592
58%	15.056	50.000%	2.8089E-02	4.8430E-02	2.2924E-02	9.6108E-05	9.9538E-02	3.4592
58%	7.528	25.000%	2.8089E-02	4.8430E-02	2.2924E-02	4.8054E-05	9.9490E-02	3.4592
58%	3.011	10.000%	2.8089E-02	4.8430E-02	2.2924E-02	1.9222E-05	9.9461E-02	3.4592
58%	1.506	5.000%	2.8089E-02	4.8430E-02	2.2924E-02	9.6108E-06	9.9452E-02	3.4592
58%	0.602	2.000%	2.8089E-02	4.8430E-02	2.2924E-02	3.8443E-06	9.9446E-02	3.4592
58%	0.301	1.000%	2.8089E-02	4.8430E-02	2.2924E-02	1.9222E-06	9.9444E-02	3.4592
58%	0.151	0.500%	2.8089E-02	4.8430E-02	2.2924E-02	9.6108E-07	9.9443E-02	3.4592
58%	0.030	0.100%	2.8089E-02	4.8430E-02	2.2924E-02	1.9222E-07	9.9442E-02	3.4592
33%	30.113	100.000%	4.4808E-02	4.1968E-02	1.3043E-02	3.0663E-04	1.0013E-01	2.3992
33%	22.584	75.000%	4.4808E-02	4.1968E-02	1.3043E-02	2.2997E-04	1.0005E-01	2.3992
33%	15.056	50.000%	4.4808E-02	4.1968E-02	1.3043E-02	1.5332E-04	9.9973E-02	2.3992
33%	7.528	25.000%	4.4808E-02	4.1968E-02	1.3043E-02	7.6658E-05	9.9896E-02	2.3992
33%	3.011	10.000%	4.4808E-02	4.1968E-02	1.3043E-02	3.0663E-05	9.9850E-02	2.3992
33%	1.506	5.000%	4.4808E-02	4.1968E-02	1.3043E-02	1.5332E-05	9.9835E-02	2.3992
33%	0.602	2.000%	4.4808E-02	4.1968E-02	1.3043E-02	6.1326E-06	9.9825E-02	2.3992
33%	0.301	1.000%	4.4808E-02	4.1968E-02	1.3043E-02	3.0663E-06	9.9822E-02	2.3992
33%	0.151	0.500%	4.4808E-02	4.1968E-02	1.3043E-02	1.5332E-06	9.9821E-02	2.3992
33%	0.030	0.100%	4.4808E-02	4.1968E-02	1.3043E-02	3.0663E-07	9.9820E-02	2.3992
0%	30.113	100.000%	6.6878E-02	3.3439E-02	0.0000E+00	4.5766E-04	1.0077E-01	1.0000
0%	22.584	75.000%	6.6878E-02	3.3439E-02	0.0000E+00	3.4324E-04	1.0066E-01	1.0000
0%	15.056	50.000%	6.6878E-02	3.3439E-02	0.0000E+00	2.2883E-04	1.0055E-01	1.0000
0%	7.528	25.000%	6.6878E-02	3.3439E-02	0.0000E+00	1.1441E-04	1.0043E-01	1.0000
0%	3.011	10.000%	6.6878E-02	3.3439E-02	0.0000E+00	4.5766E-05	1.0036E-01	1.0000
0%	1.506	5.000%	6.6878E-02	3.3439E-02	0.0000E+00	2.2883E-05	1.0034E-01	1.0000
0%	0.602	2.000%	6.6878E-02	3.3439E-02	0.0000E+00	9.1532E-06	1.0033E-01	1.0000
0%	0.301	1.000%	6.6878E-02	3.3439E-02	0.0000E+00	4.5766E-06	1.0032E-01	1.0000
0%	0.151	0.500%	6.6878E-02	3.3439E-02	0.0000E+00	2.2883E-06	1.0032E-01	1.0000
0%	0.030	0.100%	6.6878E-02	3.3439E-02	0.0000E+00	4.5766E-07	1.0032E-01	1.0000

Results
9M 8/18/97

Uniform Partial Basket
SUMMARY OUTPUT

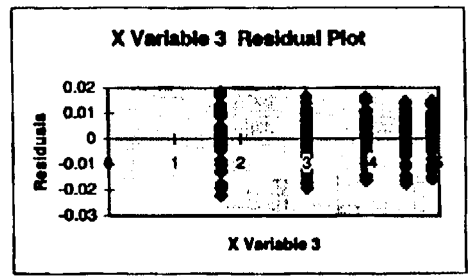
Regression Statistics	
Multiple R	0.995041869
R Square	0.990108321
Adjusted R Square	0.989697723
Standard Error	0.008305465
Observations	277

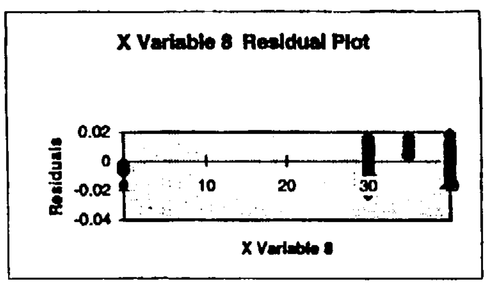


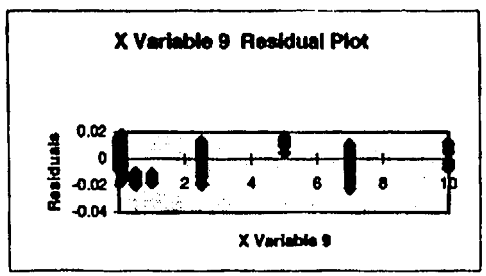
ANOVA

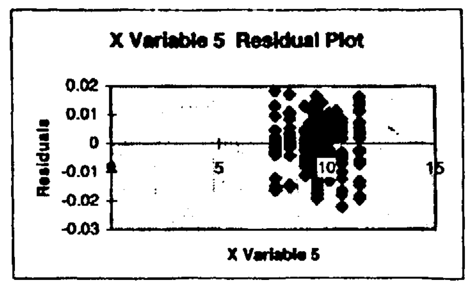
	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	1.829727825	0.166338893	2411.3812	1.68E-258
Residual	265	0.0182799	6.89808E-05		
Total	276	1.848007725			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.354976387	0.354743738	6.638528414	1.783E-10	1.6565016	3.053451194
X Variable 1	-0.006673711	0.001232013	-5.416916546	1.361E-07	-0.0090995	-0.00424793
X Variable 2	-1.8096E-05	2.02782E-05	-0.892387815	0.3729947	-5.802E-05	2.18308E-05
X Variable 3	0.141798128	0.014031672	10.10557599	1.608E-20	0.1141704	0.169425872
X Variable 4	-0.007135429	0.001699301	-4.19903733	3.664E-05	-0.0104813	-0.00378958
X Variable 5	-0.519303857	0.113075297	-4.592549142	6.773E-06	-0.7419441	-0.29666357
X Variable 6	0.059471337	0.011907475	4.994453911	1.072E-06	0.036026	0.082916632
X Variable 7	-0.002240619	0.000414146	-5.410213763	1.408E-07	-0.0030561	-0.00142518
X Variable 8	-0.005088912	0.000104812	-48.55261	6.55E-134	-0.0052953	-0.00488254
X Variable 9	-0.074906035	0.001221072	-61.34446422	1.28E-158	-0.0773103	-0.0725018
X Variable 10	0.010646202	0.000328356	32.42271859	3.212E-94	0.0099997	0.011292721
X Variable 11	-0.000523338	2.37882E-05	-21.99993668	9.892E-62	-0.0005702	-0.0004765









Settled Partial Basket
SUMMARY OUTPUT

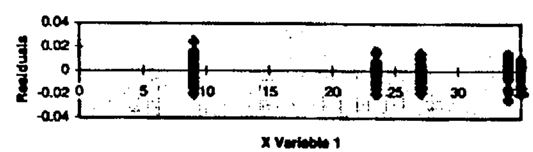
Regression Statistics	
Multiple R	0.992865556
R Square	0.985782012
Adjusted R Square	0.984971661
Standard Error	0.008464755
Observations	205

ANOVA

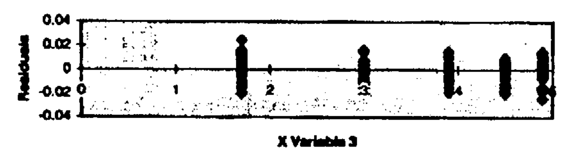
	df	SS	MS	F	Significance F
Regression	11	0.958801773	0.087163798	1216.4867	9.72E-172
Residual	193	0.01382885	7.16521E-05		
Total	204	0.972630623			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.720946107	0.432079673	3.982936976	9.838E-05	0.8687423	2.5731499
X Variable 1	-0.00672374	0.001496255	-4.493712739	1.205E-05	-0.0096748	-0.00377263
X Variable 2	-1.66674E-05	2.46444E-05	-0.676314577	0.4996508	-6.527E-05	3.19395E-05
X Variable 3	0.133476406	0.01714927	7.783212173	4.189E-13	0.0996524	0.167300429
X Variable 4	-0.006049678	0.002077096	-2.912565334	0.0040073	-0.0101464	-0.00195296
X Variable 5	-0.312320817	0.138294695	-2.258371641	0.0250414	-0.5850836	-0.03955801
X Variable 6	0.037442246	0.014614303	2.562027427	0.0111693	0.008618	0.066266478
X Variable 7	-0.001471468	0.000509727	-2.886773898	0.0043358	-0.0024768	-0.00046612
X Variable 8	-0.016796768	0.000564584	-29.75067842	5.076E-74	-0.0179103	-0.01568322
X Variable 9	-0.066316014	0.001541148	-43.03026023	7.28E-101	-0.0693557	-0.06327636
X Variable 10	0.009403563	0.000391812	24.00021364	7.664E-80	0.0086308	0.010176345
X Variable 11	-0.000469048	2.79796E-05	-16.7639454	1.628E-39	-0.0005242	-0.00041386

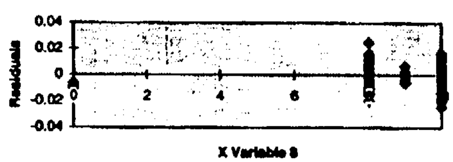
Burnup Residual Plot



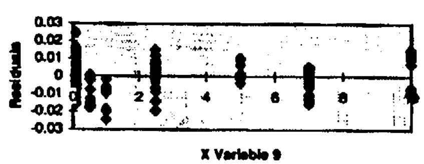
Enrichment Residual Plot



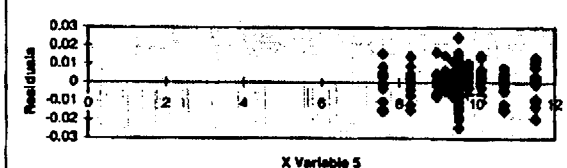
Rod Rows Covered Residual Plot



Thickness Residual Plot



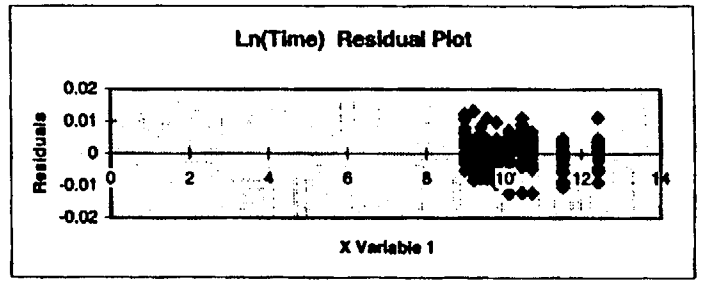
Ln(t) Residual Plot



UNIFORM RESULTS RESULTS 9/18/97

Uniform Fully Degraded
SUMMARY OUTPUT

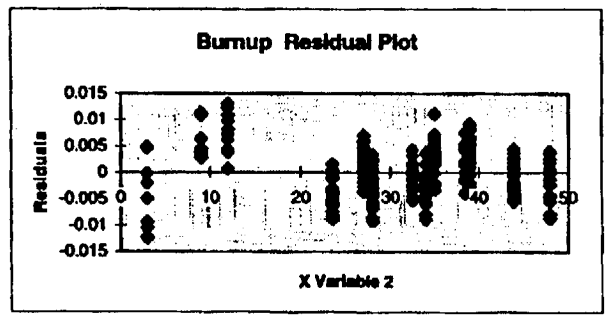
Regression Statistics	
Multiple R	0.99641958
R Square	0.99285198
Adjusted R Square	0.992537781
Standard Error	0.004626123
Observations	286

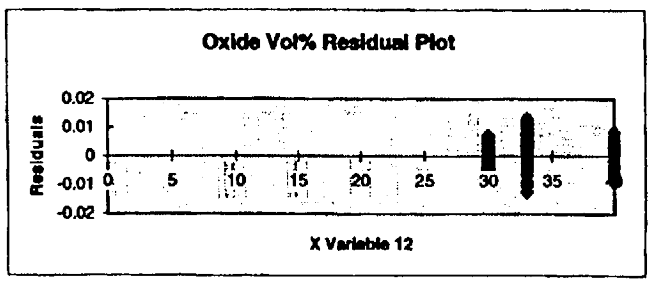


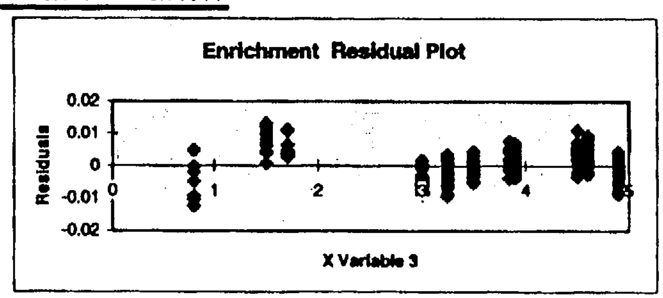
ANOVA

	df	SS	MS	F	Significance F
Regression	12	0.811513372	0.067626	3159.95	5.3E-285
Residual	273	0.005842476	2.14E-05		
Total	285	0.817355848			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-5.129549974	0.366446592	-13.9981	6.29E-34	-5.85097	-4.40813
X Variable 1	1.656153648	0.104182231	15.8967	9.9E-41	1.451051	1.861256
X Variable 2	-0.008528523	0.001109171	-7.6891	2.69E-13	-0.01071	-0.00634
X Variable 3	0.29265999	0.013658923	21.42629	2.03E-60	0.26577	0.31955
X Variable 4	-0.153971134	0.009819366	-15.6804	5.95E-40	-0.1733	-0.13464
X Variable 5	0.004670704	0.000306635	15.23214	2.43E-38	0.004067	0.005274
X Variable 6	6.8964E-05	2.78252E-05	2.478476	0.013799	1.42E-05	0.000124
X Variable 7	-1.63227E-07	2.9327E-07	-0.55658	0.578273	-7.4E-07	4.14E-07
X Variable 8	-0.067137238	0.003484692	-19.2663	8.08E-53	-0.074	-0.06028
X Variable 9	0.005360828	0.000336412	15.9353	7.19E-41	0.004699	0.006023
X Variable 10	-0.000408151	6.53331E-05	-6.24723	1.6E-09	-0.00054	-0.00028
X Variable 11	0.007237075	0.000631663	11.45718	4.47E-25	0.005994	0.008481
X Variable 12	-0.005259776	7.8362E-05	-67.1215	1E-171	-0.00541	-0.00511







III-10

BBA000000-01717-0200-00056 REV00 Att. III

August 21, 1997

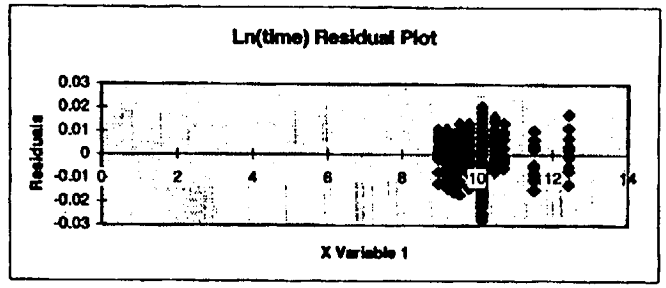
Settled Fully Degraded
SUMMARY OUTPUT

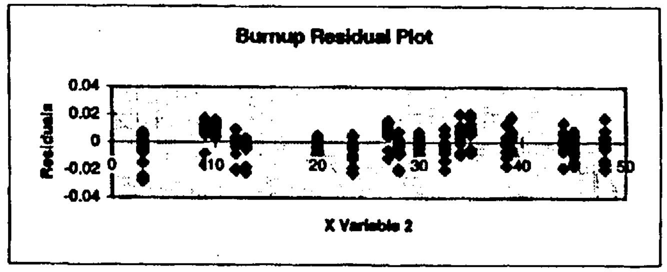
Regression Statistics	
Multiple R	0.995550944
R Square	0.991121681
Adjusted R Square	0.990727089
Standard Error	0.009056213
Observations	283

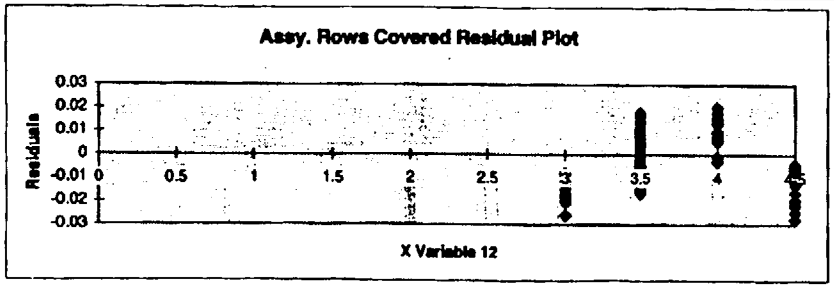
ANOVA

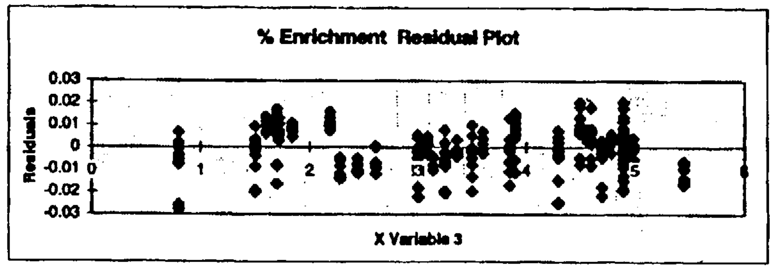
	df	SS	MS	F	Significance F
Regression	12	2.472027502	0.206002	2511.764	4.2221E-269
Residual	270	0.02214405	8.2E-05		
Total	282	2.494171552			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-1.251608633	0.884870087	-1.41445	0.158381	-2.993730002	0.490513
X Variable 1	0.683154458	0.25309973	2.699151	0.00739	0.184854817	1.181454
X Variable 2	-0.006651329	0.001081443	-6.15042	2.77E-09	-0.00878046	-0.00452
X Variable 3	0.26614457	0.014619545	18.20471	7.24E-49	0.237361789	0.294927
X Variable 4	-0.064028158	0.023965951	-2.67163	0.008007	-0.111212028	-0.01684
X Variable 5	0.001926314	0.000751819	2.562204	0.010944	0.000446142	0.003406
X Variable 6	-2.67041E-05	2.90459E-05	-0.91937	0.358721	-8.38894E-05	3.05E-05
X Variable 7	6.12197E-07	3.63912E-07	1.682266	0.093673	-1.04269E-07	1.33E-06
X Variable 8	-0.061827644	0.003901712	-15.8463	1.96E-40	-0.069509287	-0.05415
X Variable 9	0.005203523	0.000408744	12.73053	2.14E-29	0.004398794	0.006008
X Variable 10	-0.000136497	8.49922E-05	-1.606	0.109444	-0.000303829	3.08E-05
X Variable 11	0.005084904	0.000888969	5.720004	2.82E-08	0.003334714	0.006835
X Variable 12	-0.140917688	0.001980737	-71.1441	6.4E-177	-0.144817339	-0.13702







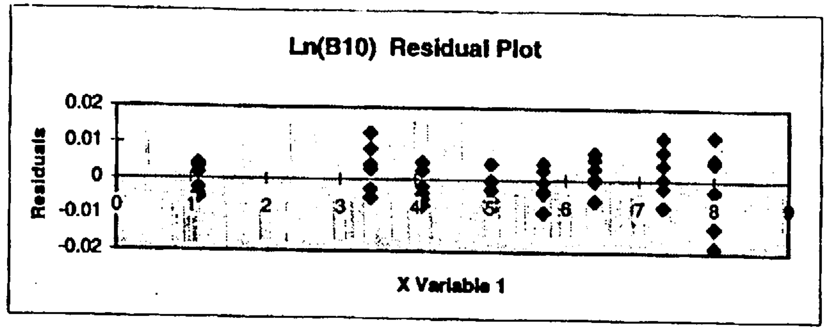


INFORMATION ONLY

BORON

Partial Basket with boron in solution
SUMMARY OUTPUT

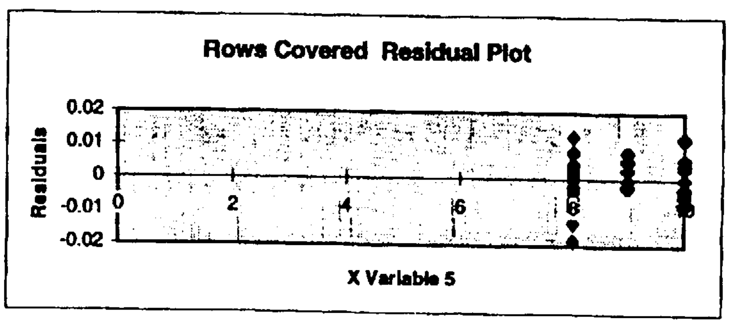
Regression Statistics	
Multiple R	0.99703497
R Square	0.994078732
Adjusted R Square	0.993373819
Standard Error	0.006760657
Observations	48

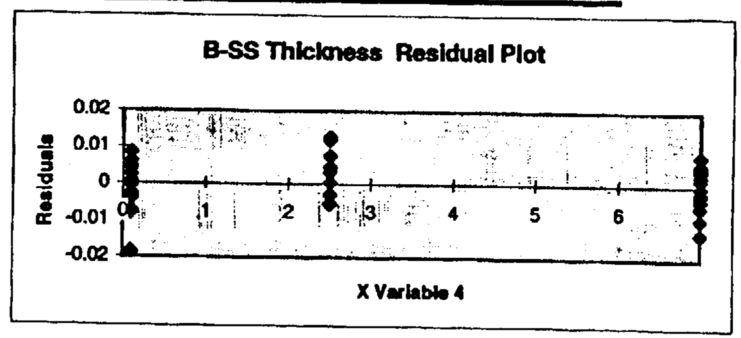


ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.322279894	0.064456	1410.2151	1.301E-45
Residual	42	0.001919673	4.57E-05		
Total	47	0.324199567			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6.37971E-03	0.012681049	0.50309	0.6175294	-0.019212	0.031971	-0.0192117	0.031971107
X Variable 1	-6.07375E-02	0.006942822	-8.74824	5.19E-11	-0.074749	-0.04673	-0.07474865	-0.046726279
X Variable 2	2.08433E-02	0.001744647	11.94698	4.284E-15	0.0173224	0.024364	0.017322424	0.024364106
X Variable 3	-2.21564E-03	0.000126828	-17.4696	7.092E-21	-0.002472	-0.00196	-0.00247159	-0.001959691
X Variable 4	3.59713E-04	0.00035207	1.021708	0.3127681	-0.000351	0.00107	-0.00035079	0.00107022
X Variable 5	4.23685E-03	0.00112191	3.776465	0.0004944	0.0019727	0.006501	0.001972747	0.006500962





delta k/k for settled fully degraded w/ boron in solution

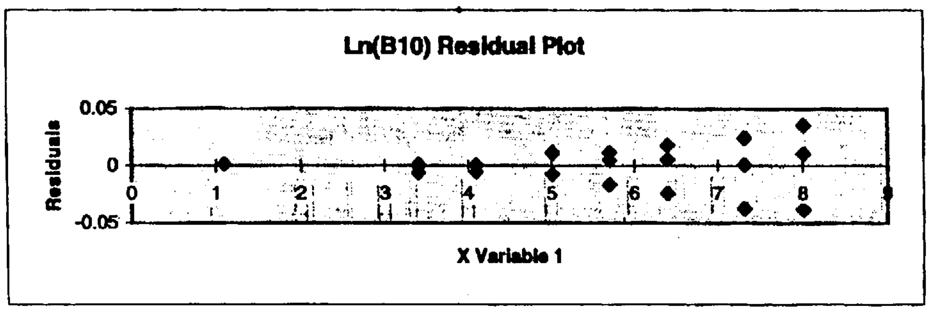
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.988368462
R Square	0.976872217
Adjusted R Square	0.973017587
Standard Error	0.019050954
Observations	22

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.275936868	0.091979	253.4282	6.60187E-15
Residual	18	0.006532899	0.000363		
Total	21	0.282469768			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.32558E-02	0.043044893	0.540269	0.595634	-0.067178234	0.113689835
X Variable 1	-3.56383E-02	0.032758847	-1.0879	0.290992	-0.104462179	0.033185493
X Variable 2	1.42821E-02	0.007630414	1.871739	0.077585	-0.001748772	0.030313062
X Variable 3	-1.91685E-03	0.000536617	-3.5721	0.002178	-0.003044241	-0.000789458



SET LOADCU.
LOADCURVE 9A 9/18/97

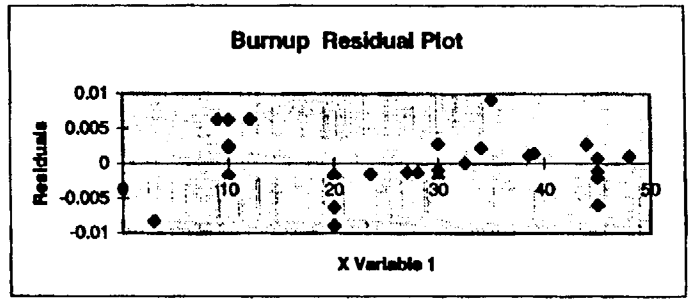
Second Fit
SUMMARY OUTPUT

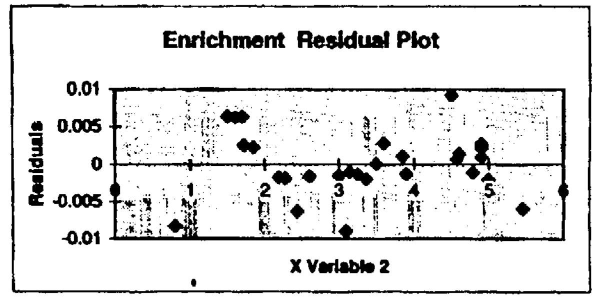
Regression Statistics	
Multiple R	0.995022923
R Square	0.990070618
Adjusted R Square	0.987233651
Standard Error	0.004825666
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	6	0.048762	0.008127	348.9892	6.55E-20
Residual	21	0.000489	2.33E-05		
Total	27	0.049251			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.640653056	0.014292	44.82526	2.46E-22	0.610931	0.670375
X Variable 1	-0.010291212	0.002021	-5.09198	4.83E-05	-0.01449	-0.00609
X Variable 2	0.300169252	0.025446	11.79613	9.98E-11	0.247251	0.353088
X Variable 3	-2.54581E-05	7.76E-05	-0.32797	0.746183	-0.00019	0.000136
X Variable 4	-0.049092949	0.00797	-6.15954	4.12E-06	-0.06567	-0.03252
X Variable 5	9.92035E-07	8.98E-07	1.10488	0.28171	-8.8E-07	2.86E-06
X Variable 6	0.003645209	0.000781	4.666798	0.000132	0.002021	0.00527





Units Definition

$\mu m := 10^{-6} \cdot m$

Estimated Average Boride Particle Surface Area for 304B6B

$B5B := 24.13 \cdot \mu m^2$ $B7B := 32.82 \cdot \mu m^2$ $B6B := \frac{B5B + B7B}{2}$ $B6B = 28.475 \cdot \mu m^2$

Estimated Max. Boride Particle Surface Area for 304B6B

$MB5B := 456 \cdot \mu m^2$ $MB7B := 597 \cdot \mu m^2$ $MB6B := \frac{MB5B + MB7B}{2}$ $MB6B = 526.5 \cdot \mu m^2$

Assumed Boride Density based on CrB in CRC

$\rho B := 6.2 \cdot \frac{gm}{cm^3}$

Assume Boride particles are spherical

$r := \sqrt{\frac{B6B}{4 \cdot \pi}}$ $r = 1.505 \cdot 10^{-6} \cdot m$

Assume Boride particles are spherical

$Mr := \sqrt{\frac{MB6B}{4 \cdot \pi}}$ $Mr = 6.473 \cdot 10^{-6} \cdot m$

Average Boride Particle Mass

$mB := \frac{4}{3} \cdot \pi \cdot r^3 \cdot \rho B$ $mB = 8.859 \cdot 10^{-11} \cdot gm$

Max. Boride Particle Mass

$MmB := \frac{4}{3} \cdot \pi \cdot Mr^3 \cdot \rho B$ $MmB = 7.043 \cdot 10^{-9} \cdot gm$

Time To Boride Particle Oxidation

Function for determining spherical surface area as a function material mass & density: $s(m,\rho) := 4\cdot\pi\cdot\left(\frac{3\cdot m}{4\cdot\pi\cdot\rho}\right)^{\frac{2}{3}}$

Corrosion Rate $CR4 := 0.01\cdot\frac{\mu m}{yr}\cdot\rho B$ $i := 0..10000$

Iterating Equation for Average Boride Particle Corrosion

$t_0 := 0$ $MB_0 := mB\cdot gm^{-1}$ $SA_0 := B6B\cdot\mu m^{-2}$ $FB_0 := 1$

$$\begin{bmatrix} t_{i+1} \\ MB_{i+1} \\ SA_{i+1} \\ FB_{i+1} \end{bmatrix} := \begin{bmatrix} t_i + 1 \\ MB_i - \left(CR4\cdot SA_i\cdot\mu m^2\cdot 1\cdot yr\right)\cdot gm^{-1} \\ s\left[\left[MB_i\cdot gm - \left(CR4\cdot SA_i\cdot\mu m^2\cdot 1\cdot yr\right)\right],\rho B\right]\cdot\mu m^{-2} \\ \frac{MB_i - \left(CR4\cdot SA_i\cdot\mu m^2\cdot 1\cdot yr\right)\cdot gm^{-1}}{MB_0} \end{bmatrix}$$

Average Boride Particle RESULTS:

$j := 0, 5 .. 110$

Time Since Exposure (yrs) t_j	Fraction of Boride Particle Remaining FB_j
0	1
5	0.903
10	0.812
15	0.728
20	0.65
25	0.577
30	0.51
35	0.449
40	0.393
45	0.341
50	0.294
55	0.252
60	0.214
65	0.18
70	0.15
75	0.123
80	0.1
85	0.079
90	0.062
95	0.047
100	0.035
105	0.025
110	0.018

Iterating Equation for Maximum Boride Particle Corrosion

$t_0 := 0 \qquad MB_0 := MmB \cdot gm^{-1} \qquad SA_0 := MB6B \cdot \mu m^{-2} \qquad FB_0 := 1$

$$\begin{bmatrix} t_{i+1} \\ MB_{i+1} \\ SA_{i+1} \\ FB_{i+1} \end{bmatrix} := \begin{bmatrix} t_i + 1 \\ MB_i - \left(CR4 \cdot SA_i \cdot \mu m^2 \cdot 1 \cdot yr\right) \cdot gm^{-1} \\ s\left[\left[MB_i \cdot gm - \left(CR4 \cdot SA_i \cdot \mu m^2 \cdot 1 \cdot yr\right)\right], \rho B\right] \cdot \mu m^{-2} \\ \dfrac{MB_i - \left(CR4 \cdot SA_i \cdot \mu m^2 \cdot 1 \cdot yr\right) \cdot gm^{-1}}{MB_0} \end{bmatrix}$$

Average Boride Particle RESULTS:

$j := 0, 25 .. 500$

Time Since Exposure (yrs) t_j	Fraction of Boride Particle Remaining FB_j
0	1
25	0.888
50	0.785
75	0.691
100	0.604
125	0.525
150	0.453
175	0.388
200	0.329
225	0.277
250	0.23
275	0.189
300	0.154
325	0.123
350	0.096
375	0.074
400	0.055
425	0.04
450	0.028
475	0.018
500	0.011

```
BEGIN {intable=0}
/0.*, grams/ {intable=1; print $0}
/basis/ {if (intable) print $0}
/charge/ {if (intable) print $0}
/initial/ {if (intable) print $0}
/o 16/ {if (intable) print $0}
/mo 95/ {if (intable) print $0}
/ru101/ {if (intable) print $0}
/tc 99/ {if (intable) print $0}
/rh103/ {if (intable) print $0}
/ag109/ {if (intable) print $0}
/nd143/ {if (intable) print $0}
/nd145/ {if (intable) print $0}
/sm147/ {if (intable) print $0}
/sm149/ {if (intable) print $0}
/sm150/ {if (intable) print $0}
/sm151/ {if (intable) print $0}
/sm152/ {if (intable) print $0}
/eu151/ {if (intable) print $0}
/eu153/ {if (intable) print $0}
/gd155/ {if (intable) print $0}
/u233/ {if (intable) print $0}
/u234/ {if (intable) print $0}
/u235/ {if (intable) print $0}
/u236/ {if (intable) print $0}
/u238/ {if (intable) print $0}
/np237/ {if (intable) print $0}
/pu238/ {if (intable) print $0}
/pu239/ {if (intable) print $0}
/pu240/ {if (intable) print $0}
/pu241/ {if (intable) print $0}
/pu242/ {if (intable) print $0}
/am241/ {if (intable) print $0}
/am242m/ {if (intable) print $0}
/am243/ {if (intable) print $0}
/total/ {if (intable) print $0}
/0.*curies/ {intable=0}
/0.*fraction/ {intable=0}
/0.*element/ {intable=0}
```

```
=sas2h    parm='halt8,skipcellwt,skipshipdata'
SAS2H: Babcock Wilcox 15x15, 4.9wt%, 34gwd/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 4.9 92234 0.0433 92236 0.0225 92238 95.0342 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=7 inplevel=2 numztotal=4  end
3 0.63246 2 0.67310 3 0.814 500 2.961
power=7.25 burn=2176 down=3652.5
   end
end
=origens
0$$  a8 26 a11 71 e
1$$ 1  1t
 b&w 15x15, 4.9%/34 Decay
3$$ 21 0 1 e
2t
35$$ 0  t
'
56$$ 0 7 a13 -1 a15 3 0 4 e   5t
Part B B&W 15x15, 4.9wt%, 34gwd/mtu decay
per B&W assembly, 0.409 mthm for grams
60**  0 1 90 365.25 730.5 1826.25  3652.5
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ 0 10 a10 7 a14 5 a17 4 e  57** 10  e  5t
60**  15 20 30 50 100 150 200 250 300 400
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ 0 10 a10 10 a14 5 a17 4 e  57** 400  e  5t
60**  500 1+3 2+3 4+3 6+3 8+3 1+4 1.2+4 1.4+4 1.5+4
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ 0 10 a10 10 a14 5 a17 4 e  57** 1.5+4  e  5t
60**  1.6+4 1.7+4 1.8+4 1.9+4 2.0+4 2.1+4 2.2+4 2.3+4 2.4+4 2.5+4
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ 0 10 a10 10 a14 5 a17 4 e  57** 2.5+4  e  5t
60**  3.5+4 4.5+4 5+4 5.5+4 6+4 6.5+4 7+4 1+5 2+5 2.5+5
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ 0 3 a10 10 a14 5 a17 4 e  57** 2.5+5  e  5t
60**  3+5 5+5 999999
65$$ a25 1 0 0 1 0 0 0 a46 1 0 0 1 0 0 0 e
6t
'
56$$ f0  t
end
```

```
AUCF-21 BW15x15 Assys, part deg, uniform case, 30% Fe2O3
c      Advanced Uncanistered Fuel Waste Package
c      THICKNESS = 7 mm
c      CELL SPECIFICATIONS
c        Assembly Sub-lattices - 1/2 Model
1      0        1  3 -13 -20   FILL=1 (0 -75 0) IMP:N=1
c      ASSEMBLY LATTICE
5      1  -2.2720  -61  60 -63  62  IMP:N=1 LAT=1 U=1
       FILL=0:3 0:7 0:0  1 1  1  1  68 66 1  1  58 58 66 1
                         58 58 64 1  58 58 62 1  60 62 1  1
                         1 1  1  1   1 1 1 1       $ 1/2 model
c      FULL ASSEMBLY LATTICE POSITIONS
c       Code: boron in [B=] all panels [all], left [l], bottom, [b], right [r], top [t]
c       WET FULL ASSEMBLY LATTICE B=all
6      1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=58
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
7      1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=58
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
8      1  -2.2720   64 -65 -45 IMP:N=1 FILL=9  U=58
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
9      1  -2.2720   46  64  65 IMP:N=1 FILL=10 U=58
c          TOP OF ASSEMBLY OUTSIDE LATTICE
10     1  -2.2720  -64  65  47 IMP:N=1 FILL=11 U=58
c       WET FULL ASSEMBLY LATTICE B=lbr
16     1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=60
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
17     1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=60
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
18     1  -2.2720   64 -65 -45 IMP:N=1 FILL=9  U=60
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
19     1  -2.2720   46  64  65 IMP:N=1 FILL=10 U=60
c          TOP OF ASSEMBLY OUTSIDE LATTICE
20     1  -2.2720  -64  65  47 IMP:N=1 FILL=19 U=60
c       WET FULL ASSEMBLY LATTICE B=lb
26     1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=62
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
27     1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=62
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
28     1  -2.2720   64 -65 -45 IMP:N=1 FILL=9  U=62
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
29     1  -2.2720   46  64  65 IMP:N=1 FILL=18 U=62
c          TOP OF ASSEMBLY OUTSIDE LATTICE
30     1  -2.2720  -64  65  47 IMP:N=1 FILL=19 U=62
c       WET FULL ASSEMBLY LATTICE B=lbt
36     1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=64
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
37     1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=64
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
38     1  -2.2720   64 -65 -45 IMP:N=1 FILL=9  U=64
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
39     1  -2.2720   46  64  65 IMP:N=1 FILL=18 U=64
c          TOP OF ASSEMBLY OUTSIDE LATTICE
40     1  -2.2720  -64  65  47 IMP:N=1 FILL=11 U=64
c       WET FULL ASSEMBLY LATTICE B=lt
46     1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=66
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
47     1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=66
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
48     1  -2.2720   64 -65 -45 IMP:N=1 FILL=17 U=66
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
49     1  -2.2720   46  64  65 IMP:N=1 FILL=18 U=66
c          TOP OF ASSEMBLY OUTSIDE LATTICE
50     1  -2.2720  -64  65  47 IMP:N=1 FILL=11 U=66
c       WET FULL ASSEMBLY LATTICE B=lrt
56     1  -2.2720  -46  44 -47  45  IMP:N=1 FILL=56     U=68
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
57     1  -2.2720  -44 -64 -65 IMP:N=1 FILL=8  U=68
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
58     1  -2.2720   64 -65 -45 IMP:N=1 FILL=17 U=68
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
```

```
59    1  -2.2720   46  64  65 IMP:N=1 FILL=10 U=68
c          TOP OF ASSEMBLY OUTSIDE LATTICE
60    1  -2.2720  -64  65  47 IMP:N=1 FILL=11 U=68
c     EMPTY ASSEMBLY LATTICE POSITIONS - Corner Guides and Spacers
c     BARRIER CELLS
c     Basket Material-Lid Gap
76    3  -1.0000    1 -20  13  -14      IMP:N=1 $ 1/2 model
c     76    1  -2.2720    1   2 -20  13  -14     IMP:N=1 $ 1/4 model
c     Inner Barrier
77    5  -8.4425    1   3  20 -21 -14  IMP:N=1 $ 1/2 model
c     77    5  -8.4425    1   2   3  20 -21 -14  IMP:N=1 $ 1/4 model
c     Inner Lid
78    5  -8.4425    1  14 -15 -21       IMP:N=1 $ 1/2 model
c     78    5  -8.4425    1   2  14 -15 -21      IMP:N=1 $ 1/4 model
c      Gap between Inner and Outer Barrier Lids
79    3  -1.0000    1  15 -16 -21       IMP:N=1 $ 1/2 model
c     79    1  -2.2720    1   2  15 -16 -21      IMP:N=1 $ 1/4 model
c      Gap between Inner and Outer Barriers
80    3  -1.0000   21 -22   1   3 -16  IMP:N=1 $ 1/2 model
c     80    1  -2.2720   21 -22   1   2   3 -16  IMP:N=1 $ 1/4 model
c     Outer Barrier
81    7  -7.8320   22 -24   1   3 -16  IMP:N=1 $ 1/2 model
c     81    7  -7.8320   22 -24   1   2   3 -16  IMP:N=1 $ 1/4 model
c     Outer Barrier Lid
82    7  -7.8320    1 -24  16 -17      IMP:N=1 $ 1/2 model
c     82    7  -7.8320    1   2 -24  16 -17      IMP:N=1 $ 1/4 model
c     12" of Water around Container
83    3  -1.0000   24 -25   1   3 -17  IMP:N=1 $ 1/2 model
c     83    1  -2.2720   24 -25   1   2   3 -17  IMP:N=1 $ 1/4 model
c     12" of Water above Container
84    3  -1.0000   17 -19   1 -25      IMP:N=1 $ 1/2 model
c     84    1  -2.2720   17 -58   1   2 -59      IMP:N=1 $ 1/4 model
c     OUTSIDE WORLD
85    0  -1:-3:19:25  IMP:N=0  $ 1/2 model
c     85    0  -1:-2:-3:19:25  IMP:N=0  $ 1/4 model
c     WET PIN LATTICE
86    1  -2.2720  -26 27 -28  29  IMP:N=1 LAT=1  U=56
      FILL -8:8 -8:8 0:0  56 16R  56 2 14R 56  56 2 14R 56
                          56 2 4R 4 2 2R 4 2 4R 56
                          56 2 2R 4 2 6R 4 2 2R 56  56 2 14R 56
                          56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                          56 2 14R 56
                          56 2 6R 6 2 6R 56
                          56 2 14R 56
                          56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                          56 2 14R 56  56 2 2R 4 2 6R 4 2 2R 56
                          56 2 4R 4 2 2R 4 2 4R 56
                          56 2 14R 56  56 2 14R 56  56 16R
c     WET FUEL ROD
89    2     6.982925E-02 -30 -10      IMP:N=1 U=2
90    4  -6.5600   -30  10 -11 IMP:N=1 U=2
91    3  -1.0000   -30  11     IMP:N=1 U=2
92    1  -2.2720    30 -31 -11 IMP:N=1 U=2
93    1  -2.2720    30 -31  11 IMP:N=1 U=2
94    4  -6.5600    31 -32 -11 IMP:N=1 U=2
95    1  -2.2720    31 -32  11 IMP:N=1 U=2
96    1  -2.2720    32         IMP:N=1 U=2
c     WET CONTROL ROD/GUIDE TUBE
105   3  -1.0000  -33        IMP:N=1 U=4  $ No DCRA Rod
c     105   9  -7.8300  -33        IMP:N=1 U=4  $ DCRA Rod
106   1  -2.2720   33  -34  IMP:N=1 U=4
107   1  -2.2720   34  -35  IMP:N=1 U=4  $ No DCRA Cladding
c     107   4  -6.5600   34  -35  IMP:N=1 U=4  $ DCRA Cladding
108   1  -2.2720   35  -36  IMP:N=1 U=4
109   4  -6.5600   36  -37  IMP:N=1 U=4
110   1  -2.2720   37       IMP:N=1 U=4
c     DRY CONTROL ROD/GUIDE TUBE
111   3  -1.0000  -33       IMP:N=1 U=5  $ No DCRA Rod
c     111   9  -7.8300  -33        IMP:N=1 U=5  $ DCRA Rod
112   3  -1.0000   33  -34  IMP:N=1 U=5
```

```
113   3  -1.0000   34  -35  IMP:N=1 U=5  $ No DCRA Cladding
c      113  4  -6.5600   34  -35  IMP:N=1 U=5  $ DCRA Cladding
114   3  -1.0000   35  -36  IMP:N=1 U=5
115   4  -6.5600   36  -37  IMP:N=1 U=5
116   3  -1.0000   37       IMP:N=1 U=5
c     WET INSTRUMENTATION TUBE
117   3  -1.0000  -38          IMP:N=1 U=6
118   4  -6.5600   38 -39      IMP:N=1 U=6
119   1  -2.2720   39          IMP:N=1 U=6
c     DRY INSTRUMENTATION TUBE
120   3  -1.0000  -38          IMP:N=1 U=7
121   4  -6.5600   38 -39      IMP:N=1 U=7
122   3  -1.0000   39          IMP:N=1 U=7
c     FUEL CELL BASKET STRUCTURE
c     Code: boron in [B=] all panels [all], left [l], bottom, [b], right [r], top [t]
c     FUEL CELL BASKET STRUCTURE -        WET - Borated panels
c        WATER GAP      - ASSEMBLY LEFT
123   1  -2.2720   52             IMP:N=1 U=8
126   8  -7.7700  -52          IMP:N=1 U=8
c        WATER GAP      - ASSEMBLY BOTTOM
127   1  -2.2720   53             IMP:N=1 U=9
c        SS PANEL - ASSEMBLY BOTTOM
130   8  -7.7700  -53          IMP:N=1 U=9
c        WATER GAP      - ASSEMBLY RIGHT
131   1  -2.2720  -54             IMP:N=1 U=10
c        SS PANEL - ASSEMBLY RIGHT
134   8  -7.7700   54          IMP:N=1 U=10
c        WATER GAP      - ASSEMBLY TOP
135   1  -2.2720  -55             IMP:N=1 U=11
c        SS PANEL - ASSEMBLY TOP
138   8  -7.7700   55          IMP:N=1 U=11
c     FUEL CELL BASKET STRUCTURE -          DRY - Borated panels
c        GAP      - ASSEMBLY LEFT
139   3  -1.0000   52             IMP:N=1 U=12
c        SS PANEL - ASSEMBLY LEFT
142   8  -7.7700  -52          IMP:N=1 U=12
c        GAP      - ASSEMBLY BOTTOM
143   3  -1.0000   53             IMP:N=1 U=13
c        SS PANEL - ASSEMBLY BOTTOM
146   8  -7.7700  -53          IMP:N=1 U=13
c        GAP      - ASSEMBLY RIGHT
147   3  -1.0000  -54             IMP:N=1 U=14
c        SS PANEL - ASSEMBLY RIGHT
150   8  -7.7700   54          IMP:N=1 U=14
c        GAP      - ASSEMBLY TOP
151   3  -1.0000  -55             IMP:N=1 U=15
c        SS PANEL - ASSEMBLY TOP
154   8  -7.7700   55          IMP:N=1 U=15
c     FUEL CELL BASKET STRUCTURE -        WET - Unborated panels
c        WATER GAP      - ASSEMBLY LEFT
155   1  -2.2720   52             IMP:N=1 U=16
c        PANEL - ASSEMBLY LEFT
158   1  -2.2720  -52          IMP:N=1 U=16
c        WATER GAP      - ASSEMBLY BOTTOM
159   1  -2.2720   53             IMP:N=1 U=17
c        PANEL - ASSEMBLY BOTTOM
162   1  -2.2720  -53          IMP:N=1 U=17
c        WATER GAP      - ASSEMBLY RIGHT
163   1  -2.2720  -54             IMP:N=1 U=18
c        PANEL - ASSEMBLY RIGHT
166   1  -2.2720   54          IMP:N=1 U=18
c        WATER GAP      - ASSEMBLY TOP
167   1  -2.2720  -55             IMP:N=1 U=19
c        PANEL - ASSEMBLY TOP
170   1  -2.2720   55          IMP:N=1 U=19
c     FUEL CELL BASKET STRUCTURE -          DRY - Unborated panels
c        GAP      - ASSEMBLY LEFT
171   3  -1.0000   52             IMP:N=1 U=20
c        PANEL - ASSEMBLY LEFT
174   3  -1.0000  -52          IMP:N=1 U=20
```

```
c        GAP     - ASSEMBLY BOTTOM
175   3  -1.0000   53          IMP:N=1 U=21
c        PANEL - ASSEMBLY BOTTOM
178   3  -1.0000  -53      IMP:N=1 U=21
c        GAP     - ASSEMBLY RIGHT
179   3  -1.0000  -54          IMP:N=1 U=22
c        PANEL - ASSEMBLY RIGHT
182   3  -1.0000   54       IMP:N=1 U=22
c        GAP     - ASSEMBLY TOP
183   3  -1.0000  -55          IMP:N=1 U=23
c        PANEL - ASSEMBLY TOP
186   3  -1.0000   55      IMP:N=1 U=23

c     SURFACE SPECIFICATIONS
1*    PX    0.0
3*    PZ    0.00
10    PZ  180.0860     $ TOP ACTIVE FUEL
11    PZ  201.2360     $ TOP FUEL HARDWARE
13    PZ  228.75       $ TOP OF BASKET MATERIAL
14    PZ  229.25       $ TOP RING/WATER GAP
15    PZ  231.75       $ TOP INNER LID
16    PZ  234.75       $ TOP LID GAP
17    PZ  245.75       $ TOP OUTER LID
19    PZ  298.75       $ TOP REFLECTOR REGION
20    CZ   71.095      $ ID OF INNER BARRIER
21    CZ   73.095      $ OD OF INNER BARRIER
22    CZ   73.10       $ ID OF OUTER BARRIER
24    CZ   83.10       $ OD OF OUTER BARRIER
25    CZ  113.60       $ OD OF REFLECTOR REGION
c     PIN LATTICE BOUNDS
26    PX  0.72136
27    PX -0.72136
28    PY  0.72136
29    PY -0.72136
c      FUEL ROD
30    CZ  0.468122
31    CZ  0.478790
32    CZ  0.546100
c      CONTROL ROD/GUIDE TUBE
33    CZ  0.45340  $ 0.49022
34    CZ  0.46990  $ 0.50292
35    CZ  0.54610  $ 0.56007
36    CZ  0.62230  $ 0.63246
37    CZ  0.67310
c      INSTRUMENTATION TUBE
38    CZ  0.56007
39    CZ  0.62611
c     ASSEMBLY LATTICE BOUNDS Actual
44    PX  -10.65  $ ACTUAL 10.82025
45    PY  -10.65
46    PX   10.65
47    PY   10.65
52    PX  -10.650001  $ UCF Intact Inside Tube ID
53    PY  -10.650001
54    PX   10.650001
55    PY   10.650001
60    PX  -11.000     $ ACTUAL 12.30
61    PX   11.000
62    PY  -11.000
63    PY   11.000
c     45 degree planes
64    P    1. -1.  0. 0.
65    P    1.  1.  0. 0.
c     EXTRA CARDS

MODE  N
c      VOL    88J
KCODE   4000 1. 7 37
KSRC    -4.3  -5.7 1.   -2.8  -5.7 5.   -1.4  -5.7 10.    0.    -5.7  5.
         1.44 -5.7 3.    2.88 -5.7 8.    4.32 -5.7  9.
```

```
        -5.7  -4.3 2.  -4.3  -4.3 1.  -2.8  -4.3  5.  -1.4  -4.3 10.
         0.   -4.3 5.   1.44 -4.3 3.   2.88 -4.3  8.   4.32 -4.3  9.
        -5.7  -2.9 2.  -4.3  -2.9 1.                  -1.4  -2.9 10.
         0.   -2.9 5.                  2.88 -2.9  8.   4.32 -2.0  9.
        -5.7  -1.4 2.  -4.3  -1.4 1.  -2.8  -1.4  5.  -1.4  -1.4 10.
         0.   -1.4 5.   1.44 -1.4 3.   2.88 -1.4  8.   4.32 -1.4  9.
        -5.7   0.0 2.  -4.3   0.0 1.  -2.8   0.0  5.  -1.4   0.0 10.
                        1.44  0.0 3.   2.88  0.0  8.   4.32  0.0  9.
        -5.7   1.4 2.                 -2.8   1.4  5.  -1.4   1.4 10.
         0.    1.4 5.   1.44  1.4 3.   2.88  1.4  8.   4.32  1.4  9.
        -5.7   2.9 2.  -4.3   2.9 1.  -2.8   2.9  5.  -1.4   2.9 10.
         0.    2.9 5.   1.44  2.9 3.   2.88  2.9  8.   4.32  2.9  9.
        -5.7   4.3 2.  -4.3   4.3 1.  -2.8   4.3  5.  -1.4   4.3 10.
         0.    4.3 5.   1.44  4.3 3.   2.88  4.3  8.   4.32  4.3  9.
C       MATERIAL SPECIFICATIONS
C          WATER AT 300 K d=1.0000 g/cc w/ 30% Fe2O3
M1     1001.50C  4.6815-2    8016.50C  4.1193-2  26000.55C 1.1857-2
MT1    LWTR.01T
C      e49b34.sum   2000  years decay
M2      8016.50C   .046947
       42095.50C   4.794679E-05
       44101.50C   4.354501E-05
       43099.50C   4.625092E-05
       45103.50C   2.608717E-05
       47109.50C   3.714096E-06
       60143.50C   3.74851E-05
       60145.50C   2.799527E-05
       62147.50C   1.138963E-05
       62149.50C   1.455085E-07
       62150.50C   1.043884E-05
       62151.50C   1.651142E-13
       62152.50C   4.59594E-06
       63151.55C   8.136066E-07
       63153.55C   3.93607E-06
       64155.50C   1.686186E-07
       92233.50C   2.231592E-08
       92234.50C   1.075017E-05
       92235.50C   4.768275E-04
       92236.50C   1.417782E-04
       92238.50C   2.174501E-02
       93237.55C   4.291222E-05
       94238.50C   2.04303E-12
       94239.55C   1.515774E-04
       94240.50C   3.901499E-05
       94241.50C   1.802804E-11
       94242.50C   7.310671E-06
       95241.50C   1.333376E-06
       95242.50C   2.531374E-12
       95243.50C   1.203514E-06
C          WATER AT 300 K d=1.0000 g/cc
M3     1001.50C  6.6878-2   8016.50C  3.3439-2
MT3    LWTR.01T
C          ZIRCALOY-4 d=6.56 g/cc
M4      8016.50C -0.0012  24000.50C -0.0010  26000.55C -0.0020
       40000.50C -0.9818  50000.35C -0.0140
C          ALLOY 625 d=8.4425 g/cc
M5      6000.50C -0.1000  13027.50C -0.4000  14000.50C -0.5000
       16032.50C -0.0150  22000.50C -0.4000  24000.50C -21.500
       25055.50C -0.5000  26000.55C -5.0000  28000.50C -58.000
       41093.50C -1.8200  42000.50C -9.0000  73181.50C -1.8200
       15031.50C -0.0150  27059.50C -0.9300
M7      6000.50C -0.00220  14000.50C -0.002750  15031.50C -0.00035
       16032.50C -0.00035  25055.50C -0.0090
       26000.55C -0.98535
C          SS316B6A  1.6%  d=7.77 g/cc
M8      5010.50C -0.00288  5011.50C -0.013120
        6000.50C -0.00030  7014.50C -0.00100 14000.50C -0.0075
       15031.50C -0.00045 16032.50C -0.00030 24000.50C -0.19000
       25055.50C -0.02000 26000.55C -0.60445 28000.50C -0.13500
       42000.50C -0.02500
```

```
C    TALLIES
PRINT
```

```
AUCF-21 BW15x15 Assys, part deg, 58% Fe2O3
c      Advanced Uncanistered Fuel Waste Package
c      THICKNESS = 7 mm
c      SETTLED CASE - 8 rows
c      CELL SPECIFICATIONS
c        Assembly Sub-lattices - 1/2 Model
1      0        1  3 -13 -20   FILL=1 (0 -75 0) IMP:N=1
c      ASSEMBLY LATTICE
5      1  -3.4592  -61  60 -63  62  IMP:N=1 LAT=1 U=1
       FILL=0:3 0:7 0:0  1 1  1  1  68 66 1  1  58 58 66 80
                         58 58 64 80  58 58 62 80  60 62 80  80
                         80 80 80 56 4R        $ 1/2 model
c      FULL ASSEMBLY LATTICE POSITIONS
c       Code: boron in [B=] all panels [all], left [l], bottom, [b], right [r], top [t]
c       WET FULL ASSEMBLY LATTICE B=all
6      1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57    U=58
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
7      1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=58
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
8      1  -3.4592   64 -65 -45 IMP:N=1 FILL=9  U=58
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
9      1  -3.4592   46  64  65 IMP:N=1 FILL=10 U=58
c          TOP OF ASSEMBLY OUTSIDE LATTICE
10     1  -3.4592  -64  65  47 IMP:N=1 FILL=11 U=58
c       DRY FULL ASSEMBLY LATTICE B=all
11     3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=59
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
12     3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=59
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
13     3  -1.0000   64 -65 -45 IMP:N=1 FILL=13 U=59
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
14     3  -1.0000   46  64  65 IMP:N=1 FILL=14 U=59
c          TOP OF ASSEMBLY OUTSIDE LATTICE
15     3  -1.0000  -64  65  47 IMP:N=1 FILL=15 U=59
c       WET FULL ASSEMBLY LATTICE B=lbr
16     1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57    U=60
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
17     1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=60
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
18     1  -3.4592   64 -65 -45 IMP:N=1 FILL=9  U=60
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
19     1  -3.4592   46  64  65 IMP:N=1 FILL=10 U=60
c          TOP OF ASSEMBLY OUTSIDE LATTICE
20     1  -3.4592  -64  65  47 IMP:N=1 FILL=19 U=60
c       DRY FULL ASSEMBLY LATTICE B=lbr
21     3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=61
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
22     3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=61
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
23     3  -1.0000   64 -65 -45 IMP:N=1 FILL=13 U=61
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
24     3  -1.0000   46  64  65 IMP:N=1 FILL=14 U=61
c          TOP OF ASSEMBLY OUTSIDE LATTICE
25     3  -1.0000  -64  65  47 IMP:N=1 FILL=23 U=61
c       WET FULL ASSEMBLY LATTICE B=lb
26     1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57    U=62
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
27     1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=62
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
28     1  -3.4592   64 -65 -45 IMP:N=1 FILL=9  U=62
c          RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
29     1  -3.4592   46  64  65 IMP:N=1 FILL=18 U=62
c          TOP OF ASSEMBLY OUTSIDE LATTICE
30     1  -3.4592  -64  65  47 IMP:N=1 FILL=19 U=62
c       DRY FULL ASSEMBLY LATTICE B=lb
31     3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=63
c          LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
32     3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=63
c          BOTTOM OF ASSEMBLY OUTSIDE LATTICE
33     3  -1.0000   64 -65 -45 IMP:N=1 FILL=13 U=63
```

```
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
34    3  -1.0000   46  64  65 IMP:N=1 FILL=22 U=63
c        TOP OF ASSEMBLY OUTSIDE LATTICE
35    3  -1.0000  -64  65  47 IMP:N=1 FILL=23 U=63
c       WET FULL ASSEMBLY LATTICE B=lbt
36    1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57     U=64
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
37    1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=64
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
38    1  -3.4592   64 -65 -45 IMP:N=1 FILL=9  U=64
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
39    1  -3.4592   46  64  65 IMP:N=1 FILL=18 U=64
c        TOP OF ASSEMBLY OUTSIDE LATTICE
40    1  -3.4592  -64  65  47 IMP:N=1 FILL=11 U=64
c       DRY FULL ASSEMBLY LATTICE B=lbt
41    3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=65
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
42    3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=65
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
43    3  -1.0000   64 -65 -45 IMP:N=1 FILL=13 U=65
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
44    3  -1.0000   46  64  65 IMP:N=1 FILL=22 U=65
c        TOP OF ASSEMBLY OUTSIDE LATTICE
45    3  -1.0000  -64  65  47 IMP:N=1 FILL=15 U=65
c       WET FULL ASSEMBLY LATTICE B=lt
46    1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57     U=66
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
47    1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=66
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
48    1  -3.4592   64 -65 -45 IMP:N=1 FILL=17 U=66
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
49    1  -3.4592   46  64  65 IMP:N=1 FILL=18 U=66
c        TOP OF ASSEMBLY OUTSIDE LATTICE
50    1  -3.4592  -64  65  47 IMP:N=1 FILL=11 U=66
c       DRY FULL ASSEMBLY LATTICE B=lt
51    3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=67
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
52    3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=67
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
53    3  -1.0000   64 -65 -45 IMP:N=1 FILL=21 U=67
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
54    3  -1.0000   46  64  65 IMP:N=1 FILL=22 U=67
c        TOP OF ASSEMBLY OUTSIDE LATTICE
55    3  -1.0000  -64  65  47 IMP:N=1 FILL=15 U=67
c       WET FULL ASSEMBLY LATTICE B=lrt
56    1  -3.4592  -46  44 -47  45  IMP:N=1 FILL=57     U=68
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
57    1  -3.4592  -44 -64 -65 IMP:N=1 FILL=8  U=68
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
58    1  -3.4592   64 -65 -45 IMP:N=1 FILL=17 U=68
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
59    1  -3.4592   46  64  65 IMP:N=1 FILL=10 U=68
c        TOP OF ASSEMBLY OUTSIDE LATTICE
60    1  -3.4592  -64  65  47 IMP:N=1 FILL=11 U=68
c       DRY FULL ASSEMBLY LATTICE B=lrt
61    3  -1.0000  -46  44 -47  45  IMP:N=1 FILL=57  U=69
c        LEFT SIDE OF ASSEMBLY OUTSIDE LATTICE
62    3  -1.0000  -44 -64 -65 IMP:N=1 FILL=12 U=69
c        BOTTOM OF ASSEMBLY OUTSIDE LATTICE
63    3  -1.0000   64 -65 -45 IMP:N=1 FILL=21 U=69
c        RIGHT SIDE OF ASSEMBLY OUTSIDE LATTICE
64    3  -1.0000   46  64  65 IMP:N=1 FILL=14 U=69
c        TOP OF ASSEMBLY OUTSIDE LATTICE
65    3  -1.0000  -64  65  47 IMP:N=1 FILL=15 U=69
c     EMPTY ASSEMBLY LATTICE POSITIONS - Corner Guides and Spacers
c     BARRIER CELLS
c     Basket Material-Lid Gap
76    3  -1.0000    1 -20  13  -14     IMP:N=1 $ 1/2 model
c     Inner Barrier
77    5  -8.4425    1   3  20 -21 -14  IMP:N=1 $ 1/2 model
```

```
c      Inner Lid
78     5  -8.4425     1  14 -15 -21       IMP:N=1 $ 1/2 model
c       Gap between Inner and Outer Barrier Lids
79     3  -1.0000     1  15 -16 -21       IMP:N=1 $ 1/2 model
c       Gap between Inner and Outer Barriers
80     3  -1.0000    21 -22   1   3 -16  IMP:N=1 $ 1/2 model
c      Outer Barrier
81     7  -7.8320    22 -24   1   3 -16  IMP:N=1 $ 1/2 model
c      Outer Barrier Lid
82     7  -7.8320     1 -24  16 -17       IMP:N=1 $ 1/2 model
c      12" of Water around Container
83     3  -1.0000    24 -25   1   3 -17  IMP:N=1 $ 1/2 model
c      12" of Water above Container
84     3  -1.0000    17 -19   1 -25       IMP:N=1 $ 1/2 model
c      OUTSIDE WORLD
85     0  -1:-3:19:25  IMP:N=0  $ 1/2 model
86     6  -2.0600  -58 56 -59  57  IMP:N=1   U=80
c      MIXED PIN LATTICE
87     3  -1.0000  -26 27 -28  29  IMP:N=1 LAT=1  U=57
       FILL -8:8 -8:8 0:0  57 16R
                           57 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 57
                           57 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 57
                           57 2 2 2 2 2 4 2 2 2 4 2 2 2 2 2 57
                           57 2 2 2 4 2 2 2 2 2 2 2 4 2 2 2 57
                           57 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 57
                           57 2 2 4 2 2 4 2 2 2 4 2 2 4 2 2 57
                           57 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 57
                           57 2 2 2 2 2 2 2 6 2 2 2 2 2 2 2 57
                           57 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 57
                           57 3 3 5 3 3 5 3 3 3 5 3 3 5 3 3 57
                           57 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 57
                           57 3 3 3 5 3 3 3 3 3 3 3 5 3 3 3 57
                           57 3 3 3 3 3 5 3 3 3 5 3 3 3 3 3 57
                           57 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 57
                           57 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 57
                           57 16R
c      WET LATTICE
88     3  -1.0000  -58 56 -59  57  IMP:N=1   U=56
c      WET FUEL ROD w/ oxide
89     2    6.982925E-02 -30 -10      IMP:N=1 U=2
90     4  -6.5600   -30  10 -11 IMP:N=1 U=2
91     1  -3.4592   -30  11     IMP:N=1 U=2
92     3  -1.0000    30 -31 -11 IMP:N=1 U=2
93     1  -3.4592    30 -31  11 IMP:N=1 U=2
94     4  -6.5600    31 -32 -11 IMP:N=1 U=2
95     1  -3.4592    31 -32  11 IMP:N=1 U=2
96     1  -3.4592    32         IMP:N=1 U=2
c      WET FUEL ROD no oxide
97     2    6.982925E-02 -30 -10      IMP:N=1 U=3
98     4  -6.5600   -30  10 -11 IMP:N=1 U=3
99     3  -1.0000   -30  11     IMP:N=1 U=3
100    3  -1.0000    30 -31 -11 IMP:N=1 U=3
101    3  -1.0000    30 -31  11 IMP:N=1 U=3
102    4  -6.5600    31 -32 -11 IMP:N=1 U=3
103    3  -1.0000    31 -32  11 IMP:N=1 U=3
104    3  -1.0000    32         IMP:N=1 U=3
c      WET CONTROL ROD/GUIDE TUBE
105    3  -1.0000  -33        IMP:N=1 U=4  $ No DCRA Rod
106    1  -3.4592   33  -34   IMP:N=1 U=4
107    1  -3.4592   34  -35   IMP:N=1 U=4  $ No DCRA Cladding
108    1  -3.4592   35  -36   IMP:N=1 U=4
109    4  -6.5600   36  -37   IMP:N=1 U=4
110    1  -3.4592   37        IMP:N=1 U=4
c      DRY CONTROL ROD/GUIDE TUBE
111    3  -1.0000  -33        IMP:N=1 U=5  $ No DCRA Rod
112    3  -1.0000   33  -34   IMP:N=1 U=5
113    3  -1.0000   34  -35   IMP:N=1 U=5  $ No DCRA Cladding
114    3  -1.0000   35  -36   IMP:N=1 U=5
115    4  -6.5600   36  -37   IMP:N=1 U=5
116    3  -1.0000   37        IMP:N=1 U=5
```

```
c      WET INSTRUMENTATION TUBE
117    3  -1.0000  -38           IMP:N=1 U=6
118    4  -6.5600   38 -39       IMP:N=1 U=6
119    1  -3.4592   39           IMP:N=1 U=6
c      DRY INSTRUMENTATION TUBE
120    3  -1.0000  -38           IMP:N=1 U=7
121    4  -6.5600   38 -39       IMP:N=1 U=7
122    3  -1.0000   39           IMP:N=1 U=7
c      FUEL CELL BASKET STRUCTURE
c      Code: boron in [B=] all panels [all], left [l], bottom, [b], right [r], top [t]
c      FUEL CELL BASKET STRUCTURE -        WET - Borated panels
c         WATER GAP     - ASSEMBLY LEFT
123    1  -3.4592   52               IMP:N=1 U=8
c         SS PANEL - ASSEMBLY LEFT
126    8  -7.7700  -52           IMP:N=1 U=8
c         WATER GAP     - ASSEMBLY BOTTOM
127    1  -3.4592   53               IMP:N=1 U=9
c         SS PANEL - ASSEMBLY BOTTOM
130    8  -7.7700  -53           IMP:N=1 U=9
c         WATER GAP     - ASSEMBLY RIGHT
131    1  -3.4592  -54               IMP:N=1 U=10
c         SS PANEL - ASSEMBLY RIGHT
134    8  -7.7700   54            IMP:N=1 U=10
c         WATER GAP     - ASSEMBLY TOP
135    1  -3.4592  -55               IMP:N=1 U=11
c         SS PANEL - ASSEMBLY TOP
138    8  -7.7700   55           IMP:N=1 U=11
c      FUEL CELL BASKET STRUCTURE -          DRY - Borated panels
c         GAP      - ASSEMBLY LEFT
139    3  -1.0000   52               IMP:N=1 U=12
c         SS PANEL - ASSEMBLY LEFT
142    8  -7.7700  -52           IMP:N=1 U=12
c         GAP      - ASSEMBLY BOTTOM
143    3  -1.0000   53               IMP:N=1 U=13
c         SS PANEL - ASSEMBLY BOTTOM
146    8  -7.7700  -53           IMP:N=1 U=13
c         GAP      - ASSEMBLY RIGHT
147    3  -1.0000  -54               IMP:N=1 U=14
c         SS PANEL - ASSEMBLY RIGHT
150    8  -7.7700   54            IMP:N=1 U=14
c         GAP      - ASSEMBLY TOP
151    3  -1.0000  -55               IMP:N=1 U=15
c         SS PANEL - ASSEMBLY TOP
154    8  -7.7700   55           IMP:N=1 U=15
c      FUEL CELL BASKET STRUCTURE -        WET - Unborated panels
c         WATER GAP     - ASSEMBLY LEFT
155    1  -3.4592   52               IMP:N=1 U=16
c         PANEL - ASSEMBLY LEFT
158    1  -3.4592  -52           IMP:N=1 U=16
c         WATER GAP     - ASSEMBLY BOTTOM
159    1  -3.4592   53               IMP:N=1 U=17
c         PANEL - ASSEMBLY BOTTOM
162    1  -3.4592  -53           IMP:N=1 U=17
c         WATER GAP     - ASSEMBLY RIGHT
163    1  -3.4592  -54               IMP:N=1 U=18
c         PANEL - ASSEMBLY RIGHT
166    1  -3.4592   54            IMP:N=1 U=18
c         WATER GAP     - ASSEMBLY TOP
167    1  -3.4592  -55               IMP:N=1 U=19
c         PANEL - ASSEMBLY TOP
170    1  -3.4592   55           IMP:N=1 U=19
c      FUEL CELL BASKET STRUCTURE -          DRY - Unborated panels
c         GAP      - ASSEMBLY LEFT
171    3  -1.0000   52               IMP:N=1 U=20
c         PANEL - ASSEMBLY LEFT
174    3  -1.0000  -52           IMP:N=1 U=20
c         GAP      - ASSEMBLY BOTTOM
175    3  -1.0000   53               IMP:N=1 U=21
c         PANEL - ASSEMBLY BOTTOM
178    3  -1.0000  -53           IMP:N=1 U=21
```

```
C        GAP     - ASSEMBLY RIGHT
179   3  -1.0000  -54              IMP:N=1 U=22
C        PANEL - ASSEMBLY RIGHT
182   3  -1.0000   54          IMP:N=1 U=22
C        GAP     - ASSEMBLY TOP
183   3  -1.0000  -55              IMP:N=1 U=23
C        PANEL - ASSEMBLY TOP
186   3  -1.0000   55          IMP:N=1 U=23

C     SURFACE SPECIFICATIONS
1*    PX    0.0
3*    PZ    0.00
10    PZ  180.0860     $ TOP ACTIVE FUEL
11    PZ  201.2360     $ TOP FUEL HARDWARE
13    PZ  228.75       $ TOP OF BASKET MATERIAL
14    PZ  229.25       $ TOP RING/WATER GAP
15    PZ  231.75       $ TOP INNER LID
16    PZ  234.75       $ TOP LID GAP
17    PZ  245.75       $ TOP OUTER LID
19    PZ  298.75       $ TOP REFLECTOR REGION
20    CZ   71.095      $ ID OF INNER BARRIER
21    CZ   73.095      $ OD OF INNER BARRIER
22    CZ   73.10       $ ID OF OUTER BARRIER
24    CZ   83.10       $ OD OF OUTER BARRIER
25    CZ  113.60       $ OD OF REFLECTOR REGION
C     PIN LATTICE BOUNDS
26    PX  0.72136
27    PX -0.72136
28    PY  0.72136
29    PY -0.72136
C      FUEL ROD
30    CZ  0.468122
31    CZ  0.478790
32    CZ  0.546100
C      CONTROL ROD/GUIDE TUBE
33    CZ  0.45340  $ 0.49022
34    CZ  0.46990  $ 0.50292
35    CZ  0.54610  $ 0.56007
36    CZ  0.62230  $ 0.63246
37    CZ  0.67310
C      INSTRUMENTATION TUBE
38    CZ  0.56007
39    CZ  0.62611
C     ASSEMBLY LATTICE BOUNDS Actual
44    PX  -10.65  $ ACTUAL 10.82025
45    PY  -10.65
46    PX   10.65
47    PY   10.65
52    PX  -10.650001  $ UCF Intact Inside Tube ID
53    PY  -10.650001
54    PX   10.650001
55    PY   10.650001
56    PX  -11.95   $ UCF Intact Outside Tube ID
57    PY  -11.95
58    PX   11.95
59    PY   11.95
C     FUEL CELL LATTICE BOUNDS
60    PX  -11.0       $ ACTUAL 12.30
61    PX   11.0
62    PY  -11.0
63    PY   11.0
C     45 degree planes
64    P    1. -1.  0. 0.
65    P    1.  1.  0. 0.
C     EXTRA CARDS

MODE  N
KCODE    4000 1. 7 37
KSRC    -4.3  -5.7 1.   -2.8  -5.7 5.   -1.4  -5.7 10.    0.    -5.7  5.
         1.44 -5.7 3.    2.88 -5.7 8.    4.32 -5.7  9.
```

```
       -5.7  -4.3 2.  -4.3  -4.3 1.  -2.8  -4.3  5.  -1.4  -4.3 10.
        0.   -4.3 5.   1.44 -4.3 3.   2.88 -4.3  8.   4.32 -4.3  9.
       -5.7  -2.9 2.  -4.3  -2.9 1.                  -1.4  -2.9 10.
        0.   -2.9 5.                  2.88 -2.9  8.   4.32 -2.0  9.
       -5.7  -1.4 2.  -4.3  -1.4 1.  -2.8  -1.4  5.  -1.4  -1.4 10.
        0.   -1.4 5.   1.44 -1.4 3.   2.88 -1.4  8.   4.32 -1.4  9.
       -5.7   0.0 2.  -4.3   0.0 1.  -2.8   0.0  5.  -1.4   0.0 10.
                       1.44  0.0 3.   2.88  0.0  8.   4.32  0.0  9.
       -5.7   1.4 2.                 -2.8   1.4  5.  -1.4   1.4 10.
        0.    1.4 5.   1.44  1.4 3.   2.88  1.4  8.   4.32  1.4  9.
       -5.7   2.9 2.  -4.3   2.9 1.  -2.8   2.9  5.  -1.4   2.9 10.
        0.    2.9 5.   1.44  2.9 3.   2.88  2.9  8.   4.32  2.9  9.
       -5.7   4.3 2.  -4.3   4.3 1.  -2.8   4.3  5.  -1.4   4.3 10.
        0.    4.3 5.   1.44  4.3 3.   2.88  4.3  8.   4.32  4.3  9.
c      MATERIAL SPECIFICATIONS
c         WATER AT 300 K d=1.0000 g/cc w/ 58% Fe2O3
m1     1001.50c  2.8089-2    8016.50c  4.8430-2  26000.55c 2.2924-2
mt1    lwtr.01t
c      e49b34.sum    2000  years decay
m2     8016.50c    .046947
      42095.50c   4.794679E-05
      44101.50c   4.354501E-05
      43099.50c   4.625092E-05
      45103.50c   2.608717E-05
      47109.50c   3.714096E-06
      60143.50c   3.74851E-05
      60145.50c   2.799527E-05
      62147.50c   1.138963E-05
      62149.50c   1.455085E-07
      62150.50c   1.043884E-05
      62151.50c   1.651142E-13
      62152.50c   4.59594E-06
      63151.55c   8.136066E-07
      63153.55c   3.93607E-06
      64155.50c   1.686186E-07
      92233.50c   2.231592E-08
      92234.50c   1.075017E-05
      92235.50c   4.768275E-04
      92236.50c   1.417782E-04
      92238.50c   2.174501E-02
      93237.55c   4.291222E-05
      94238.50c   2.04303E-12
      94239.55c   1.515774E-04
      94240.50c   3.901499E-05
      94241.50c   1.802804E-11
      94242.50c   7.310671E-06
      95241.50c   1.333376E-06
      95242.50c   2.531374E-12
      95243.50c   1.203514E-06
c          WATER AT 300 K d=1.0000 g/cc
m3     1001.50c  6.6878-2   8016.50c  3.3439-2
mt3    lwtr.01t
c          ZIRCALOY-4 d=6.56 g/cc
m4      8016.50c -0.0012  24000.50c -0.0010  26000.55c -0.0020
       40000.50c -0.9818  50000.35c -0.0140
c         ALLOY 625 d=8.4425 g/cc
m5      6000.50c -0.1000  13027.50c -0.4000  14000.50c -0.5000
       16032.50c -0.0150  22000.50c -0.4000  24000.50c -21.500
       25055.50c -0.5000  26000.55c -5.0000  28000.50c -58.000
       41093.50c -1.8200  42000.50c -9.0000  73181.50c -1.8200
       15031.50c -0.0150  27059.50c -0.9300
c          WATER AT 300 K d=1.0000 g/cc w/ 25% Fe2O3
m6     1001.50c  5.3502-2    8016.50c  3.9900-2  26000.55c 9.8803-3
mt6    lwtr.01t
c         A516 CARBON STEEL d=7.832 g/cc
m7      6000.50c -0.00220  14000.50c -0.002750  15031.50c -0.00035
       16032.50c -0.00035  25055.50c -0.0090
       26000.55c -0.98535
c         SS316B6A  1.6%  d=7.77 g/cc
m8      5010.50c -0.00288  5011.50c -0.013120
```

```
      6000.50C -0.00030  7014.50C -0.00100 14000.50C -0.0075
     15031.50C -0.00045 16032.50C -0.00030 24000.50C -0.19000
     25055.50C -0.02000 26000.55C -0.60445 28000.50C -0.13500
     42000.50C -0.02500
C    TALLIES
PRINT
```

```
AUCF-21 BW15x15, full deg, 33% Fe2O3 uniform
c     CELL SPECIFICATIONS
c       Assembly Sub-lattices - 1/2 Model
1     0        1  3 -13 -20    FILL=1 (0 -74 0) IMP:N=1
c     ASSEMBLY LATTICE
5     3  -2.3992  -61  60 -63  62  IMP:N=1 LAT=1 U=1
      FILL=0:3 0:7 0:0  1 1  1  1  56 56 1  1  56 56 56 1
                        56 56 56 1  56 56 56 1  56 56 1  1
                        1 1  1  1   1 1 1 1       $ 1/2 model
c     BARRIER CELLS
c     Basket Material-Lid Gap
76    1  -1.0000    1 -20  13  -14      IMP:N=1 $ 1/2 model
c     Inner Barrier
77    5  -8.4425    1   3  20 -21 -14  IMP:N=1 $ 1/2 model
c     Inner Lid
78    5  -8.4425    1  14 -15 -21      IMP:N=1 $ 1/2 model
c      Gap between Inner and Outer Barrier Lids
79    1  -1.0000    1  15 -16 -21      IMP:N=1 $ 1/2 model
c      Gap between Inner and Outer Barriers
80    1  -1.0000   21 -22   1   3 -16  IMP:N=1 $ 1/2 model
c     Outer Barrier
81    7  -7.8320   22 -24   1   3 -16  IMP:N=1 $ 1/2 model
c     Outer Barrier Lid
82    7  -7.8320    1 -24  16 -17      IMP:N=1 $ 1/2 model
c     12" of Water around Container
83    1  -1.0000   24 -25   1   3 -17  IMP:N=1 $ 1/2 model
c     12" of Water above Container
84    1  -1.0000   17 -19   1 -25      IMP:N=1 $ 1/2 model
c     OUTSIDE WORLD
85    0  -1:-3:19:25  IMP:N=0  $ 1/2 model
c     WET PIN LATTICE
86    3  -2.3992  -26 27 -28  29  IMP:N=1 LAT=1  U=56
      FILL -8:8 -8:8 0:0  56 16R  56 2 14R 56  56 2 14R 56
                          56 2 4R 4 2 2R 4 2 4R 56
                          56 2 2R 4 2 6R 4 2 2R 56  56 2 14R 56
                          56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                          56 2 14R 56
                          56 2 6R 6 2 6R 56
                          56 2 14R 56
                          56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                          56 2 14R 56  56 2 2R 4 2 6R 4 2 2R 56
                          56 2 4R 4 2 2R 4 2 4R 56
                          56 2 14R 56  56 2 14R 56  56 16R
c     MIXED PIN LATTICE
c     WET FUEL ROD
89    2     6.982844E-02 -30 -10     IMP:N=1 U=2
90    4  -6.5600    -30  10 -11 IMP:N=1 U=2
91    3  -2.3992    -30  11      IMP:N=1 U=2
92    1  -1.0000     30 -31 -11 IMP:N=1 U=2
93    3  -2.3992     30 -31  11 IMP:N=1 U=2
94    4  -6.5600     31 -32 -11 IMP:N=1 U=2
95    3  -2.3992     31 -32  11 IMP:N=1 U=2
96    3  -2.3992     32          IMP:N=1 U=2
c     WET CONTROL ROD/GUIDE TUBE
105   1  -1.0000  -33        IMP:N=1 U=4  $ No DCRA Rod
106   3  -2.3992   33  -34  IMP:N=1 U=4
107   3  -2.3992   34  -35  IMP:N=1 U=4  $ No DCRA Cladding
108   3  -2.3992   35  -36  IMP:N=1 U=4
109   4  -6.5600   36  -37  IMP:N=1 U=4
110   3  -2.3992   37       IMP:N=1 U=4
c     WET INSTRUMENTATION TUBE
117   1  -1.0000  -38         IMP:N=1 U=6
118   4  -6.5600   38 -39     IMP:N=1 U=6
119   3  -2.3992   39         IMP:N=1 U=6

c     SURFACE SPECIFICATIONS
1*   PX    0.0
3*   PZ    0.00
10   PZ  180.0860    $ TOP ACTIVE FUEL
11   PZ  201.2360    $ TOP FUEL HARDWARE
```

```
13   PZ  228.75      $ TOP OF BASKET MATERIAL
14   PZ  229.25      $ TOP RING/WATER GAP
15   PZ  231.75      $ TOP INNER LID
16   PZ  234.75      $ TOP LID GAP
17   PZ  245.75      $ TOP OUTER LID
19   PZ  298.75      $ TOP REFLECTOR REGION
20   CZ   71.095     $ ID OF INNER BARRIER
21   CZ   73.095     $ OD OF INNER BARRIER
22   CZ   73.10      $ ID OF OUTER BARRIER
24   CZ   83.10      $ OD OF OUTER BARRIER
25   CZ  113.60      $ OD OF REFLECTOR REGION
C    PIN LATTICE BOUNDS
26   PX  0.72136
27   PX -0.72136
28   PY  0.72136
29   PY -0.72136
C     FUEL ROD
30   CZ  0.468122
31   CZ  0.478790
32   CZ  0.546100
C     CONTROL ROD/GUIDE TUBE
33   CZ  0.45340  $ 0.49022
34   CZ  0.46990  $ 0.50292
35   CZ  0.54610  $ 0.56007
36   CZ  0.62230  $ 0.63246
37   CZ  0.67310
C     INSTRUMENTATION TUBE
38   CZ  0.56007
39   CZ  0.62611
C    ASSEMBLY LATTICE BOUNDS Actual
44   PX  -10.65  $ ACTUAL 10.82025
45   PY  -10.65
46   PX   10.65
47   PY   10.65
52   PX  -10.650001  $ UCF Intact Inside Tube ID
53   PY  -10.650001
54   PX   10.650001
55   PY   10.650001
56   PX  -11.95    $ UCF Intact Outside Tube ID
57   PY  -11.95
58   PX   11.95
59   PY   11.95
C    FUEL CELL LATTICE BOUNDS
60   PX  -10.65     $ ACTUAL 12.30
61   PX   10.65
62   PY  -10.65
63   PY   10.65
C    45 degree planes
64   P     1. -1.  0. 0.
65   P     1.  1.  0. 0.
C    EXTRA CARDS

MODE  N
KCODE   4000 1. 7 37
KSRC   -4.3  -5.7 1.   -2.8  -5.7 5.   -1.4  -5.7 10.   0.    -5.7  5.
        1.44 -5.7 3.    2.88 -5.7 8.    4.32 -5.7  9.
       -5.7  -4.3 2.   -4.3  -4.3 1.   -2.8  -4.3  5.  -1.4  -4.3 10.
        0.   -4.3 5.    1.44 -4.3 3.    2.88 -4.3  8.   4.32 -4.3  9.
       -5.7  -2.9 2.   -4.3  -2.9 1.                   -1.4  -2.9 10.
        0.   -2.9 5.                    2.88 -2.9  8.   4.32 -2.0  9.
       -5.7  -1.4 2.   -4.3  -1.4 1.   -2.8  -1.4  5.  -1.4  -1.4 10.
        0.   -1.4 5.    1.44 -1.4 3.    2.88 -1.4  8.   4.32 -1.4  9.
       -5.7   0.0 2.   -4.3   0.0 1.   -2.8   0.0  5.  -1.4   0.0 10.
                        1.44  0.0 3.    2.88  0.0  8.   4.32  0.0  9.
       -5.7   1.4 2.                   -2.8   1.4  5.  -1.4   1.4 10.
        0.    1.4 5.    1.44  1.4 3.    2.88  1.4  8.   4.32  1.4  9.
       -5.7   2.9 2.   -4.3   2.9 1.   -2.8   2.9  5.  -1.4   2.9 10.
        0.    2.9 5.    1.44  2.9 3.    2.88  2.9  8.   4.32  2.9  9.
       -5.7   4.3 2.   -4.3   4.3 1.   -2.8   4.3  5.  -1.4   4.3 10.
        0.    4.3 5.    1.44  4.3 3.    2.88  4.3  8.   4.32  4.3  9.
```

```
c      MATERIAL SPECIFICATIONS
c         WATER AT 300 K d=1.0000 g/cc
M1     1001.50C  6.6878-2    8016.50C  3.3439-2
MT1    LWTR.01T
c
c      e49b34.sum   8000  years decay
M2       8016.50C   .046947
       42095.50C   4.794679E-05
       44101.50C   4.354501E-05
       43099.50C   4.527722E-05
       45103.50C   2.608717E-05
       47109.50C   3.714096E-06
       60143.50C   3.74851E-05
       60145.50C   2.799527E-05
       62147.50C   1.138963E-05
       62149.50C   1.455085E-07
       62150.50C   1.043884E-05
       62151.50C   1.395893E-33
       62152.50C   4.59594E-06
       63151.55C   8.136066E-07
       63153.55C   3.93607E-06
       64155.50C   1.686186E-07
       92233.50C   1.064139E-07
       92234.50C   1.059586E-05
       92235.50C   5.008994E-04
       92236.50C   1.60138E-04
       92238.50C   2.174501E-02
       93237.55C   4.413103E-05
       94238.50C   5.360425E-25
       94239.55C   1.284128E-04
       94240.50C   2.071104E-05
       94241.50C   1.103656E-11
       94242.50C   7.211206E-06
       95241.50C   4.364685E-10
       95242.50C   3.923878E-25
       95243.50C   6.834769E-07
c         WATER AT 300 K d=1.0000 g/cc w/ 33% Fe2O3 w/ 0% B10
M3     1001.50C  4.4808-2    8016.50C  4.1968-2  26000.55C 1.3043-2
MT3    LWTR.01T
c         ZIRCALOY-4 d=6.56 g/cc
M4     8016.50C -0.0012  24000.50C -0.0010  26000.55C -0.0020
       40000.50C -0.9818  50000.35C -0.0140
c        ALLOY 625 d=8.4425 g/cc
M5     6000.50C -0.1000  13027.50C -0.4000  14000.50C -0.5000
       16032.50C -0.0150  22000.50C -0.4000  24000.50C -21.500
       25055.50C -0.5000  26000.55C -5.0000  28000.50C -58.000
       41093.50C -1.8200  42000.50C -9.0000  73181.50C -1.8200
       15031.50C -0.0150  27059.50C -0.9300
c        A516 CARBON STEEL d=7.832 g/cc
M7     6000.50C -0.00220  14000.50C -0.002750  15031.50C -0.00035
       16032.50C -0.00035  25055.50C -0.0090
       26000.55C -0.98535
c        SS316B6A  1.6%  d=7.77 g/cc
M8     5010.50C -0.00288  5011.50C -0.013120
        6000.50C -0.00030  7014.50C -0.00100 14000.50C -0.0075
       15031.50C -0.00045 16032.50C -0.00030 24000.50C -0.19000
       25055.50C -0.02000 26000.55C -0.60445 28000.50C -0.13500
       42000.50C -0.02500
c      TALLIES
PRINT
```

```
AUCF-21 BW15x15, full deg, 58% Fe2O3, settled
c      CELL SPECIFICATIONS
c        Assembly Sub-lattices - 1/2 Model
1      0        1  3 -13 -20   FILL=1 (0 -74 0) IMP:N=1
c      ASSEMBLY LATTICE
5      1  -3.4592  -61  60 -63  62  IMP:N=1 LAT=1 U=1
       FILL=0:3 0:7 0:0  1 3R  56 56 1  1  56 56 56 1
                         56 56 56 1  59 59 59 60  57 57 58  58
                         58 3R   58 3R       $ 1/2 model
c      BARRIER CELLS
c      Basket Material-Lid Gap
76     8  -1.0000    1 -20  13  -14     IMP:N=1 $ 1/2 model
c      Inner Barrier
77     5  -8.4425    1   3  20 -21 -14  IMP:N=1 $ 1/2 model
c      Inner Lid
78     5  -8.4425    1  14 -15 -21      IMP:N=1 $ 1/2 model
c       Gap between Inner and Outer Barrier Lids
79     8  -1.0000    1  15 -16 -21      IMP:N=1 $ 1/2 model
c       Gap between Inner and Outer Barriers
80     8  -1.0000   21 -22   1   3 -16  IMP:N=1 $ 1/2 model
c      Outer Barrier
81     7  -7.8320   22 -24   1   3 -16  IMP:N=1 $ 1/2 model
c      Outer Barrier Lid
82     7  -7.8320    1 -24  16 -17      IMP:N=1 $ 1/2 model
c      12" of Water around Container
83     8  -1.0000   24 -25   1   3 -17  IMP:N=1 $ 1/2 model
c      12" of Water above Container
84     8  -1.0000   17 -19   1 -25      IMP:N=1 $ 1/2 model
c      OUTSIDE WORLD
85     0  -1:-3:19:25  IMP:N=0  $ 1/2 model
c      WET w/ Fe2O3 PIN LATTICE
86     1  -3.4592  -26 27 -28  29  IMP:N=1 LAT=1  U=56
       FILL -8:8 -8:8 0:0  56 16R  56 2 14R 56  56 2 14R 56
                           56 2 4R 4 2 2R 4 2 4R 56
                           56 2 2R 4 2 6R 4 2 2R 56  56 2 14R 56
                           56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                           56 2 14R 56
                           56 2 6R 6 2 6R 56
                           56 2 14R 56
                           56 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 56
                           56 2 14R 56  56 2 2R 4 2 6R 4 2 2R 56
                           56 2 4R 4 2 2R 4 2 4R 56
                           56 2 14R 56  56 2 14R 56  56 16R
c      Water LATTICE
87     8  -1.0000  -58 56 -59  57  IMP:N=1    U=58
c      WET PIN LATTICE
88     8  -1.0000  -26 27 -28  29  IMP:N=1 LAT=1  U=57
       FILL -8:8 -8:8 0:0  57 16R  57 3 14R 57  57 3 14R 57
                           57 3 4R 5 3 2R 5 3 4R 57
                           57 3 2R 5 3 6R 5 3 2R 57  57 3 14R 57
                           57 3 3 5 3 3 5 3 2R 5 3 3 5 3 3 57
                           57 3 14R 57
                           57 3 6R 7 3 6R 57
                           57 3 14R 57
                           57 3 3 5 3 3 5 3 2R 5 3 3 5 3 3 57
                           57 3 14R 57  57 3 2R 5 3 6R 5 3 2R 57
                           57 3 4R 5 3 2R 5 3 4R 57
                           57 3 14R 57  57 3 14R 57  57 16R
c      WET W/ Fe2O3 FUEL ROD
89     2     6.982783E-02 -30 -10      IMP:N=1 U=2
90     4  -6.5600    -30  10 -11 IMP:N=1 U=2
91     1  -3.4592    -30  11      IMP:N=1 U=2
92     8  -1.0000     30 -31 -11 IMP:N=1 U=2
93     1  -3.4592     30 -31  11 IMP:N=1 U=2
94     4  -6.5600     31 -32 -11 IMP:N=1 U=2
95     1  -3.4592     31 -32  11 IMP:N=1 U=2
96     1  -3.4592     32          IMP:N=1 U=2
c      Wet FUEL ROD
97     2     6.982783E-02 -30 -10      IMP:N=1 U=3
98     4  -6.5600    -30  10 -11 IMP:N=1 U=3
```

```
99    8  -1.0000   -30  11       IMP:N=1 U=3
100   8  -1.0000    30 -31 -11 IMP:N=1 U=3
101   8  -1.0000    30 -31  11 IMP:N=1 U=3
102   4  -6.5600    31 -32 -11 IMP:N=1 U=3
103   8  -1.0000    31 -32  11 IMP:N=1 U=3
104   8  -1.0000    32          IMP:N=1 U=3
c     WET w/ Fe2O3 CONTROL ROD/GUIDE TUBE
105   8  -1.0000  -33        IMP:N=1 U=4  $ No DCRA Rod
c     105   9  -7.8300  -33        IMP:N=1 U=4  $ DCRA Rod
106   1  -3.4592   33  -34  IMP:N=1 U=4
107   1  -3.4592   34  -35  IMP:N=1 U=4  $ No DCRA Cladding
c     107   4  -6.5600   34  -35  IMP:N=1 U=4  $ DCRA Cladding
108   1  -3.4592   35  -36  IMP:N=1 U=4
109   4  -6.5600   36  -37  IMP:N=1 U=4
110   1  -3.4592   37       IMP:N=1 U=4
c     Wet CONTROL ROD/GUIDE TUBE
111   8  -1.0000  -33        IMP:N=1 U=5  $ No DCRA Rod
c     111   9  -7.8300  -33        IMP:N=1 U=5  $ DCRA Rod
112   8  -1.0000   33  -34  IMP:N=1 U=5
113   8  -1.0000   34  -35  IMP:N=1 U=5  $ No DCRA Cladding
c     113   4  -6.5600   34  -35  IMP:N=1 U=5  $ DCRA Cladding
114   8  -1.0000   35  -36  IMP:N=1 U=5
115   4  -6.5600   36  -37  IMP:N=1 U=5
116   8  -1.0000   37       IMP:N=1 U=5
c     WET w/ Fe2O3 INSTRUMENTATION TUBE
117   8  -1.0000  -38          IMP:N=1 U=6
118   4  -6.5600   38 -39      IMP:N=1 U=6
119   1  -3.4592   39          IMP:N=1 U=6
c     Wet INSTRUMENTATION TUBE
120   8  -1.0000  -38          IMP:N=1 U=7
121   4  -6.5600   38 -39      IMP:N=1 U=7
122   8  -1.0000   39          IMP:N=1 U=7
c     WET w/ Partial Fe2O3 PIN LATTICE
123   1  -3.4592  -26 27 -28  29  IMP:N=1 LAT=1  U=59
      FILL -8:8 -8:8 0:0  59 16R  59 2 14R 59  59 2 14R 59
                          59 2 4R 4 2 2R 4 2 4R 59
                          59 2 2R 4 2 6R 4 2 2R 59  59 2 14R 59
                          59 2 2 4 2 2 4 2 2R 4 2 2 4 2 2 59
                          59 2 14R 59
                          59 2 6R 6 2 6R 59
                          59 3 14R 59
                          59 3 3 5 3 3 5 3 2R 5 3 3 5 3 3 59
                          59 3 14R 59  59 3 2R 5 3 6R 5 3 2R 59
                          59 3 4R 5 3 2R 5 3 4R 59
                          59 3 14R 59  59 3 14R 59  59 16R
c     Half Water/Half Fe2O3 LATTICE
124   8  -1.0000  -58 56 -59  66  IMP:N=1   U=60
125   1  -3.4592  -58 56 -66  57  IMP:N=1   U=60

c     SURFACE SPECIFICATIONS
1*    PX    0.0
3*    PZ    0.00
10    PZ  180.0860    $ TOP ACTIVE FUEL
11    PZ  201.2360    $ TOP FUEL HARDWARE
c     12    PZ  226.75     $ TOP TUBE - (Shielding Model)
13    PZ  228.75      $ TOP OF BASKET MATERIAL
14    PZ  229.25      $ TOP RING/WATER GAP
15    PZ  231.75      $ TOP INNER LID
16    PZ  234.75      $ TOP LID GAP
17    PZ  245.75      $ TOP OUTER LID
c     18    PZ  268.25     $ TOP SKIRT - (Shielding Model)
19    PZ  298.75      $ TOP REFLECTOR REGION
20    CZ   71.095     $ ID OF INNER BARRIER
21    CZ   73.095     $ OD OF INNER BARRIER
22    CZ   73.10      $ ID OF OUTER BARRIER
c     23    CZ   76.45     $ ID OF SKIRT LIP - (Shielding Model)
24    CZ   83.10      $ OD OF OUTER BARRIER
25    CZ  113.60      $ OD OF REFLECTOR REGION
c     PIN LATTICE BOUNDS
26    PX  0.72136
```

```
27   PX -0.72136
28   PY  0.72136
29   PY -0.72136
C     FUEL ROD
30   CZ  0.468122
31   CZ  0.478790
32   CZ  0.546100
C     CONTROL ROD/GUIDE TUBE
33   CZ  0.45340  $ 0.49022
34   CZ  0.46990  $ 0.50292
35   CZ  0.54610  $ 0.56007
36   CZ  0.62230  $ 0.63246
37   CZ  0.67310
C     INSTRUMENTATION TUBE
38   CZ  0.56007
39   CZ  0.62611
C    ASSEMBLY LATTICE BOUNDS Actual
56   PX  -11.95    $ UCF Intact Outside Tube ID
57   PY  -11.95
58   PX   11.95
59   PY   11.95
C    FUEL CELL LATTICE BOUNDS
60   PX  -10.65     $ ACTUAL 12.30
61   PX   10.65
62   PY  -10.65
63   PY   10.65
C    plane for half water/half oxide lattice cell
66   PY   0.72136

MODE  N
C      VOL   88J
KCODE   4000 1. 7 37
KSRC    -4.3  -5.7 1.  -2.8  -5.7 5.  -1.4  -5.7 10.   0.   -5.7  5.
         1.44 -5.7 3.   2.88 -5.7 8.   4.32 -5.7  9.
        -5.7  -4.3 2.  -4.3  -4.3 1.  -2.8  -4.3  5.  -1.4  -4.3 10.
         0.   -4.3 5.   1.44 -4.3 3.   2.88 -4.3  8.   4.32 -4.3  9.
        -5.7  -2.9 2.  -4.3  -2.9 1.                  -1.4  -2.9 10.
         0.   -2.9 5.                  2.88 -2.9  8.   4.32 -2.0  9.
        -5.7  -1.4 2.  -4.3  -1.4 1.  -2.8  -1.4  5.  -1.4  -1.4 10.
         0.   -1.4 5.   1.44 -1.4 3.   2.88 -1.4  8.   4.32 -1.4  9.
        -5.7   0.0 2.  -4.3   0.0 1.  -2.8   0.0  5.  -1.4   0.0 10.
                        1.44  0.0 3.   2.88  0.0  8.   4.32  0.0  9.
        -5.7   1.4 2.                 -2.8   1.4  5.  -1.4   1.4 10.
         0.    1.4 5.   1.44  1.4 3.   2.88  1.4  8.   4.32  1.4  9.
        -5.7   2.9 2.  -4.3   2.9 1.  -2.8   2.9  5.  -1.4   2.9 10.
         0.    2.9 5.   1.44  2.9 3.   2.88  2.9  8.   4.32  2.9  9.
.       -5.7   4.3 2.  -4.3   4.3 1.  -2.8   4.3  5.  -1.4   4.3 10.
         0.    4.3 5.   1.44  4.3 3.   2.88  4.3  8.   4.32  4.3  9.
C       MATERIAL SPECIFICATIONS
C          WATER AT 300 K d=3.4592 g/cc w/ 58% Fe2O3
M1     1001.50C  2.8089-2    8016.50C  4.8430-2  26000.55C 2.2924-2
MT1    LWTR.01T
C      e49b34.sum   25000  years decay
M2      8016.50C    .046947
      42095.50C    4.794679E-05
      44101.50C    4.354501E-05
      43099.50C    4.284296E-05
      45103.50C    2.608717E-05
      47109.50C    3.714096E-06
      60143.50C    3.74851E-05
      60145.50C    2.799527E-05
      62147.50C    1.138963E-05
      62149.50C    1.455085E-07
      62150.50C    1.043884E-05
      62152.50C    4.59594E-06
      63151.55C    8.136066E-07
      63153.55C    3.93607E-06
      64155.50C    1.686186E-07
      92233.50C    3.326725E-07
      92234.50C    1.018437E-05
```

```
     92235.50C    5.531404E-04
     92236.50C    1.774777E-04
     92238.50C    2.174501E-02
     93237.55C    4.392789E-05
     94239.55C    7.906197E-05
     94240.50C    3.440139E-06
     94241.50C    2.761636E-12
     94242.50C    7.012276E-06
     95241.50C    8.639479E-11
     95243.50C    1.386765E-07
C          Air d=0.001225 g/cc
M3     7014.50C  -0.80    8016.50C  -0.20
C          ZIRCALOY-4 d=6.56 g/cc
M4     8016.50C -0.0012  24000.50C -0.0010  26000.55C -0.0020
      40000.50C -0.9818  50000.35C -0.0140
C         ALLOY 625 d=8.4425 g/cc
M5     6000.50C -0.1000  13027.50C -0.4000  14000.50C -0.5000
      16032.50C -0.0150  22000.50C -0.4000  24000.50C -21.500
      25055.50C -0.5000  26000.55C -5.0000  28000.50C -58.000
      41093.50C -1.8200  42000.50C -9.0000  73181.50C -1.8200
      15031.50C -0.0150  27059.50C -0.9300
C         A516 CARBON STEEL d=7.832 g/cc
M7     6000.50C -0.00220  14000.50C -0.002750  15031.50C -0.00035
      16032.50C -0.00035  25055.50C -0.0090
      26000.55C -0.98535
C          WATER AT 300 K d=1.0000 g/cc
M8     1001.50C  2.    8016.50C  1.
MT8    LWTR.01T
C     TALLIES
PRINT
```

0 nuclide radioactivity, curies
basis =single reactor assembly

	initial	608.8 d	1217.5 d	1826.3 d	2435.0 d	3043.8 d	3652.5 d
total	2.29E+04	2.73E+03	9.75E+02	4.54E+02	2.54E+02	1.57E+02	1.01E+02

0 nuclide radioactivity, curies
basis =single reactor assembly

	initial	608.8 d	1217.5 d	1826.3 d	2435.0 d	3043.8 d	3652.5 d
ra226	5.24E-08	7.83E-08	1.13E-07	1.57E-07	2.09E-07	2.71E-07	3.42E-07
ac227	3.51E-06	5.78E-06	7.94E-06	1.00E-05	1.21E-05	1.40E-05	1.59E-05
th230	2.98E-05	4.21E-05	5.44E-05	6.68E-05	7.94E-05	9.20E-05	1.05E-04
pa231	4.67E-05	4.74E-05	4.81E-05	4.88E-05	4.95E-05	5.02E-05	5.09E-05
u233	1.63E-05	1.77E-05	1.90E-05	2.03E-05	2.17E-05	2.30E-05	2.43E-05
u234	7.95E-01	8.01E-01	8.08E-01	8.14E-01	8.21E-01	8.27E-01	8.33E-01
u235	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02
u236	1.68E-01	1.68E-01	1.69E-01	1.69E-01	1.69E-01	1.69E-01	1.69E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	1.71E-01	1.72E-01	1.73E-01	1.73E-01	1.73E-01	1.74E-01	1.74E-01
pu236	1.67E-01	1.12E-01	7.54E-02	5.07E-02	3.40E-02	2.28E-02	1.53E-02
pu238	1.33E+03	1.40E+03	1.39E+03	1.37E+03	1.35E+03	1.34E+03	1.32E+03
pu238	1.33E+03	1.40E+03	1.39E+03	1.37E+03	1.35E+03	1.34E+03	1.32E+03
pu239	1.97E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02
pu240	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02
pu241	6.16E+04	5.69E+04	5.25E+04	4.84E+04	4.47E+04	4.12E+04	3.80E+04
pu242	5.82E-01	5.82E-01	5.82E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01
am241	1.44E+02	3.01E+02	4.46E+02	5.79E+02	7.02E+02	8.15E+02	9.18E+02
am242m	9.93E+00	9.85E+00	9.77E+00	9.69E+00	9.61E+00	9.53E+00	9.46E+00
am243	5.86E+00	5.87E+00	5.87E+00	5.86E+00	5.86E+00	5.86E+00	5.86E+00

0 nuclide radioactivity, curies
basis =single reactor assembly

	initial	608.8 d	1217.5 d	1826.3 d	2435.0 d	3043.8 d	3652.5 d
cm244	5.71E+02	5.36E+02	5.03E+02	4.72E+02	4.43E+02	4.16E+02	3.90E+02
cm245	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.38E-02	4.38E-02	4.38E-02
cm246	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.53E-03
total	7.95E+06	6.09E+04	5.54E+04	5.13E+04	4.76E+04	4.42E+04	4.11E+04

0 nuclide radioactivity, curies
basis =single reactor assembly

	initial	608.8 d	1217.5 d	1826.3 d	2435.0 d	3043.8 d	3652.5 d
c 14	5.66E-05	5.66E-05	5.66E-05	5.66E-05	5.66E-05	5.66E-05	5.66E-05
se 79	3.26E-02	3.26E-02	3.26E-02	3.26E-02	3.26E-02	3.26E-02	3.26E-02
nb 93m	7.37E-02	1.10E-01	1.44E-01	1.75E-01	2.04E-01	2.31E-01	2.57E-01
nb 94	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.74E-05
tc 99	6.52E+00	6.54E+00	6.54E+00	6.54E+00	6.54E+00	6.54E+00	6.54E+00
pd107	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02
sn126	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01
i129	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
cs135	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01

0 nuclide radioactivity, curies
basis =single reactor assembly

	initial	608.8 d	1217.5 d	1826.3 d	2435.0 d	3043.8 d	3652.5 d
sm151	2.65E+02	2.63E+02	2.60E+02	2.57E+02	2.53E+02	2.50E+02	2.47E+02
total	3.48E+07	4.60E+05	2.68E+05	2.08E+05	1.75E+05	1.59E+05	1.48E+05

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
pb210	5.69E-09	5.69E-09	5.69E-09	5.69E-09	6.16E-09	7.44E-09	9.52E-09	1.92E-08	5.17E-08
ra226	5.24E-08	5.24E-08	5.24E-08	5.25E-08	5.57E-08	6.69E-08	8.46E-08	1.57E-07	3.42E-07
ra228	6.35E-12	6.35E-12	6.35E-12	6.36E-12	7.04E-12	9.37E-12	1.30E-11	2.68E-11	5.68E-11
ac227	3.51E-06	3.51E-06	3.51E-06	3.52E-06	3.85E-06	4.87E-06	6.21E-06	1.00E-05	1.59E-05
th229	2.97E-08	2.97E-08	2.97E-08	2.97E-08	3.01E-08	3.12E-08	3.27E-08	3.78E-08	4.76E-08
th230	2.98E-05	2.98E-05	2.98E-05	2.99E-05	3.17E-05	3.72E-05	4.45E-05	6.68E-05	1.05E-04

0 nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
th232	2.87E-11	2.87E-11	2.87E-11	2.87E-11	3.07E-11	3.70E-11	4.53E-11	7.02E-11	1.12E-10
pa231	4.67E-05	4.67E-05	4.67E-05	4.67E-05	4.68E-05	4.71E-05	4.76E-05	4.88E-05	5.09E-05
u233	1.63E-05	1.63E-05	1.63E-05	1.63E-05	1.65E-05	1.72E-05	1.80E-05	2.03E-05	2.41E-05
u234	7.95E-01	7.95E-01	7.95E-01	7.95E-01	7.96E-01	7.99E-01	8.03E-01	8.14E-01	8.33E-01
u235	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02
u236	1.68E-01	1.68E-01	1.68E-01	1.68E-01	1.68E-01	1.68E-01	1.69E-01	1.69E-01	1.69E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	1.71E-01	1.71E-01	1.71E-01	1.71E-01	1.72E-01	1.72E-01	1.72E-01	1.73E-01	1.74E-01
pu236	1.67E-01	1.67E-01	1.67E-01	1.67E-01	1.58E-01	1.32E-01	1.04E-01	5.07E-02	1.53E-02
pu238	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.36E+03	1.39E+03	1.40E+03	1.37E+03	1.32E+03
pu238	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.36E+03	1.39E+03	1.40E+03	1.37E+03	1.32E+03
pu239	1.97E+02	1.97E+02	1.97E+02	1.97E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02
pu240	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02
pu241	6.16E+04	6.16E+04	6.16E+04	6.16E+04	6.09E+04	5.87E+04	5.60E+04	4.84E+04	3.80E+04
pu242	5.82E-01	5.82E-01	5.82E-01	5.82E-01	5.82E-01	5.82E-01	5.82E-01	5.83E-01	5.83E-01
am241	1.44E+02	1.44E+02	1.44E+02	1.44E+02	1.68E+02	2.40E+02	3.31E+02	5.79E+02	9.18E+02
am242m	9.93E+00	9.93E+00	9.93E+00	9.93E+00	9.92E+00	9.88E+00	9.84E+00	9.69E+00	9.46E+00
am243	5.86E+00	5.86E+00	5.86E+00	5.87E+00	5.87E+00	5.87E+00	5.87E+00	5.86E+00	5.86E+00

0 nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
cm244	5.71E+02	5.71E+02	5.71E+02	5.72E+02	5.66E+02	5.50E+02	5.30E+02	4.72E+02	3.90E+02
cm245	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.39E-02	4.38E-02
cm246	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.53E-03
total	7.95E+06	7.95E+06	7.95E+06	3.14E+06	7.59E+04	6.52E+04	5.95E+04	5.13E+04	4.11E+04

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
c 14	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
se 79	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00
se 79m	4.04E-06	4.04E-06	4.04E-06	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
nb 93m	3.09E-04	3.09E-04	3.09E-04	3.09E-04	3.32E-04	4.01E-04	4.90E-04	7.34E-04	1.08E-03

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
nb 94	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04
nb 94m	3.11E-10	3.11E-10	3.11E-10	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
tc 99	3.81E+02	3.81E+02	3.81E+02	3.81E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02
tc 99m	6.13E-02	6.13E-02	6.13E-02	5.18E-02	9.25E-12	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
pd107	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01
pd107m	1.25E-07	1.25E-07	1.25E-07	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
sn126	7.92E+00	7.92E+00	7.92E+00	7.92E+00	7.92E+00	7.92E+00	7.92E+00	7.92E+00	7.92E+00

basis =per B&W assembly, 0.409 mthm for grams

```
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
i129     8.25E+01 8.25E+01  8.25E+01  8.25E+01  8.28E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
cs135    3.66E+02 3.66E+02  3.66E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02
cs135m   1.76E-04 1.76E-04  1.76E-04  1.16E-12   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
sm151    1.01E+01 1.01E+01  1.01E+01  1.01E+01  1.01E+01  1.01E+01  9.97E+00  9.75E+00  9.38E+00
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
                                       basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
total    1.63E+04 1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
c 14     5.66E-05 5.66E-05  5.66E-05  5.66E-05  5.66E-05  5.66E-05  5.66E-05  5.66E-05  5.66E-05
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
se 79    3.26E-02 3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02
se 79m   2.46E+03 2.46E+03  2.46E+03   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
rb 93m   7.37E-02 7.37E-02  7.37E-02  7.37E-02  7.92E-02  9.57E-02  1.17E-01  1.75E-01  2.57E-01
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
rb 94    3.74E-05 3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.74E-05
rb 94m   9.95E-02 9.95E-02  9.95E-02   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
tc 99    6.52E+00 6.52E+00  6.52E+00  6.53E+00  6.54E+00  6.54E+00  6.54E+00  6.54E+00  6.54E+00
tc 99m   3.23E+05 3.23E+05  3.23E+05  2.73E+05  4.87E-05   .00E+00   .00E+00   .00E+00   .00E+00
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
pd107    4.23E-02 4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02
pd107m   6.21E+02 6.21E+02  6.21E+02   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
0                                        nuclide radioactivity, curies
                                         basis =per B&W assembly, 0.409 mthm for grams
         charge   discharge    .0 d      1.0 d     90.0 d    365.3 d   730.5 d   1826.3 d  3652.5 d
sn126    2.25E-01 2.25E-01  2.25E-01  2.25E-01  2.25E-01  2.25E-01  2.25E-01  2.25E-01  2.25E-01
0                                        nuclide radioactivity, curies
```

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
i129	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
cs135	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01
cs136m	4.62E+03	4.62E+03	4.62E+03	3.06E-05	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
sm151	2.65E+02	2.65E+02	2.65E+02	2.66E+02	2.66E+02	2.65E+02	2.63E+02	2.57E+02	2.47E+02

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	charge	discharge	.0 d	1.0 d	90.0 d	365.3 d	730.5 d	1826.3 d	3652.5 d
total	3.48E+07	3.48E+07	3.48E+07	7.37E+06	1.63E+06	6.54E+05	4.01E+05	2.08E+05	1.48E+05

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
pb210	6.76E-10	1.47E-09	2.73E-09	7.03E-09	2.47E-08	1.39E-07	3.75E-07	7.46E-07	1.26E-06	1.92E-06	3.67E-06
ra226	3.46E-07	6.16E-07	9.72E-07	1.94E-06	4.97E-06	1.93E-05	4.40E-05	7.96E-05	1.26E-04	1.84E-04	3.34E-04
ra228	2.08E-13	3.37E-13	4.77E-13	7.71E-13	1.38E-12	2.90E-12	4.43E-12	5.97E-12	7.50E-12	9.04E-12	1.24E-11
ac227	2.20E-07	2.93E-07	3.60E-07	4.78E-07	6.68E-07	1.02E-06	1.33E-06	1.62E-06	1.90E-06	2.19E-06	2.77E-06
th229	2.40E-07	2.98E-07	3.64E-07	5.22E-07	9.45E-07	2.68E-06	5.49E-06	9.52E-06	1.49E-05	2.17E-05	4.02E-05
th230	5.08E-03	6.95E-03	8.87E-03	1.28E-02	2.11E-02	4.39E-02	6.86E-02	9.48E-02	1.22E-01	1.50E-01	2.06E-01

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
th232	1.02E-03	1.40E-03	1.78E-03	2.54E-03	4.06E-03	7.88E-03	1.17E-02	1.55E-02	1.93E-02	2.31E-02	3.08E-02
pa231	1.08E-03	1.12E-03	1.17E-03	1.25E-03	1.43E-03	1.87E-03	2.31E-03	2.75E-03	3.19E-03	3.63E-03	4.51E-03
u233	2.50E-03	2.89E-03	3.29E-03	4.11E-03	5.81E-03	1.06E-02	1.60E-02	2.21E-02	2.87E-02	3.60E-02	5.19E-02
u234	1.34E+02	1.37E+02	1.40E+02	1.45E+02	1.54E+02	1.72E+02	1.85E+02	1.93E+02	1.98E+02	2.02E+02	2.06E+02
u235	9.14E+03	9.14E+03	9.14E+03	9.14E+03	9.14E+03	9.15E+03	9.15E+03	9.16E+03	9.16E+03	9.17E+03	9.17E+03
u236	2.60E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.62E+03	2.62E+03	2.63E+03	2.63E+03	2.64E+03
u238	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05
np237	2.47E+02	2.49E+02	2.52E+02	2.59E+02	2.76E+02	3.20E+02	3.62E+02	4.02E+02	4.38E+02	4.71E+02	5.30E+02
pu236	2.93E-05	8.88E-06	2.69E-06	2.47E-07	2.82E-09	7.52E-10	7.51E-10	7.51E-10	7.51E-10	7.51E-10	7.50E-10
pu238	7.69E+01	7.40E+01	7.11E+01	6.57E+01	5.62E+01	3.80E+01	2.57E+01	1.73E+01	1.17E+01	7.94E+00	3.65E+00
pu238	7.69E+01	7.40E+01	7.11E+01	6.57E+01	5.62E+01	3.80E+01	2.57E+01	1.73E+01	1.17E+01	7.94E+00	3.65E+00
pu239	3.19E+03	3.19E+03	3.19E+03	3.19E+03	3.18E+03	3.18E+03	3.17E+03	3.17E+03	3.17E+03	3.16E+03	3.15E+03
pu240	9.56E+02	9.56E+02	9.56E+02	9.56E+02	9.55E+02	9.51E+02	9.46E+02	9.41E+02	9.36E+02	9.31E+02	9.22E+02
pu241	3.68E+02	2.89E+02	2.27E+02	1.40E+02	5.32E+01	4.75E+00	4.25E-01	3.83E-02	3.80E-03	7.17E-04	4.14E-04
pu242	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.47E+02
am241	2.68E+02	3.44E+02	4.08E+02	4.83E+02	5.53E+02	5.56E+02	5.17E+02	4.78E+02	4.41E+02	4.07E+02	3.47E+02
am242m	9.02E-01	8.80E-01	8.59E-01	8.18E-01	7.41E-01	5.80E-01	4.53E-01	3.55E-01	2.77E-01	2.17E-01	1.33E-01
am243	2.94E+01	2.93E+01	2.93E+01	2.93E+01	2.92E+01	2.91E+01	2.90E+01	2.88E+01	2.87E+01	2.86E+01	2.83E+01

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
cm244	4.81E+00	3.98E+00	3.28E+00	2.24E+00	1.04E+00	1.53E-01	2.26E-02	3.33E-03	4.91E-04	7.23E-05	1.57E-06
cm245	2.55E-01	2.55E-01	2.55E-01	2.55E-01	2.54E-01	2.53E-01	2.52E-01	2.51E-01	2.50E-01	2.49E-01	2.47E-01
cm246	2.13E-02	2.12E-02	2.12E-02	2.12E-02	2.11E-02	2.10E-02	2.08E-02	2.07E-02	2.06E-02	2.04E-02	2.01E-02
total	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
pb210	5.17E-08	1.12E-07	2.09E-07	5.37E-07	1.89E-06	1.06E-05	2.87E-05	5.70E-05	9.61E-05	1.46E-04	2.80E-04
ra226	3.42E-07	6.09E-07	9.61E-07	1.92E-06	4.92E-06	1.91E-05	4.35E-05	7.87E-05	1.25E-04	1.82E-04	3.30E-04
ra228	5.68E-11	9.21E-11	1.30E-10	2.10E-10	3.76E-10	7.92E-10	1.21E-09	1.63E-09	2.05E-09	2.47E-09	3.38E-09
ac227	1.59E-05	2.12E-05	2.60E-05	3.46E-05	4.84E-05	7.41E-05	9.59E-05	1.17E-04	1.38E-04	1.59E-04	2.00E-04
th229	4.76E-08	5.90E-08	7.21E-08	1.03E-07	1.87E-07	5.30E-07	1.09E-06	1.89E-06	2.95E-06	4.31E-06	7.97E-06
th230	1.06E-04	1.43E-04	1.83E-04	2.64E-04	4.36E-04	9.08E-04	1.42E-03	1.96E-03	2.51E-03	3.09E-03	4.25E-03

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
th232	1.12E-10	1.53E-10	1.95E-10	2.78E-10	4.45E-10	8.62E-10	1.28E-09	1.70E-09	2.12E-09	2.54E-09	3.38E-09
pa231	5.09E-05	5.30E-05	5.51E-05	5.92E-05	6.76E-05	8.84E-05	1.09E-04	1.30E-04	1.51E-04	1.72E-04	2.13E-04
u233	2.41E-05	2.79E-05	3.18E-05	3.96E-05	5.60E-05	1.02E-04	1.54E-04	2.13E-04	2.77E-04	3.47E-04	5.01E-04
u234	8.33E-01	8.51E-01	8.69E-01	9.02E-01	9.61E-01	1.07E+00	1.15E+00	1.20E+00	1.23E+00	1.26E+00	1.28E+00
u235	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02	1.98E-02
u236	1.69E-01	1.69E-01	1.69E-01	1.69E-01	1.69E-01	1.69E-01	1.69E-01	1.70E-01	1.70E-01	1.70E-01	1.71E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	1.74E-01	1.76E-01	1.78E-01	1.83E-01	1.94E-01	2.26E-01	2.56E-01	2.83E-01	3.09E-01	3.32E-01	3.74E-01
pu236	1.53E-02	4.64E-03	1.40E-03	1.29E-04	1.47E-06	3.93E-07	3.93E-07	3.93E-07	3.92E-07	3.92E-07	3.92E-07
pu238	1.32E+03	1.27E+03	1.22E+03	1.13E+03	9.63E+02	6.50E+02	4.39E+02	2.97E+02	2.01E+02	1.36E+02	6.25E+01
pu238	1.32E+03	1.27E+03	1.22E+03	1.13E+03	9.63E+02	6.50E+02	4.39E+02	2.97E+02	2.01E+02	1.36E+02	6.25E+01
pu239	1.98E+02	1.98E+02	1.98E+02	1.98E+02	1.98E+02	1.97E+02	1.97E+02	1.97E+02	1.97E+02	1.96E+02	1.96E+02
pu240	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.17E+02	2.16E+02	2.15E+02	2.14E+02	2.13E+02	2.12E+02	2.09E+02
pu241	3.80E+04	2.99E+04	2.38E+04	1.45E+04	5.51E+03	4.92E+02	4.40E+01	3.97E+00	3.95E-01	7.42E-02	4.28E-02
pu242	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01	5.83E-01
am241	9.18E+02	1.18E+03	1.38E+03	1.66E+03	1.90E+03	1.91E+03	1.77E+03	1.64E+03	1.51E+03	1.40E+03	1.19E+03
am242m	9.46E+00	9.23E+00	9.00E+00	8.57E+00	7.77E+00	6.08E+00	4.75E+00	3.72E+00	2.91E+00	2.27E+00	1.39E+00
am243	5.86E+00	5.86E+00	5.86E+00	5.85E+00	5.84E+00	5.81E+00	5.79E+00	5.76E+00	5.73E+00	5.70E+00	5.65E+00

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
cm244	3.90E+02	3.22E+02	2.66E+02	1.81E+02	8.43E+01	1.24E+01	1.83E+00	2.70E-01	3.97E-02	5.85E-03	1.27E-04
cm245	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.37E-02	4.35E-02	4.33E-02	4.32E-02	4.30E-02	4.28E-02	4.25E-02
cm246	6.53E-03	6.53E-03	6.52E-03	6.51E-03	6.50E-03	6.45E-03	6.40E-03	6.35E-03	6.31E-03	6.26E-03	6.17E-03
total	4.11E+04	3.31E+04	2.68E+04	1.79E+04	8.90E+03	3.51E+03	2.70E+03	2.38E+03	2.15E+03	1.96E+03	1.68E+03

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
c 14	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.26E-05	1.26E-05	1.25E-05	1.24E-05	1.23E-05	1.23E-05	1.21E-05

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
se 79	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00	2.38E+00
se 79m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
rb 93m	1.08E-03	1.35E-03	1.58E-03	1.90E-03	2.25E-03	2.48E-03	2.50E-03	2.51E-03	2.51E-03	2.51E-03	2.51E-03

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
nb 94	2.00E-04	2.00E-04	2.00E-04	1.99E-04	1.99E-04	1.99E-04	1.99E-04	1.98E-04	1.98E-04	1.98E-04	1.97E-04
nb 94m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
tc 99	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02	3.82E+02
tc 99m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
pd107	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01	8.23E+01
pd107m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

```
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  sn126 7.92E+00  7.92E+00  7.92E+00  7.92E+00  7.92E+00  7.92E+00  7.91E+00  7.91E+00  7.91E+00  7.90E+00  7.90E+00
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
   i129 8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01  8.29E+01
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  cs135 3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02  3.67E+02
 cs135m  .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  sm151 9.38E+00  9.02E+00  8.68E+00  8.04E+00  6.89E+00  4.69E+00  3.19E+00  2.17E+00  1.48E+00  1.00E+00  4.65E-01
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  total 1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
   c 14 5.66E-05  5.65E-05  5.65E-05  5.64E-05  5.63E-05  5.60E-05  5.56E-05  5.53E-05  5.50E-05  5.46E-05  5.40E-05
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  se 79 3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02  3.26E-02
 se 79m  .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
 rb 93m 2.57E-01  3.23E-01  3.78E-01  4.53E-01  5.37E-01  5.91E-01  5.97E-01  5.98E-01  5.98E-01  5.98E-01  5.98E-01
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  rb 94 3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.74E-05  3.73E-05  3.72E-05  3.72E-05  3.71E-05  3.70E-05  3.69E-05
 rb 94m  .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
  tc 99 6.54E+00  6.54E+00  6.54E+00  6.54E+00  6.54E+00  6.54E+00  6.53E+00  6.53E+00  6.53E+00  6.53E+00  6.53E+00
 tc 99m  .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
  pd107 4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02  4.23E-02
 pd107m  .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                                nuclide radioactivity, curies
                                basis =per B&W assembly, 0.409 mthm for grams
         initial   15.0 yr   20.0 yr   30.0 yr   50.0 yr  100.0 yr  150.0 yr  200.0 yr  250.0 yr  300.0 yr  400.0 yr
```

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
sn126	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.25E-01	2.24E-01	2.24E-01	2.24E-01

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
i129	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
cs135	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01
cs135m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
sm151	2.47E+02	2.38E+02	2.29E+02	2.12E+02	1.81E+02	1.23E+02	8.40E+01	5.71E+01	3.89E+01	2.64E+01	1.22E+01

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr

0

nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	15.0 yr	20.0 yr	30.0 yr	50.0 yr	100.0 yr	150.0 yr	200.0 yr	250.0 yr	300.0 yr	400.0 yr
total	1.48E+05	1.26E+05	1.10E+05	8.63E+04	5.33E+04	1.63E+04	5.03E+03	1.58E+03	5.10E+02	1.77E+02	3.44E+01

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
pb210	3.67E-06	5.99E-06	2.72E-05	9.95E-05	3.19E-04	5.88E-04	8.67E-04	1.15E-03	1.43E-03	1.71E-03	1.85E-03
ra226	3.34E-04	5.28E-04	2.10E-03	7.67E-03	2.46E-02	4.52E-02	6.70E-02	8.89E-02	1.11E-01	1.32E-01	1.43E-01
ra228	1.24E-11	1.55E-11	3.11E-11	6.32E-11	1.30E-10	2.00E-10	2.73E-10	3.47E-10	4.23E-10	5.00E-10	5.40E-10
ac227	2.77E-06	3.34E-06	6.38E-06	1.20E-05	2.32E-05	3.41E-05	4.47E-05	5.50E-05	6.51E-05	7.50E-05	7.98E-05
th229	4.02E-05	6.57E-05	3.17E-04	1.53E-03	6.86E-03	1.56E-02	2.72E-02	4.11E-02	5.69E-02	7.44E-02	8.36E-02
th230	2.06E-01	2.64E-01	5.52E-01	1.13E+00	2.25E+00	3.35E+00	4.43E+00	5.48E+00	6.50E+00	7.50E+00	7.99E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
th232	3.08E-02	3.85E-02	7.74E-02	1.57E-01	3.24E-01	4.98E-01	6.78E-01	8.63E-01	1.05E+00	1.24E+00	1.34E+00
pa231	4.51E-03	5.39E-03	9.77E-03	1.84E-02	3.55E-02	5.22E-02	6.84E-02	8.43E-02	9.97E-02	1.15E-01	1.22E-01
u233	5.19E-02	6.96E-02	1.76E-01	4.32E-01	9.75E-01	1.52E+00	2.06E+00	2.59E+00	3.12E+00	3.64E+00	3.90E+00
u234	2.08E+02	2.08E+02	2.10E+02	2.09E+02	2.08E+02	2.07E+02	2.06E+02	2.05E+02	2.04E+02	2.03E+02	2.03E+02
u235	9.17E+03	9.18E+03	9.23E+03	9.31E+03	9.48E+03	9.64E+03	9.78E+03	9.92E+03	1.01E+04	1.02E+04	1.02E+04
u236	2.64E+03	2.65E+03	2.70E+03	2.78E+03	2.95E+03	3.05E+03	3.14E+03	3.22E+03	3.28E+03	3.33E+03	3.35E+03
u238	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05
np237	5.30E+02	5.81E+02	7.41E+02	8.45E+02	8.69E+02	8.70E+02	8.69E+02	8.69E+02	8.68E+02	8.68E+02	8.68E+02
pu236	7.50E-10	7.50E-10	7.48E-10	7.43E-10	7.34E-10	7.25E-10	7.17E-10	7.08E-10	7.00E-10	6.91E-10	6.87E-10
pu238	3.65E+00	1.68E+00	3.96E-02	4.04E-05	3.67E-09	1.97E-13	1.06E-17	5.70E-22	3.06E-26	1.64E-30	4.60E-33
pu238	3.65E+00	1.68E+00	3.96E-02	4.04E-05	3.67E-09	1.97E-13	1.06E-17	5.70E-22	3.06E-26	1.64E-30	4.60E-33
pu239	3.15E+03	3.14E+03	3.10E+03	3.01E+03	2.86E+03	2.69E+03	2.55E+03	2.41E+03	2.27E+03	2.15E+03	2.09E+03
pu240	9.22E+02	9.12E+02	8.65E+02	7.78E+02	6.30E+02	5.10E+02	4.13E+02	3.34E+02	2.71E+02	2.19E+02	1.97E+02
pu241	4.14E-04	4.08E-04	3.92E-04	3.61E-04	3.07E-04	2.60E-04	2.21E-04	1.88E-04	1.60E-04	1.36E-04	1.25E-04
pu242	1.47E+02	1.47E+02	1.47E+02	1.47E+02	1.46E+02	1.46E+02	1.45E+02	1.45E+02	1.44E+02	1.44E+02	1.43E+02
am241	3.47E+02	2.95E+02	1.33E+02	2.67E+01	1.09E+00	5.21E-02	8.74E-03	5.98E-03	5.03E-03	4.27E-03	3.92E-03
am242m	1.33E-01	8.11E-02	6.95E-03	5.09E-05	2.73E-09	1.47E-13	7.89E-18	4.24E-22	2.28E-26	1.22E-30	8.96E-33

am243	2.83E+01	2.80E+01	2.67E+01	2.43E+01	2.02E+01	1.67E+01	1.38E+01	1.15E+01	9.51E+00	7.88E+00	7.17E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
cm244	1.57E-06	3.41E-08	1.65E-16	3.83E-33	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	2.47E-01	2.45E-01	2.35E-01	2.17E-01	1.84E-01	1.57E-01	1.33E-01	1.13E-01	9.60E-02	8.15E-02	7.51E-02
cm246	2.01E-02	1.98E-02	1.84E-02	1.59E-02	1.18E-02	8.84E-03	6.59E-03	4.92E-03	3.67E-03	2.74E-03	2.36E-03
total	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
pb210	2.80E-04	4.58E-04	2.08E-03	7.58E-03	2.44E-02	4.47E-02	6.62E-02	8.79E-02	1.09E-01	1.31E-01	1.41E-01
ra226	3.30E-04	5.22E-04	2.08E-03	7.59E-03	2.44E-02	4.47E-02	6.62E-02	8.80E-02	1.09E-01	1.31E-01	1.41E-01
ra228	3.38E-09	4.22E-09	8.49E-09	1.72E-08	3.55E-08	5.46E-08	7.44E-08	9.47E-08	1.15E-07	1.37E-07	1.47E-07
ac227	2.00E-04	2.42E-04	4.62E-04	8.72E-04	1.68E-03	2.47E-03	3.23E-03	3.98E-03	4.71E-03	5.43E-03	5.78E-03
th229	7.97E-06	1.30E-05	6.28E-05	3.04E-04	1.36E-03	3.09E-03	5.39E-03	8.15E-03	1.13E-02	1.47E-02	1.66E-02
th230	4.25E-03	5.44E-03	1.14E-02	2.32E-02	4.65E-02	6.92E-02	9.13E-02	1.13E-01	1.34E-01	1.55E-01	1.65E-01

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
th232	3.38E-09	4.22E-09	8.49E-09	1.72E-08	3.55E-08	5.46E-08	7.44E-08	9.47E-08	1.15E-07	1.37E-07	1.47E-07
pa231	2.13E-04	2.55E-04	4.62E-04	8.72E-04	1.68E-03	2.46E-03	3.23E-03	3.98E-03	4.71E-03	5.42E-03	5.77E-03
u233	5.01E-04	6.71E-04	1.70E-03	4.16E-03	9.40E-03	1.46E-02	1.98E-02	2.50E-02	3.01E-02	3.51E-02	3.76E-02
u234	1.28E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.29E+00	1.28E+00	1.28E+00	1.27E+00	1.26E+00	1.26E+00
u235	1.98E-02	1.99E-02	2.00E-02	2.01E-02	2.05E-02	2.08E-02	2.12E-02	2.15E-02	2.17E-02	2.20E-02	2.21E-02
u236	1.71E-01	1.72E-01	1.75E-01	1.80E-01	1.90E-01	1.97E-01	2.03E-01	2.08E-01	2.12E-01	2.16E-01	2.17E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	3.74E-01	4.10E-01	5.23E-01	5.96E-01	6.13E-01	6.14E-01	6.13E-01	6.13E-01	6.12E-01	6.12E-01	6.12E-01
pu236	3.92E-07	3.92E-07	3.91E-07	3.88E-07	3.84E-07	3.79E-07	3.75E-07	3.70E-07	3.66E-07	3.61E-07	3.59E-07
pu238	6.25E+01	2.89E+01	6.78E-01	6.93E-04	6.29E-08	3.38E-12	1.82E-16	9.78E-21	5.24E-25	2.82E-29	6.85E-32
pu238	6.25E+01	2.89E+01	6.78E-01	6.93E-04	6.29E-08	3.38E-12	1.82E-16	9.78E-21	5.24E-25	2.82E-29	6.85E-32
pu239	1.96E+02	1.95E+02	1.92E+02	1.87E+02	1.77E+02	1.67E+02	1.58E+02	1.49E+02	1.41E+02	1.33E+02	1.30E+02
pu240	2.09E+02	2.07E+02	1.98E+02	1.77E+02	1.43E+02	1.16E+02	9.38E+01	7.59E+01	6.15E+01	4.98E+01	4.48E+01
pu241	4.28E-02	4.22E-02	4.05E-02	3.73E-02	3.17E-02	2.69E-02	2.29E-02	1.94E-02	1.65E-02	1.40E-02	1.29E-02
pu242	5.83E-01	5.83E-01	5.82E-01	5.81E-01	5.79E-01	5.77E-01	5.75E-01	5.72E-01	5.70E-01	5.68E-01	5.67E-01
am241	1.19E+03	1.01E+03	4.55E+02	9.16E+01	3.75E+00	1.79E-01	3.00E-02	2.05E-02	1.72E-02	1.46E-02	1.35E-02
am242m	1.39E+00	8.50E-01	7.28E-02	5.34E-04	2.87E-08	1.54E-12	8.27E-17	4.44E-21	2.39E-25	1.28E-29	9.13E-32
am243	5.65E+00	5.60E+00	5.34E+00	4.86E+00	4.03E+00	3.34E+00	2.77E+00	2.29E+00	1.90E+00	1.57E+00	1.43E+00

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
cm244	1.27E-04	2.76E-06	1.33E-14	3.19E-31	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	4.25E-02	4.21E-02	4.04E-02	3.73E-02	3.17E-02	2.69E-02	2.28E-02	1.94E-02	1.65E-02	1.40E-02	1.29E-02
cm246	6.17E-03	6.08E-03	5.65E-03	4.88E-03	3.64E-03	2.72E-03	2.03E-03	1.51E-03	1.13E-03	8.41E-04	7.27E-04
total	1.68E+03	1.46E+03	8.59E+02	4.69E+02	3.36E+02	2.94E+02	2.62E+02	2.35E+02	2.11E+02	1.92E+02	1.83E+02

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
c 14	1.21E-05	1.20E-05	1.13E-05	9.97E-06	7.83E-06	6.15E-06	4.83E-06	3.79E-06	2.97E-06	2.34E-06	2.07E-06

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
se 79	2.38E+00	2.38E+00	2.37E+00	2.37E+00	2.36E+00	2.35E+00	2.34E+00	2.33E+00	2.32E+00	2.31E+00	2.30E+00
se 79m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
rb 93m	2.51E-03	2.51E-03	2.51E-03	2.51E-03	2.50E-03	2.50E-03	2.50E-03	2.50E-03	2.49E-03	2.49E-03	2.49E-03

basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
rb 94	1.97E-04	1.96E-04	1.93E-04	1.86E-04	1.74E-04	1.63E-04	1.52E-04	1.42E-04	1.33E-04	1.24E-04	1.20E-04
rb 94m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

```
   tc 99   3.82E+02 3.81E+02 3.81E+02 3.80E+02 3.77E+02 3.75E+02 3.72E+02 3.70E+02 3.67E+02 3.65E+02 3.64E+02
   tc 99m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                                    basis =per B&W assembly, 0.409 mthm for grams.
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   pd107   8.23E+01 8.23E+01 8.23E+01 8.23E+01 8.23E+01 8.23E+01 8.22E+01 8.22E+01 8.22E+01 8.22E+01 8.22E+01
   pd107m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   sn126   7.90E+00 7.89E+00 7.87E+00 7.81E+00 7.70E+00 7.60E+00 7.49E+00 7.39E+00 7.29E+00 7.19E+00 7.14E+00
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
    i129   8.29E+01 8.29E+01 8.29E+01 8.29E+01 8.28E+01 8.28E+01 8.28E+01 8.28E+01 8.28E+01 8.28E+01 8.28E+01
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   cs135   3.67E+02 3.67E+02 3.67E+02 3.66E+02 3.66E+02 3.66E+02 3.66E+02 3.66E+02 3.65E+02 3.65E+02 3.65E+02
   cs135m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   sm151   4.65E-01 2.15E-01 4.57E-03 2.07E-06 4.21E-13 8.59E-20 1.75E-26 3.57E-33 7.29E-40  .00E+00  .00E+00
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
                                    basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
  total    1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
    c 14   5.40E-05 5.33E-05 5.02E-05 4.45E-05 3.49E-05 2.74E-05 2.15E-05 1.69E-05 1.33E-05 1.04E-05 9.23E-06
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   se 79   3.26E-02 3.26E-02 3.26E-02 3.25E-02 3.24E-02 3.22E-02 3.21E-02 3.20E-02 3.18E-02 3.17E-02 3.16E-02
   se 79m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   rb 93m  5.98E-01 5.98E-01 5.98E-01 5.97E-01 5.97E-01 5.96E-01 5.96E-01 5.95E-01 5.95E-01 5.94E-01 5.94E-01
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
   rb 94   3.69E-05 3.68E-05 3.62E-05 3.50E-05 3.26E-05 3.06E-05 2.86E-05 2.66E-05 2.48E-05 2.32E-05 2.24E-05
   rb 94m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
   tc 99   6.53E+00 6.53E+00 6.52E+00 6.49E+00 6.45E+00 6.41E+00 6.37E+00 6.33E+00 6.28E+00 6.24E+00 6.22E+00
   tc 99m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                     nuclide radioactivity, curies
                                      basis =per B&W assembly, 0.409 mthm for grams
           initial  500.0 yr 1000.0 yr 2000.0 yr 4000.0 yr 6000.0 yr 8000.0 yr10000.0 yr12000.0 yr14000.0 yr15000.0 yr
```

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
pd107	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02	4.23E-02
pd107m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
sn126	2.24E-01	2.24E-01	2.23E-01	2.22E-01	2.19E-01	2.16E-01	2.13E-01	2.10E-01	2.07E-01	2.04E-01	2.03E-01

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
i129	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
cs135	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.22E-01	4.21E-01	4.21E-01	4.21E-01	4.21E-01	4.20E-01
cs135m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
sm151	1.22E+01	5.67E+00	1.20E-01	5.44E-05	1.11E-11	2.26E-18	4.61E-25	9.13E-32	.00E+00	.00E+00	.00E+00

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr

0 nuclide radioactivity, curies
basis =per B&W assembly, 0.409 mthm for grams

	initial	500.0 yr	1000.0 yr	2000.0 yr	4000.0 yr	6000.0 yr	8000.0 yr	10000.0 yr	12000.0 yr	14000.0 yr	15000.0 yr
total	3.44E+01	1.57E+01	8.82E+00	8.68E+00	8.62E+00	8.57E+00	8.52E+00	8.48E+00	8.43E+00	8.38E+00	8.35E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
pb210	1.85E-03	1.98E-03	2.11E-03	2.24E-03	2.37E-03	2.50E-03	2.63E-03	2.76E-03	2.88E-03	3.00E-03	3.12E-03
ra226	1.43E-01	1.53E-01	1.63E-01	1.73E-01	1.83E-01	1.93E-01	2.03E-01	2.13E-01	2.22E-01	2.32E-01	2.41E-01
ra228	5.40E-10	5.79E-10	6.18E-10	6.58E-10	6.98E-10	7.38E-10	7.78E-10	8.19E-10	8.59E-10	9.00E-10	9.41E-10
ac227	7.98E-05	8.46E-05	8.93E-05	9.39E-05	9.85E-05	1.03E-04	1.07E-04	1.12E-04	1.16E-04	1.20E-04	1.25E-04
th229	8.36E-02	9.30E-02	1.03E-01	1.13E-01	1.23E-01	1.33E-01	1.44E-01	1.55E-01	1.65E-01	1.76E-01	1.87E-01
th230	7.99E+00	8.48E+00	8.96E+00	9.43E+00	9.90E+00	1.04E+01	1.08E+01	1.13E+01	1.17E+01	1.22E+01	1.26E+01

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
th232	1.34E+00	1.44E+00	1.54E+00	1.64E+00	1.74E+00	1.84E+00	1.94E+00	2.04E+00	2.14E+00	2.24E+00	2.34E+00
pa231	1.22E-01	1.29E-01	1.37E-01	1.44E-01	1.51E-01	1.58E-01	1.64E-01	1.71E-01	1.78E-01	1.84E-01	1.91E-01
u233	3.90E+00	4.16E+00	4.42E+00	4.67E+00	4.93E+00	5.18E+00	5.44E+00	5.69E+00	5.94E+00	6.19E+00	6.44E+00
u234	2.03E+02	2.02E+02	2.02E+02	2.01E+02	2.01E+02	2.00E+02	2.00E+02	1.99E+02	1.99E+02	1.98E+02	1.98E+02
u235	1.02E+04	1.03E+04	1.04E+04	1.04E+04	1.05E+04	1.05E+04	1.06E+04	1.06E+04	1.07E+04	1.07E+04	1.08E+04
u236	3.35E+03	3.37E+03	3.39E+03	3.41E+03	3.42E+03	3.43E+03	3.44E+03	3.45E+03	3.46E+03	3.47E+03	3.48E+03
u238	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05
np237	8.68E+02	8.67E+02	8.67E+02	8.67E+02	8.66E+02	8.66E+02	8.66E+02	8.66E+02	8.65E+02	8.65E+02	8.65E+02
pu236	6.87E-10	6.83E-10	6.79E-10	6.75E-10	6.71E-10	6.67E-10	6.63E-10	6.59E-10	6.55E-10	6.51E-10	6.47E-10

pu238	4.60E-33	1.70E-36	6.29E-40	3.34E-43	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu238	4.60E-33	1.70E-36	6.29E-40	3.34E-43	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu239	2.09E+03	2.03E+03	1.97E+03	1.92E+03	1.86E+03	1.81E+03	1.76E+03	1.71E+03	1.66E+03	1.62E+03	1.57E+03
pu240	1.97E+02	1.77E+02	1.60E+02	1.44E+02	1.29E+02	1.16E+02	1.05E+02	9.41E+01	8.47E+01	7.62E+01	6.86E+01
pu241	1.25E-04	1.15E-04	1.06E-04	9.79E-05	9.02E-05	8.31E-05	7.66E-05	7.06E-05	6.51E-05	6.00E-05	5.53E-05
pu242	1.43E+02	1.43E+02	1.43E+02	1.43E+02	1.42E+02	1.42E+02	1.42E+02	1.42E+02	1.41E+02	1.41E+02	1.41E+02
am241	3.92E-03	3.61E-03	3.33E-03	3.07E-03	2.83E-03	2.61E-03	2.40E-03	2.22E-03	2.04E-03	1.88E-03	1.73E-03
am242m	8.96E-33	6.57E-35	4.81E-37	3.53E-39	2.58E-41	3.39E-43	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am243	7.17E+00	6.53E+00	5.94E+00	5.41E+00	4.92E+00	4.48E+00	4.08E+00	3.71E+00	3.38E+00	3.07E+00	2.80E+00

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
cm244	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	7.51E-02	6.93E-02	6.38E-02	5.88E-02	5.42E-02	5.00E-02	4.61E-02	4.25E-02	3.91E-02	3.61E-02	3.32E-02
cm246	2.36E-03	2.04E-03	1.76E-03	1.52E-03	1.32E-03	1.14E-03	9.82E-04	8.48E-04	7.32E-04	6.32E-04	5.46E-04
total	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05

0 nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
pb210	1.41E-01	1.51E-01	1.61E-01	1.71E-01	1.81E-01	1.91E-01	2.01E-01	2.10E-01	2.20E-01	2.29E-01	2.38E-01
ra226	1.41E-01	1.51E-01	1.61E-01	1.72E-01	1.81E-01	1.91E-01	2.01E-01	2.11E-01	2.20E-01	2.29E-01	2.39E-01
ra228	1.47E-07	1.58E-07	1.69E-07	1.80E-07	1.91E-07	2.01E-07	2.12E-07	2.23E-07	2.35E-07	2.46E-07	2.57E-07
ac227	5.78E-03	6.12E-03	6.46E-03	6.79E-03	7.13E-03	7.45E-03	7.77E-03	8.09E-03	8.40E-03	8.71E-03	9.01E-03
th229	1.66E-02	1.86E-02	2.04E-02	2.23E-02	2.44E-02	2.64E-02	2.85E-02	3.06E-02	3.28E-02	3.49E-02	3.71E-02
th230	1.65E-01	1.75E-01	1.85E-01	1.95E-01	2.04E-01	2.14E-01	2.23E-01	2.32E-01	2.42E-01	2.51E-01	2.60E-01

0 nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
th232	1.47E-07	1.58E-07	1.69E-07	1.80E-07	1.91E-07	2.01E-07	2.12E-07	2.23E-07	2.35E-07	2.46E-07	2.57E-07
pa231	5.77E-03	6.12E-03	6.46E-03	6.79E-03	7.12E-03	7.45E-03	7.77E-03	8.08E-03	8.40E-03	8.71E-03	9.01E-03
u233	3.78E-02	4.01E-02	4.26E-02	4.51E-02	4.75E-02	5.00E-02	5.24E-02	5.48E-02	5.73E-02	5.97E-02	6.20E-02
u234	1.26E+00	1.26E+00	1.25E+00	1.25E+00	1.25E+00	1.24E+00	1.24E+00	1.24E+00	1.24E+00	1.23E+00	1.23E+00
u235	2.21E-02	2.23E-02	2.24E-02	2.25E-02	2.26E-02	2.27E-02	2.29E-02	2.30E-02	2.31E-02	2.32E-02	2.33E-02
u236	2.17E-01	2.18E-01	2.19E-01	2.20E-01	2.21E-01	2.22E-01	2.23E-01	2.24E-01	2.24E-01	2.25E-01	2.25E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	6.12E-01	6.12E-01	6.11E-01	6.11E-01	6.11E-01	6.11E-01	6.11E-01	6.10E-01	6.10E-01	6.10E-01	6.10E-01
pu236	3.59E-07	3.57E-07	3.55E-07	3.53E-07	3.51E-07	3.48E-07	3.46E-07	3.44E-07	3.42E-07	3.40E-07	3.38E-07
pu238	6.85E-32	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu238	6.85E-32	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu239	1.30E+02	1.26E+02	1.22E+02	1.19E+02	1.16E+02	1.12E+02	1.09E+02	1.06E+02	1.03E+02	1.00E+02	9.74E+01
pu240	4.48E+01	4.03E+01	3.62E+01	3.26E+01	2.93E+01	2.64E+01	2.38E+01	2.14E+01	1.92E+01	1.73E+01	1.56E+01
pu241	1.29E-02	1.19E-02	1.10E-02	1.01E-02	9.33E-03	8.60E-03	7.93E-03	7.30E-03	6.73E-03	6.21E-03	5.72E-03
pu242	5.67E-01	5.66E-01	5.65E-01	5.64E-01	5.63E-01	5.62E-01	5.61E-01	5.60E-01	5.59E-01	5.58E-01	5.57E-01
am241	1.35E-02	1.24E-02	1.14E-02	1.05E-02	9.71E-03	8.95E-03	8.25E-03	7.60E-03	7.01E-03	6.46E-03	5.95E-03
am242m	9.13E-32	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am243	1.43E+00	1.30E+00	1.19E+00	1.08E+00	9.83E-01	8.94E-01	8.14E-01	7.41E-01	6.75E-01	6.14E-01	5.59E-01

0 nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
cm244	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	1.29E-02	1.19E-02	1.10E-02	1.01E-02	9.31E-03	8.58E-03	7.91E-03	7.29E-03	6.72E-03	6.19E-03	5.71E-03
cm246	7.27E-04	6.28E-04	5.42E-04	4.68E-04	4.04E-04	3.49E-04	3.02E-04	2.61E-04	2.25E-04	1.94E-04	1.68E-04
total	1.83E+02	1.74E+02	1.67E+02	1.60E+02	1.53E+02	1.47E+02	1.41E+02	1.35E+02	1.30E+02	1.25E+02	1.21E+02

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
c 14	2.07E-06	1.83E-06	1.62E-06	1.44E-06	1.28E-06	1.13E-06	1.00E-06	8.87E-07	7.86E-07	6.96E-07	6.17E-07

basis =per B&W assembly, 0.409 mthm for grams

	initial	16000.0 yr	17000.0 yr	18000.0 yr	19000.0 yr	20000.0 yr	21000.0 yr	22000.0 yr	23000.0 yr	24000.0 yr	25000.0 yr
se 79	2.30E+00	2.30E+00	2.29E+00	2.29E+00	2.28E+00	2.28E+00	2.28E+00	2.27E+00	2.27E+00	2.26E+00	2.26E+00
se 79m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00

basis =per B&W assembly, 0.409 mthm for grams

```
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  rb 93m  2.49E-03  2.49E-03  2.49E-03  2.49E-03  2.49E-03  2.48E-03  2.48E-03  2.48E-03  2.48E-03  2.48E-03  2.48E-03
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  rb 94   1.20E-04  1.16E-04  1.12E-04  1.08E-04  1.04E-04  1.01E-04  9.75E-05  9.42E-05  9.10E-05  8.80E-05  8.50E-05
  rb 94m   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
  tc 99   3.64E+02  3.62E+02  3.61E+02  3.60E+02  3.59E+02  3.58E+02  3.57E+02  3.55E+02  3.54E+02  3.53E+02  3.52E+02
  tc 99m   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  pd107   8.22E+01  8.22E+01  8.22E+01  8.22E+01  8.21E+01  8.21E+01  8.21E+01  8.21E+01  8.21E+01  8.21E+01  8.21E+01
  pd107m   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  sn126   7.14E+00  7.09E+00  7.04E+00  6.99E+00  6.94E+00  6.90E+00  6.85E+00  6.80E+00  6.75E+00  6.71E+00  6.66E+00
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
   i129   8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01  8.28E+01
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  cs135   3.65E+02  3.65E+02  3.65E+02  3.65E+02  3.65E+02  3.64E+02  3.64E+02  3.64E+02  3.64E+02  3.64E+02  3.64E+02
  cs135m   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  sm151    .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 total    1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04  1.63E+04
0                             nuclide radioactivity, curies
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
   c 14   9.23E-06  8.17E-06  7.24E-06  6.42E-06  5.69E-06  5.04E-06  4.46E-06  3.96E-06  3.50E-06  3.10E-06  2.75E-06
0                             nuclide radioactivity, curies
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  se 79   3.16E-02  3.16E-02  3.15E-02  3.14E-02  3.14E-02  3.13E-02  3.12E-02  3.12E-02  3.11E-02  3.10E-02  3.10E-02
  se 79m   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00   .00E+00
0                             nuclide radioactivity, curies
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                             nuclide radioactivity, curies
                              basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
  rb 93m  5.94E-01  5.94E-01  5.93E-01  5.93E-01  5.93E-01  5.92E-01  5.92E-01  5.92E-01  5.92E-01  5.91E-01  5.91E-01
0                             nuclide radioactivity, curies
                              basis =per B&W assembly, 0.409 mthm for grams
```

```
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 rb 94    2.24E-05 2.17E-05 2.09E-05 2.02E-05 1.96E-05 1.89E-05 1.83E-05 1.77E-05 1.71E-05 1.65E-05 1.59E-05
 rb 94m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
 tc 99    6.22E+00 6.20E+00 6.18E+00 6.16E+00 6.14E+00 6.12E+00 6.10E+00 6.08E+00 6.06E+00 6.04E+00 6.02E+00
 tc 99m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 pd107    4.23E-02 4.23E-02 4.23E-02 4.23E-02 4.22E-02 4.22E-02 4.22E-02 4.22E-02 4.22E-02 4.22E-02 4.22E-02
 pd107m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 sn126    2.03E-01 2.01E-01 2.00E-01 1.98E-01 1.97E-01 1.96E-01 1.94E-01 1.93E-01 1.92E-01 1.90E-01 1.89E-01
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 i129     1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 cs135    4.20E-01 4.20E-01 4.20E-01 4.20E-01 4.20E-01 4.20E-01 4.20E-01 4.20E-01 4.19E-01 4.19E-01 4.19E-01
 cs135m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 sm151    .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
0                                 nuclide radioactivity, curies
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial16000.0 yr17000.0 yr18000.0 yr19000.0 yr20000.0 yr21000.0 yr22000.0 yr23000.0 yr24000.0 yr25000.0 yr
 total    8.35E+00 8.33E+00 8.31E+00 8.28E+00 8.26E+00 8.23E+00 8.21E+00 8.19E+00 8.16E+00 8.14E+00 8.12E+00
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 pb210    3.12E-03 4.25E-03 5.25E-03 5.70E-03 6.12E-03 6.52E-03 6.89E-03 7.23E-03 9.07E-03 1.07E-02 1.05E-02
 ra226    2.41E-01 3.28E-01 4.05E-01 4.40E-01 4.73E-01 5.03E-01 5.32E-01 5.59E-01 7.00E-01 8.24E-01 8.11E-01
 ra228    9.41E-10 1.35E-09 1.76E-09 1.97E-09 2.18E-09 2.38E-09 2.59E-09 2.80E-09 4.04E-09 8.18E-09 1.02E-08
 ac227    1.25E-04 1.63E-04 1.97E-04 2.11E-04 2.25E-04 2.37E-04 2.49E-04 2.59E-04 3.06E-04 3.59E-04 3.65E-04
 th229    1.87E-01 3.01E-01 4.14E-01 4.71E-01 5.26E-01 5.80E-01 6.33E-01 6.84E-01 9.71E-01 1.77E+00 1.91E+00
 th230    1.26E+01 1.67E+01 2.02E+01 2.19E+01 2.34E+01 2.48E+01 2.61E+01 2.74E+01 3.31E+01 3.92E+01 3.83E+01
                                  basis =per B&W assembly, 0.409 mthm for grams
          initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 th232    2.34E+00 3.36E+00 4.39E+00 4.90E+00 5.42E+00 5.93E+00 6.45E+00 6.96E+00 1.01E+01 2.03E+01 2.55E+01
```

pa231	1.91E-01	2.50E-01	3.01E-01	3.23E-01	3.44E-01	3.63E-01	3.81E-01	3.97E-01	4.69E-01	5.50E-01	5.58E-01
u233	6.44E+00	8.85E+00	1.12E+01	1.23E+01	1.34E+01	1.44E+01	1.55E+01	1.65E+01	2.20E+01	3.57E+01	4.03E+01
u234	1.98E+02	1.93E+02	1.88E+02	1.86E+02	1.83E+02	1.81E+02	1.79E+02	1.77E+02	1.64E+02	1.30E+02	1.16E+02
u235	1.08E+04	1.11E+04	1.14E+04	1.15E+04	1.16E+04	1.17E+04	1.18E+04	1.19E+04	1.21E+04	1.23E+04	1.23E+04
u236	3.48E+03	3.52E+03	3.54E+03	3.54E+03	3.54E+03	3.54E+03	3.54E+03	3.54E+03	3.54E+03	3.53E+03	3.52E+03
u238	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05	4.30E+05
np237	8.65E+02	8.62E+02	8.59E+02	8.58E+02	8.56E+02	8.55E+02	8.54E+02	8.52E+02	8.44E+02	8.17E+02	8.04E+02
pu236	6.47E-10	6.09E-10	5.73E-10	5.56E-10	5.40E-10	5.24E-10	5.08E-10	4.93E-10	4.12E-10	2.25E-10	1.67E-10
pu238	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu238	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu239	1.57E+03	1.18E+03	8.85E+02	7.67E+02	6.64E+02	5.75E+02	4.98E+02	4.31E+02	1.82E+02	1.03E+01	2.44E+00
pu240	6.86E+01	2.38E+01	8.29E+00	4.89E+00	2.88E+00	1.70E+00	1.00E+00	5.91E-01	2.49E-02	6.43E-07	4.04E-09
pu241	5.53E-05	2.45E-05	1.08E-05	7.20E-06	4.79E-06	3.18E-06	2.12E-06	1.41E-06	1.22E-07	3.50E-11	5.92E-13
pu242	1.41E+02	1.38E+02	1.36E+02	1.34E+02	1.33E+02	1.32E+02	1.31E+02	1.29E+02	1.22E+02	1.02E+02	9.27E+01
am241	1.73E-03	7.37E-04	3.26E-04	2.17E-04	1.44E-04	9.60E-05	6.39E-05	4.25E-05	3.67E-06	1.11E-09	1.79E-11
am242m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am243	2.80E+00	1.09E+00	4.27E-01	2.67E-01	1.67E-01	1.04E-01	6.50E-02	4.06E-02	2.42E-03	3.55E-07	1.57E-07

basis =per B&W assembly, 0.409 mthm for grams

	initial	35000. yr	45000. yr	50000. yr	55000. yr	60000. yr	65000. yr	70000. yr	100000. yr	200000. yr	250000. yr
cm244	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	3.32E-02	1.47E-02	6.50E-03	4.33E-03	2.88E-03	1.91E-03	1.27E-03	8.46E-04	7.33E-05	2.10E-08	3.56E-10
cm246	5.46E-04	1.26E-04	2.92E-05	1.40E-05	6.74E-06	3.24E-06	1.56E-06	7.48E-07	9.22E-09	4.00E-15	2.90E-18
total	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05	4.47E+05

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	35000. yr	45000. yr	50000. yr	55000. yr	60000. yr	65000. yr	70000. yr	100000. yr	200000. yr	250000. yr
pb210	2.38E-01	3.25E-01	4.01E-01	4.35E-01	4.68E-01	4.98E-01	5.26E-01	5.52E-01	6.93E-01	8.15E-01	8.02E-01
ra226	2.39E-01	3.25E-01	4.01E-01	4.35E-01	4.68E-01	4.98E-01	5.26E-01	5.53E-01	6.93E-01	8.16E-01	8.02E-01
ra228	2.57E-07	3.69E-07	4.81E-07	5.38E-07	5.94E-07	6.51E-07	7.07E-07	7.64E-07	1.10E-06	2.23E-06	2.79E-06
ac227	9.01E-03	1.18E-02	1.42E-02	1.53E-02	1.63E-02	1.72E-02	1.80E-02	1.88E-02	2.22E-02	2.60E-02	2.64E-02
th229	3.71E-02	5.96E-02	8.21E-02	9.32E-02	1.04E-01	1.15E-01	1.25E-01	1.36E-01	1.92E-01	3.51E-01	3.79E-01
th230	2.60E-01	3.44E-01	4.17E-01	4.51E-01	4.82E-01	5.11E-01	5.39E-01	5.64E-01	6.84E-01	8.10E-01	7.91E-01

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	35000. yr	45000. yr	50000. yr	55000. yr	60000. yr	65000. yr	70000. yr	100000. yr	200000. yr	250000. yr
th232	2.57E-07	3.69E-07	4.81E-07	5.38E-07	5.94E-07	6.51E-07	7.07E-07	7.64E-07	1.10E-06	2.23E-06	2.79E-06
pa231	9.01E-03	1.18E-02	1.42E-02	1.53E-02	1.63E-02	1.72E-02	1.80E-02	1.88E-02	2.22E-02	2.60E-02	2.64E-02
u233	6.20E-02	8.53E-02	1.08E-01	1.18E-01	1.29E-01	1.39E-01	1.49E-01	1.59E-01	2.13E-01	3.44E-01	3.89E-01
u234	1.23E+00	1.20E+00	1.17E+00	1.16E+00	1.14E+00	1.13E+00	1.11E+00	1.10E+00	1.02E+00	8.07E-01	7.20E-01
u235	2.33E-02	2.41E-02	2.47E-02	2.50E-02	2.52E-02	2.54E-02	2.55E-02	2.57E-02	2.62E-02	2.66E-02	2.66E-02
u236	2.25E-01	2.28E-01	2.29E-01	2.29E-01	2.29E-01	2.29E-01	2.29E-01	2.29E-01	2.29E-01	2.28E-01	2.28E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	6.10E-01	6.08E-01	6.06E-01	6.05E-01	6.04E-01	6.03E-01	6.02E-01	6.01E-01	5.95E-01	5.76E-01	5.67E-01
pu236	3.38E-07	3.18E-07	3.00E-07	2.91E-07	2.82E-07	2.74E-07	2.66E-07	2.58E-07	2.15E-07	1.18E-07	8.71E-08
pu238	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu238	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
pu239	9.74E+01	7.32E+01	5.49E+01	4.76E+01	4.12E+01	3.57E+01	3.09E+01	2.68E+01	1.13E+01	6.38E-01	1.51E-01
pu240	1.56E+01	5.41E+00	1.88E+00	1.11E+00	6.55E-01	3.86E-01	2.28E-01	1.34E-01	5.65E-03	1.46E-07	9.18E-10
pu241	5.72E-03	2.53E-03	1.12E-03	7.44E-04	4.95E-04	3.29E-04	2.19E-04	1.46E-04	1.26E-05	3.62E-09	6.12E-11
pu242	5.57E-01	5.47E-01	5.37E-01	5.32E-01	5.27E-01	5.22E-01	5.17E-01	5.12E-01	4.84E-01	4.02E-01	3.67E-01
am241	5.95E-03	2.53E-03	1.12E-03	7.45E-04	4.95E-04	3.29E-04	2.19E-04	1.46E-04	1.26E-05	3.81E-09	6.12E-11
am242m	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
am243	5.59E-01	2.18E-01	8.52E-02	5.32E-02	3.33E-02	2.08E-02	1.30E-02	8.12E-03	4.83E-04	7.08E-08	3.14E-08

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	35000. yr	45000. yr	50000. yr	55000. yr	60000. yr	65000. yr	70000. yr	100000. yr	200000. yr	250000. yr
cm244	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00
cm245	5.71E-03	2.53E-03	1.12E-03	7.43E-04	4.94E-04	3.29E-04	2.19E-04	1.45E-04	1.26E-05	3.61E-09	6.11E-11
cm246	1.68E-04	3.88E-05	8.96E-06	4.31E-06	2.07E-06	9.95E-07	4.78E-07	2.30E-07	2.83E-09	1.23E-15	8.90E-19
total	1.21E+02	8.66E+01	6.55E+01	5.78E+01	5.13E+01	4.59E+01	4.13E+01	3.74E+01	2.36E+01	1.53E+01	1.48E+01

```
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  c 14  6.17E-07 1.84E-07 5.49E-08 3.00E-08 1.64E-08 8.94E-09 4.88E-09 2.66E-09 7.07E-11 3.93E-16 9.27E-19
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 se 79  2.26E+00 2.21E+00 2.16E+00 2.14E+00 2.12E+00 2.10E+00 2.07E+00 2.05E+00 1.93E+00 1.56E+00 1.41E+00
 se 79m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
rb 93m  2.48E-03 2.47E-03 2.46E-03 2.45E-03 2.45E-03 2.44E-03 2.43E-03 2.43E-03 2.40E-03 2.29E-03 2.24E-03
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 rb 94  8.50E-05 6.04E-05 4.29E-05 3.62E-05 3.05E-05 2.57E-05 2.17E-05 1.83E-05 6.56E-06 2.14E-07 3.91E-08
 rb 94m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
 tc 99  3.52E+02 3.41E+02 3.30E+02 3.24E+02 3.19E+02 3.14E+02 3.09E+02 3.04E+02 2.75E+02 1.98E+02 1.68E+02
 tc 99m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 pd107  8.21E+01 8.20E+01 8.19E+01 8.19E+01 8.18E+01 8.18E+01 8.17E+01 8.17E+01 8.14E+01 8.06E+01 8.02E+01
 pd107m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 sn126  6.66E+00 6.21E+00 5.80E+00 5.60E+00 5.41E+00 5.23E+00 5.05E+00 4.88E+00 3.96E+00 1.98E+00 1.40E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  i129  8.28E+01 8.27E+01 8.27E+01 8.27E+01 8.27E+01 8.26E+01 8.26E+01 8.26E+01 8.25E+01 8.21E+01 8.20E+01
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 cs135  3.64E+02 3.63E+02 3.62E+02 3.61E+02 3.61E+02 3.60E+02 3.60E+02 3.59E+02 3.56E+02 3.45E+02 3.40E+02
 cs135m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 sm151   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 total    1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04 1.63E+04
0                         nuclide radioactivity, curies
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  c 14  2.75E-06 8.20E-07 2.45E-07 1.34E-07 7.30E-08 3.98E-08 2.18E-08 1.19E-08 3.15E-10 1.75E-15 4.13E-18
0                         nuclide radioactivity, curies
                      basis =per B&W assembly, 0.409 mthm for grams
        initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
 se 79  3.10E-02 3.03E-02 2.97E-02 2.94E-02 2.91E-02 2.88E-02 2.85E-02 2.82E-02 2.64E-02 2.14E-02 1.93E-02
 se 79m  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                         nuclide radioactivity, curies
```

```
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  rb 93m  5.91E-01 5.88E-01 5.86E-01 5.84E-01 5.83E-01 5.82E-01 5.81E-01 5.79E-01 5.71E-01 5.46E-01 5.34E-01
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  rb 94   1.59E-05 1.13E-05 8.05E-06 6.79E-06 5.72E-06 4.82E-06 4.07E-06 3.43E-06 1.23E-06 4.05E-08 7.34E-09
  rb 94m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
  tc 99   6.02E+00 5.83E+00 5.64E+00 5.55E+00 5.46E+00 5.37E+00 5.28E+00 5.19E+00 4.71E+00 3.39E+00 2.88E+00
  tc 99m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  pd107   4.22E-02 4.22E-02 4.21E-02 4.21E-02 4.21E-02 4.21E-02 4.20E-02 4.20E-02 4.19E-02 4.14E-02 4.12E-02
  pd107m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  sn126   1.89E-01 1.76E-01 1.65E-01 1.59E-01 1.54E-01 1.48E-01 1.43E-01 1.38E-01 1.12E-01 5.62E-02 3.97E-02
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  i129    1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.46E-02 1.45E-02 1.45E-02
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  cs135   4.19E-01 4.18E-01 4.17E-01 4.16E-01 4.15E-01 4.15E-01 4.14E-01 4.14E-01 4.10E-01 3.98E-01 3.92E-01
  cs135m   .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  sm151    .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00  .00E+00
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
0                                  nuclide radioactivity, curies
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial 35000. yr 45000. yr 50000. yr 55000. yr 60000. yr 65000. yr 70000. yr100000. yr200000. yr250000. yr
  total   8.12E+00 7.89E+00 7.67E+00 7.56E+00 7.45E+00 7.35E+00 7.25E+00 7.15E+00 6.58E+00 5.08E+00 4.50E+00
                                   basis =per B&W assembly, 0.409 mthm for grams
             initial300000. yr500000. yr999999. yr
  pb210   1.05E-02 9.95E-03 7.05E-03 3.20E-03
```

ra226	8.11E-01	7.68E-01	5.44E-01	2.47E-01
ra228	1.02E-08	1.23E-08	2.05E-08	4.08E-08
ac227	3.65E-04	3.66E-04	3.67E-04	3.67E-04
th229	1.91E+00	2.10E+00	2.52E+00	2.40E+00
th230	3.83E+01	3.63E+01	2.60E+01	1.19E+01

basis =per B&W assembly, 0.409 mthm for grams

	initial	300000. yr	500000. yr	999999. yr
th232	2.55E+01	3.06E+01	5.10E+01	1.02E+02
pa231	5.58E-01	5.61E-01	5.63E-01	5.62E-01
u233	4.03E+01	4.38E+01	5.08E+01	4.89E+01
u234	1.16E+02	1.04E+02	6.89E+01	3.44E+01
u235	1.23E+04	1.23E+04	1.23E+04	1.23E+04
u236	3.52E+03	3.52E+03	3.50E+03	3.45E+03
u238	4.30E+05	4.30E+05	4.30E+05	4.30E+05
np237	8.04E+02	7.91E+02	7.41E+02	6.31E+02
pu236	1.67E-10	1.23E-10	3.69E-11	1.81E-12
pu238	.00E+00	.00E+00	.00E+00	.00E+00
pu238	.00E+00	.00E+00	.00E+00	.00E+00
pu239	2.44E+00	5.79E-01	1.84E-03	4.84E-07
pu240	4.04E-09	9.07E-10	1.27E-09	1.72E-09
pu241	5.92E-13	1.00E-14	8.25E-22	.00E+00
pu242	9.27E+01	8.45E+01	5.83E+01	2.31E+01
am241	1.79E-11	3.02E-13	2.62E-20	5.09E-38
am242m	.00E+00	.00E+00	.00E+00	.00E+00
am243	1.57E-07	1.55E-07	1.54E-07	1.50E-07

basis =per B&W assembly, 0.409 mthm for grams

	initial	300000. yr	500000. yr	999999. yr
cm244	.00E+00	.00E+00	.00E+00	.00E+00
cm245	3.56E-10	6.03E-12	4.98E-19	9.64E-37
cm246	2.90E-18	3.81E-20	1.72E-23	3.84E-32
total	4.47E+05	4.47E+05	4.47E+05	4.47E+05

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	300000. yr	500000. yr	999999. yr
pb210	8.02E-01	7.60E-01	5.38E-01	2.44E-01
ra226	8.02E-01	7.60E-01	5.39E-01	2.45E-01
ra228	2.79E-06	3.36E-06	5.60E-06	1.11E-05
ac227	2.64E-02	2.65E-02	2.66E-02	2.66E-02
th229	3.79E-01	4.15E-01	4.99E-01	4.75E-01
th230	7.91E-01	7.49E-01	5.36E-01	2.44E-01

0

nuclide radioactivity, curies

basis =per B&W assembly, 0.409 mthm for grams

	initial	300000. yr	500000. yr	999999. yr
th232	2.79E-06	3.36E-06	5.60E-06	1.11E-05
pa231	2.64E-02	2.65E-02	2.66E-02	2.66E-02
u233	3.89E-01	4.23E-01	4.89E-01	4.72E-01
u234	7.20E-01	6.44E-01	4.29E-01	2.14E-01
u235	2.66E-02	2.66E-02	2.66E-02	2.66E-02
u236	2.28E-01	2.28E-01	2.26E-01	2.23E-01
u238	1.45E-01	1.45E-01	1.45E-01	1.45E-01
np237	5.67E-01	5.58E-01	5.23E-01	4.45E-01
pu236	8.71E-08	6.44E-08	1.93E-08	9.47E-10
pu238	.00E+00	.00E+00	.00E+00	.00E+00
pu238	.00E+00	.00E+00	.00E+00	.00E+00
pu239	1.51E-01	3.60E-02	1.14E-04	3.01E-08
pu240	9.18E-10	2.06E-10	2.89E-10	3.92E-10
pu241	6.12E-11	1.04E-12	8.54E-20	.00E+00
pu242	3.67E-01	3.34E-01	2.31E-01	9.12E-02
am241	6.12E-11	1.04E-12	8.99E-20	.00E+00
am242m	.00E+00	.00E+00	.00E+00	.00E+00

```
    am243  3.14E-08 3.09E-08 3.07E-08 3.00E-08
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    cm244   .00E+00  .00E+00  .00E+00  .00E+00
    cm245  6.11E-11 1.04E-12 8.52E-20  .00E+00
    cm246  8.90E-19 1.17E-20 5.29E-24 2.28E-32
   total   1.48E+01 1.44E+01 1.25E+01 8.86E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
     c 14  9.27E-19 2.19E-21 6.77E-32  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    se 79  1.41E+00 1.27E+00 8.32E-01 2.91E-01
    se 79m  .00E+00  .00E+00  .00E+00  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    nb 93m 2.24E-03 2.19E-03 2.00E-03 1.59E-03
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    nb 94  3.91E-08 7.10E-09 7.67E-12 2.95E-19
    nb 94m  .00E+00  .00E+00  .00E+00  .00E+00
    tc 99  1.68E+02 1.43E+02 7.40E+01 1.43E+01
    tc 99m  .00E+00  .00E+00  .00E+00  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    pd107  8.02E+01 7.97E+01 7.80E+01 7.40E+01
    pd107m  .00E+00  .00E+00  .00E+00  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    sn126  1.40E+00 9.90E-01 2.48E-01 7.74E-03
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
     i129  8.20E+01 8.18E+01 8.11E+01 7.95E+01
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    cs135  3.40E+02 3.35E+02 3.15E+02 2.71E+02
    cs135m  .00E+00  .00E+00  .00E+00  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
    sm151   .00E+00  .00E+00  .00E+00  .00E+00
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
                                         basis =per B&W assembly, 0.409 mthm for grams
            initial300000. yr500000. yr999999. yr
   total   1.63E+04 1.63E+04 1.63E+04 1.63E+04
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
```

```
          initial300000. yr500000. yr999999. yr
  c 14    4.13E-18 9.75E-21 2.97E-31  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  se 79   1.93E-02 1.74E-02 1.14E-02 3.99E-03
  se 79m   .00E+00  .00E+00  .00E+00  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  rb 93m  5.34E-01 5.22E-01 4.77E-01 3.80E-01
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  rb 94   7.34E-09 1.33E-09 1.44E-12 5.53E-20
  rb 94m   .00E+00  .00E+00  .00E+00  .00E+00
  tc 99   2.88E+00 2.44E+00 1.27E+00 2.45E-01
  tc 99m   .00E+00  .00E+00  .00E+00  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  pd107   4.12E-02 4.10E-02 4.01E-02 3.81E-02
  pd107m   .00E+00  .00E+00  .00E+00  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  sn126   3.97E-02 2.81E-02 7.08E-03 2.20E-04
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
   i129   1.45E-02 1.44E-02 1.43E-02 1.40E-02
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  cs135   3.92E-01 3.86E-01 3.63E-01 3.12E-01
  cs135m   .00E+00  .00E+00  .00E+00  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
          initial300000. yr500000. yr999999. yr
  sm151    .00E+00  .00E+00  .00E+00  .00E+00
0                                          nuclide radioactivity, curies
                                           basis =per B&W assembly, 0.409 mthm for grams
```

```
           initial300000. yr500000. yr999999. yr
0                                                nuclide radioactivity, curies
                                                 basis =per B&W assembly, 0.409 mthm for grams
           initial300000. yr500000. yr999999. yr
  total    4.50E+00  4.00E+00  2.66E+00  1.37E+00
```