D-6.6.2 Arrays of IF-300 Casks with BWR Fuel under HAC

An infinite array of casks was modeled to conservatively represent 2N damaged packages. Once again, a triangular array configuration was used and the pitch was varied to determine the optimum distance between the casks (i.e., cask pitch). Sensitivity cases were run for various water densities within the containment (inleakage is assumed under HAC), and various water densities for the interspersed moderation (between packages) for different cask pitches. Figure D-6.6-2 illustrates the BWR Cask infinite array model under HAC. Note that, although the cask coolant jacket is not included in the model, because the model includes interspersed moderator between the infinite array of casks, the neutronic effects of the coolant jacket are accounted for.

D-6.6.2.1 Results of the HAC Infinite Array Package Evaluation for the IF-300 Cask With GE BWR Fuel Assemblies from Brunswick

Table D-6.6-2 summarizes the results of the calculations made for an infinite array of BWR casks which conservatively represents 2N damaged packages under HAC. The density of water both within the cask containment, and between (i.e., interspersed) the casks was varied in this evaluation, and the distance between the casks was also varied. Cases were run for the assemblies shifted radially inward and outward in the basket, as well as an their nominal centered locations. Because the effective multiplication of the system is maximized with the assemblies shifted inward, most cases were run with the assemblies shifted inward. The maximum k_{eff} including all biases and uncertainties is 0.93407. This occurs for an infinite array of packages with the fuel assemblies shifted inward, with a distance of 16 cm between the casks, with water at a density of 1 g/cc in the containment, and with water at a density of 0.9 g/cc interspersed between the casks (case bsi8i19d). The results in Table D-6.6-2 indicate that the casks are effectively isolated from each other since the change in the effective multiplication of the infinite cask system is relatively small as the cask spacing is varied from 2 cm to 20 cm, and as the interspersed

moderator density is varied from 0 g/cc to 1 g/cc. Example MCNP input files for the cases listed in Table D-6.6-2 are included in the Appendix.

It is concluded that an infinite array of IF-300 Casks will meet the criticality safety limit of $k_{eff} < 0.95$ when the cask contains seventeen channeled BWR fuel assemblies with a maximum lattice average enrichment of 4.25 wt% ^{235}U. Therefore, the IF-300 Cask meets the requirement that an array of 2 times N damaged packages stacked together in any arrangement with optimum interspersed hydrogenous moderation between the packages must be subcritical, where N in this case is equal to infinity. Note that the model did not use close full reflection of the array on all sides by water because an infinite array was analyzed.

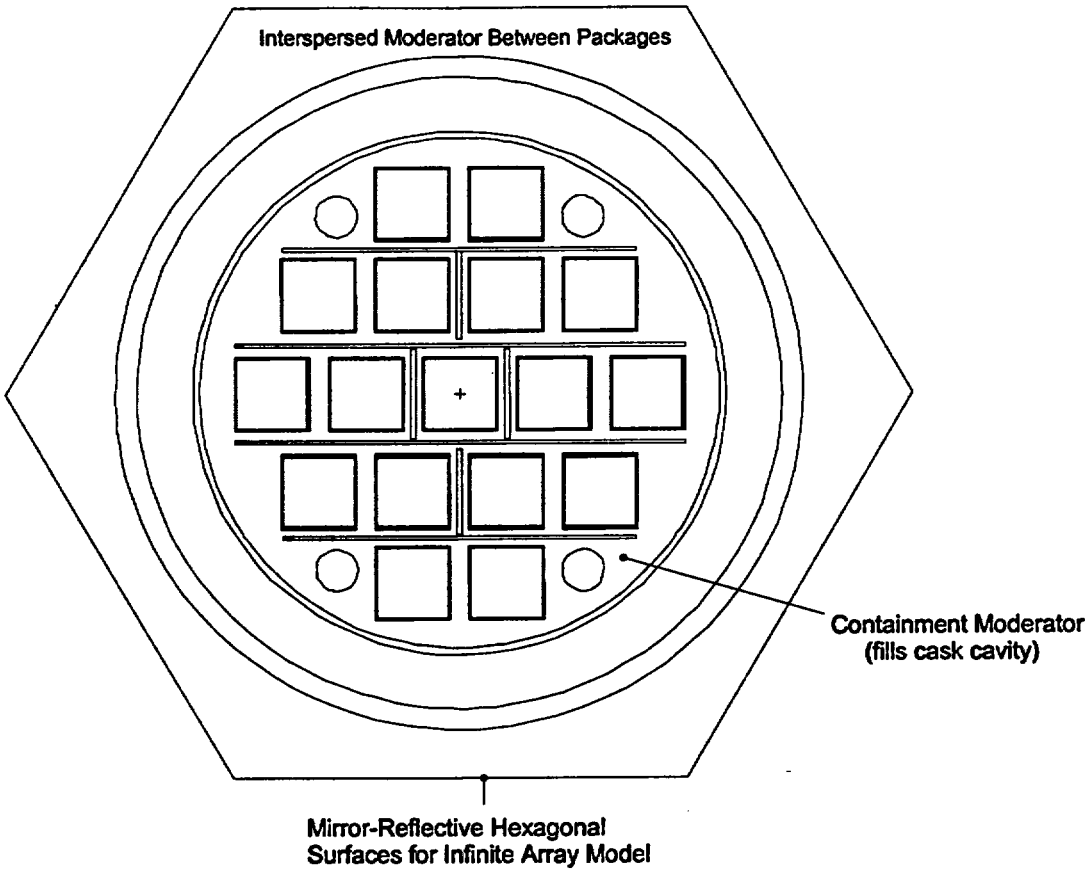

Figure D-6.6-2

BWR Cask HAC Infinite Array Model

Table D-6.6-2

Infinite Multiplication Factors for an Infinite Array of IF-300 Casks[a] Under HAC with 17 GE BWR Fuel Assemblies with 4.25 wt% ^{235}U (2 sheets total)

MCNP input file[b]	Containment Water density g/cc	Interspersed Water density g/cc	cask spacing cm	k_∞	σ	k_{tot}[c]
bsi8i11a	1	1	2	0.91673	0.00113	0.93401
bsi8i19a	1	0.9	2	0.91575	0.00108	0.93300
bsi8i17a	1	0.7	2	0.91426	0.00105	0.93149
ifb8i14a	1	0.4	2	0.90394	0.00099	0.92114
bso8i14a	1	0.4	2	0.88662	0.00114	0.90390
bsi8i14a	1	0.4	2	0.91591	0.00104	0.93314
bsi8i1-a	1	0.1	2	0.91560	0.00113	0.93288
bsi8i10a	1	0	2	0.91421	0.00107	0.93145
bsi8i11b	1	1	6	0.91481	0.00103	0.93203
bsi8i19b	1	0.9	6	0.91426	0.00102	0.93148
bsi8i17b	1	0.7	6	0.91428	0.00113	0.93156
bsi8i14b	1	0.4	6	0.91433	0.00098	0.93152
bsi8i1-b	1	0.1	6	0.91397	0.00095	0.93115
bsi8i10b	1	0	6	0.91407	0.00106	0.93131
bsi8i11c	1	1	10	0.91530	0.00100	0.93250
ifb8i19c	1	0.9	10	0.90277	0.00118	0.92008
bso8i19c	1	0.9	10	0.88790	0.00107	0.90514
bsi8i19c	1	0.9	10	0.91419	0.00113	0.93147
bsi8i17c	1	0.7	10	0.91476	0.00107	0.93200
bsi8i14c	1	0.4	10	0.91444	0.00108	0.93169
bsi8i1-c	1	0.1	10	0.91421	0.00107	0.93145
bsi8i10c	1	0	10	0.91562	0.00098	0.93281
bsi8i11d	1	1	16	0.91479	0.00109	0.93204
bsi8i19d	1	0.9	16	0.91686	0.00101	0.93407

MCNP input file[b]	Containment Water density g/cc	Interspersed Water density g/cc	cask spacing cm	k_∞	σ	k_{tot}[c]
bsi8i17d	1	0.7	16	0.91441	0.00102	0.93163
bsi8i14d	1	0.4	16	0.91544	0.00103	0.93266
bsi8i1-d	1	0.1	16	0.91560	0.00113	0.93288
bsi8i10d	1	0	16	0.91421	0.00107	0.93145
bsi8i11e	1	1	20	0.91486	0.00107	0.93210
bsi8i19e	1	0.9	20	0.91400	0.00098	0.93119
bsi8i17e	1	0.7	20	0.91537	0.00104	0.93260
bsi8i14e	1	0.4	20	0.91530	0.00102	0.93252
ifb8i1-e	1	0.1	20	0.90445	0.00101	0.92166
bso8i1-e	1	0.1	20	0.88917	0.00103	0.90639
bsi8i1-e	1	0.1	20	0.91261	0.00099	0.92981
bsi8i10e	1	0	20	0.91302	0.00107	0.93026
bsi8i91c	0.9	1	10	0.89765	0.00150	0.91518
bsi8i71c	0.7	1	10	0.84491	0.00174	0.86264
bsi8i41c	0.4	1	10	0.70345	0.00236	0.72179
bsi8i01c	0	1	10	0.33011	0.00109	0.34736

[a] Credit is only taken for 75% of the ^{10}B poison present in the cask basket.

[b] All MCNP input files with a "bsi" prefix have the fuel assemblies shifted inward in the basket to minimize the assembly-to-assembly spacing. All cases with a "bso" prefix have the fuel assemblies shifted outward in the basket to maximize the assembly-to-assembly spacing. Cases with a "ifb" prefix have the fuel assemblies in their nominal (centered) positions.

[c] $k_{tot} = k_{eff}$ including the benchmark experiment bias and uncertainties (see Section D-6.7), and the bias and uncertainty associated with the tolerance for the thickness of the boron plates (see Section D-6.4.2.3-A).

D-6.7 Benchmark Evaluations

D-6.7.1 Validation of MCNP Calculational Method

The MCNP computer code is used throughout the world and has been extensively tested with its ENDF/B-V-based cross sections. The code development group at LANL, where MCNP was developed, has a set of 25 calculational benchmarks that extensively test various options within the code. Additionally, MCNP Version 4B2 has been certified for use on WMNW PC computer platforms (Savino 1998 and McCoy 1998). This section justifies the validity of the calculational methods and neutron cross sections used by reporting the results of critical benchmark experiment analyses.

D-6.7.2 Benchmark Experiments and Applicability

Benchmark analyses have been performed with MCNP and the associated cross sections. These analyses were performed for low-enriched uranium (LEU) critical benchmark problems that are particularly applicable to the fuel designs to be transported in the IF-300 Casks. These experiments and results are discussed below.

Numerous sets of critical experiments were performed at the Pacific Northwest National Laboratory critical mass laboratory, the MATR facility at the Institute of Physics and Power Engineering in Obninsk, Russia, and at the Tank-Type Critical Assembly (TCA). These experiments are documented in the International Handbook of Evaluated Criticality Safety Benchmark Experiments (NEA 1998). The measurements of interest for this evaluation involve critical experiments for water-moderated uranium dioxide (UO_2) fuel rods in square-pitched and hexagonal arrays. These measurements are designated in NEA (1998) as LEU-COMP-THERM-001, 002, 003, 004, 006, 016, and 026. The MCNP input files for these critical experiments were taken directly from NEA (1998) and were run unaltered.

The fuel rods in the experiments contained UO_2 with ^{235}U enrichments from 2.3 to 4.92 wt%. This enrichment range bounds the values used in the

criticality evaluation for the BWR fuel (4.25 wt%) and the PWR fuel (4.65 wt%).

NRC (1997) recommends using the following general relationship for establishing the acceptance criteria for criticality calculations:

$$k_c - \Delta k_u \geq k_{eff} + 2\sigma + \Delta k_m,$$

where,

k_c = mean value of k_{eff} resulting from the calculation of benchmark critical experiments using a specific calculational method and data;

Δk_u = an allowance for the calculational uncertainty

Δk_m = a required margin of subcriticality (0.05)

k_{eff} = the calculated value obtained from the Monte Carlo analysis for the package or array of packages.

σ = the standard deviation of the k_{eff} value obtained from the Monte Carlo analysis.

If the calculational bias β is defined as $\beta = 1 - k_c$, then the bias is positive if $k_c < 1$ and negative if $k_c > 1$. The acceptance criteria may be rewritten as:

$$1.00 - \beta - \Delta k_u \geq k_{eff} + 2\sigma + 0.05,$$

or

$$k_{eff} + \beta + 2\sigma + \Delta k_u \leq 0.95.$$

Table D-6.7-1 lists the results of the MCNP calculations for the relevant critical experiments contained in NEA (1998). The mean value of k_{eff} from these 111 critical experiments is k_c = 0.99260, which results in a calculational bias of β= 0.0074 (7.4 mk). The mean value of σ_{crit} for the critical experiments is 0.00151.

NEA (1998) states that some experimental uncertainties or model simplifications result in an uncertainty in the benchmark model k_{eff}. Table D-6.7-1 lists the total uncertainty in the benchmark model k_{eff} for each critical experiment from NEA (1998). The mean value of σ_{exp} for the critical experiments is 0.00316.

In order to account for calculational and experimental uncertainty for the benchmark criticals, the mean value of σ_{crit} from MCNP for the critical experiments (0.00151), and the experimental uncertainty σ_{exp} (0.00316), will be combined in quadrature with the standard deviation (σ) of the k_{eff} value obtained from the MCNP Monte Carlo analysis. This results in the following acceptance criteria:

$$k_{eff} + \beta + 2(\sigma^2 + \sigma^2_{crit} + \sigma^2_{exp})^{0.5} \leq 0.95$$

or

$$k_{eff} + 0.0074 + 2(\sigma^2 + 0.00316^2 + 0.00151^2)^{0.5} \leq 0.95$$

which becomes, for the final acceptance criteria used in this evaluation,

$$k_{eff} + 0.0074 + 2(\sigma^2 + 1.2266 \times 10^{-5})^{0.5} \leq 0.95$$

or

$$k_{tot} \leq 0.95,$$

where,

$$k_{tot} = k_{eff} + 0.0074 + 2(\sigma^2 + 1.2266 \times 10^{-5})^{0.5} \quad \text{(PWR Fuel)}$$

This formula will be used for all of the MCNP calculations for the IF-300 Cask loaded with PWR fuel. For example, for a typical MCNP calculation, the calculated standard deviation (σ) is 0.001, which means that k_{eff} from the MCNP calculation would need to be less than 0.93532 to demonstrate that adequate subcritical margin exists.

When the cask is loaded with BWR fuel, an additional bias and uncertainty is necessary to account for the manufacturing tolerance of the boron plate thickness for the basket. The bias and uncertainty are

discussed in Section D-6.4.3, and are β_{plate} = 0.00232 and σ_{plate} = 0.00086, respectively. This results in the formula below for k_{tot} which will be used for all of the MCNP calculations for the IF-300 Cask loaded with BWR fuel. For example, for a typical MCNP calculation, the calculated standard deviation (σ) is 0.001, which means that k_{eff} from the MCNP calculation would need to be less than 0.93280 to demonstrate that adequate subcritical margin exists.

$$k_{tot} = k_{eff} + 0.00972 + 2(\sigma^2 + 1.3005 \times 10^{-5})^{0.5} \text{ (BWR Fuel)}$$

Table D-6.7-1

MCNP Calculations from Criticality Benchmark Experiments Contained in NEA (1998) (3 sheets total)

Experiment	Case Number	No. of Clusters	Cluster Dimen. (No. rods, X x Y)	Benchmark Uncertainty[a]	MCNP k_{eff}	MCNP σ
LEUCT001	CASE_1	1	20X18	0.003	0.99895	0.00153
LEUCT001	CASE_2	3	20X17	0.003	0.99598	0.00147
LEUCT001	CASE_3	3	20X16	0.003	0.99465	0.00174
LEUCT001	CASE_4	2	22X16	0.003	0.99619	0.00146
LEUCT001	CASE_5	3	20X15	0.003	0.99223	0.00168
LEUCT001	CASE_6	2	24X15	0.003	0.99783	0.00167
LEUCT001	CASE_7	3	20X14	0.0031	0.99611	0.00161
LEUCT001	CASE_8	3	19X16	0.003	0.99332	0.00169
LEUCT002	CASE_1	1	10X11	0.002	0.99801	0.00185
LEUCT002	CASE_2	1	9X13	0.002	0.99882	0.0017
LEUCT002	CASE_3	1	8X16	0.002	0.999	0.00186
LEUCT002	CASE_4	3	15X8	0.0018	0.99443	0.00218
LEUCT002	CASE_5	3	13X8	0.0019	0.99469	0.00161
LEUCT003	CASE_1	1	17X36	0.0039	0.98453	0.00167
LEUCT003	CASE_2	1	21X25	0.0039	0.98879	0.00197
LEUCT003	CASE_3	1	23X22	0.0039	0.98554	0.00164
LEUCT003	CASE_4	1	24X21	0.0039	0.98852	0.00169
LEUCT003	CASE_5	1	34X17	0.0039	0.98603	0.00143
LEUCT003	CASE_6	1	23X22	0.0039	0.98593	0.00145
LEUCT003	CASE_7	1	23X23	0.0039	0.99111	0.00182
LEUCT003	CASE_8	1	23X23	0.0039	0.99029	0.00173
LEUCT003	CASE_9	2	11X1, 17X17	0.0039	0.98123	0.00171
LEUCT003	CASE_10	2	17X17,17x17	0.0039	0.97811	0.00188
LEUCT003	CASE_11	2	17X3, 17X3	0.0039	0.98646	0.00156
LEUCT003	CASE_12	2	17X15,17X15	0.0039	0.9819	0.00171
LEUCT003	CASE_13	2	17X1, 17X17	0.0039	0.9846	0.00166
LEUCT003	CASE_14	2	17X2, 17X17	0.0039	0.98411	0.00169
LEUCT003	CASE_15	2	17X4, 17X17	0.0039	0.98322	0.00181
LEUCT003	CASE_16	2	17X9, 17X17	0.0039	0.9837	0.00172
LEUCT003	CASE_17	2	17X12,17X17	0.0039	0.98304	0.00157
LEUCT003	CASE_18	2	17X15,17X17	0.0039	0.98355	0.00146
LEUCT003	CASE_19	4	17X17	0.0039	0.98448	0.00159
LEUCT003	CASE_20	2	17X20	0.0039	0.98127	0.00182
LEUCT003	CASE_21	2	20X18	0.0039	0.979	0.00169
LEUCT003	CASE_22	2	20X18	0.0039	0.9895	0.0018
LEUCT004	CASE_1	1	12X18	0.0033	0.98528	0.00194
LEUCT004	CASE_2	1	14X15	0.0033	0.99063	0.00172
LEUCT004	CASE_3	1	16X13	0.0033	0.98733	0.00192
LEUCT004	CASE_4	1	17X12	0.0033	0.99145	0.00172
LEUCT004	CASE_5	1	14X13	0.0033	0.98826	0.00202
LEUCT004	CASE_6	1	14X16	0.0033	0.9838	0.00195
LEUCT004	CASE_7	1	14X14	0.0033	0.99078	0.00212
LEUCT004	CASE_8	2	9X12	0.0035	0.98624	0.00186
LEUCT004	CASE_9	3	12X16	0.0035	0.98438	0.00179
LEUCT004	CASE_10	3	12X16	0.0035	0.99978	0.00196
LEUCT004	CASE_11	4	9X12,9X2	0.0035	0.98168	0.00176
LEUCT004	case_12	4	9X12	0.0035	0.98161	0.00175
LEUCT004	CASE_13	4	9X12,4X1,5X1	0.0035	0.98675	0.00183
LEUCT004	case_14	4	9X12,9X1	0.0035	0.9882	0.00184
LEUCT004	case_15	4	9X12,9X2	0.0035	0.98552	0.002

Experiment	Case Number	No. of Clusters	Cluster Dimen. (No. rods, X x Y)	Benchmark Uncertainty[a]	MCNP k_{eff}	MCNP σ
LEUCT004	case_16	4	9X12,9X4	0.0035	0.98702	0.00183
LEUCT004	case_17	4	9X12,9X8	0.0035	0.98219	0.00208
LEUCT004	case_18	4	9X12,9X10	0.0035	0.98613	0.00161
LEUCT004	case_19	4	9X12,9X12	0.0035	0.98715	0.00199
LEUCT004	CASE_20	4	9X10,9X9	0.0035	0.98232	0.00182
LEUCT006	CASE_1	1	19X19	0.002	0.99373	0.00076
LEUCT006	CASE_2	1	20X20	0.002	0.99591	0.00067
LEUCT006	CASE_3	1	21X21	0.002	0.99508	0.00075
LEUCT006	CASE_4	1	17X17	0.002	0.99573	0.00073
LEUCT006	CASE_5	1	18X18	0.002	0.99492	0.00077
LEUCT006	CASE_6	1	19X19	0.002	0.99502	0.00069
LEUCT006	CASE_7	1	20X20	0.002	0.99541	0.00077
LEUCT006	CASE_8	1	21X21	0.002	0.99429	0.00071
LEUCT006	CASE_9	1	16X16	0.002	0.99579	0.00074
LEUCT006	CASE_10	1	17X17	0.002	0.99578	0.00073
LEUCT006	CASE_11	1	18X18	0.002	0.99681	0.0007
LEUCT006	CASE_12	1	19X19	0.002	0.99649	0.0007
LEUCT006	CASE_13	1	20X20	0.002	0.99787	0.00076
LEUCT006	CASE_14	1	15X15	0.002	0.99703	0.00068
LEUCT006	CASE_15	1	16X16	0.002	0.99829	0.00069
LEUCT006	CASE_16	1	17X17	0.002	0.99711	0.00082
LEUCT006	CASE_17	1	18X18	0.002	0.99792	0.00068
LEUCT006	CASE_18	1	19X19	0.002	0.99645	0.00071
LEUCT016	CASE_1	3	20X16	0.0031	0.99785	0.00154
LEUCT016	CASE_2	3	20X16	0.0031	0.99461	0.00176
LEUCT016	CASE_3	3	20X16	0.0031	0.9964	0.00165
LEUCT016	CASE_4	3	20X16	0.0031	0.9951	0.00171
LEUCT016	CASE_5	3	20X16	0.0031	0.99819	0.0015
LEUCT016	CASE_6	3	20X17	0.0031	0.99676	0.00179
LEUCT016	CASE_7	3	20X17	0.0031	0.99593	0.00161
LEUCT016	CASE_8	3	20X17	0.0031	0.99449	0.00162
LEUCT016	CASE_9	3	20X17	0.0031	0.99894	0.00171
LEUCT016	CASE_10	3	20X17	0.0031	1.00023	0.00162
LEUCT016	CASE_11	3	20X17	0.0031	0.99779	0.00172
LEUCT016	CASE_12	3	20X17	0.0031	0.99595	0.00161
LEUCT016	CASE_13	3	20X17	0.0031	0.99569	0.00154
LEUCT016	CASE_14	1	20X16,22x16	0.0031	0.99632	0.00175
LEUCT016	CASE_15	3	20X16	0.0031	0.99867	0.00156
LEUCT016	CASE_16	3	20X16	0.0031	0.99133	0.00183
LEUCT016	CASE_17	3	20X16	0.0031	0.99226	0.00184
LEUCT016	CASE_18	3	24X15	0.0031	0.99712	0.00161
LEUCT016	CASE_19	3	24X15	0.0031	0.99622	0.00137
LEUCT016	CASE_20	3	24X15	0.0031	0.9957	0.00155
LEUCT016	CASE_21	3	20X17	0.0031	0.9955	0.00167
LEUCT016	CASE_22	3	20X17	0.0031	0.99666	0.0016
LEUCT016	CASE_23	3	20X17	0.0031	0.99763	0.00171
LEUCT016	CASE_24	3	20X17	0.0031	0.99329	0.00174
LEUCT016	CASE_25	3	20X17	0.0031	0.99739	0.00151
LEUCT016	CASE_26	3	20X17	0.0031	0.99847	0.00151
LEUCT016	CASE_27	3	20X17	0.0031	0.99394	0.00177
LEUCT016	CASE_28	3	20X16	0.0031	0.99564	0.0018
LEUCT016	CASE_29	3	20X16	0.0031	0.99871	0.00164
LEUCT016	CASE_30	3	20X16	0.0031	0.99923	0.00156
LEUCT016	CASE_31	3	20X16	0.0031	0.99824	0.00175
LEUCT016	CASE_32	3	20X16	0.0031	0.99414	0.00163
LEUCT026	CASE_1	1	HEX Lattice	0.0033	1.00016	0.0008

Experiment	Case Number	No. of Clusters	Cluster Dimen. (No. rods, X x Y)	Benchmark Uncertainty[a]	MCNP k_{eff}	MCNP σ
LEUCT026	CASE_2	1	HEX Lattice	0.0033	1.00349	0.00079
LEUCT026	CASE_3	1	HEX Lattice	0.0062	1.00015	0.00078
LEUCT026	CASE_4	1	HEX Lattice	0.0062	1.00451	0.00077
LEUCT026	CASE_5	1	HEX Lattice	0.0041	0.99927	0.00078
LEUCT026	CASE_6	1	HEX Lattice	0.0041	1.00513	0.00078
			MEAN =	0.00316	0.99260	0.00151

[a] Total uncertainty in k_{eff} for each case from NEA (1998)

D-6.8 References

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D-6.9 Appendix

D-6.9-1 Example MCNP Input Files for the IF-300 Cask with SPC PWR Fuel

Note: The highlighted information in these input files is proprietary to Siemens Power Corporation.

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MCNP Case: ifp6-10

PWR Cask - 6 FAs (Center H20 Hole) - 4.65% - 1.00 g/cc - 12 in Refl
1     1 -10.4 -1       22 -23        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.000     1 -2 22 -23        u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   22 -23        u=1 imp:n=1 $ Zr4 Clad
4     4 -1.00  3 16 -17 18 -19 22 -23 u=1 imp:n=1 $ Moderator
401   3 -6.565 (-16:17:-18:19) 22 -23 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.4 -1       23 -21        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.000     1 -2 23 -21        u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   23 -21        u=1 imp:n=1 $ Zr4 Clad
8     4 -1.00  3 16 -17 18 -19 23 -21 u=1 imp:n=1 $ Moderator
801   3 -6.565 (-16:17:-18:19) 23 -21 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.4 -1       20 -22        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.000     1 -2 20 -22        u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   20 -22        u=1 imp:n=1 $ Zr4 Clad
12    4 -1.00  3 16 -17 18 -19 20 -22 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 20 -22 u=1 imp:n=1 $ Zr4 - Spacer
c     Plenum region - below fuel pins
13    4 -1.000     -2   24 -20        u=1 imp:n=1 $ He
14    3 -6.565  2 -3   24 -20        u=1 imp:n=1 $ Zr4 Clad
15    4 -1.00  3        24 -20        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.000     -2   21 -25        u=1 imp:n=1 $ He
17    3 -6.565  2 -3   21 -25        u=1 imp:n=1 $ Zr4 Clad
18    4 -1.00  3        21 -25        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  30 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
191   4 -1.00  -30                   u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  25                    u=1 imp:n=1 $ 304L SS in LTP
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2  fill= -7:7  -7:7 0:0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1          $ x=-7 to x=7:y=7
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1          $ "          ";y=6
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1          $ "          ";y=5
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1          $ "          ";y=4
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1          $ "          ";y=3
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1          $ "          ";y=2
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1          $ "          ";y=1
          1 1 1 3 1 1 1 3 1 1 1 3 1 1 1          $ "          ";y=0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1          $ "          ";y=-1
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1          $ "          ";y=-2
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1          $ "          ";y=-3
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1          $ "          ";y=-4
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1          $ "          ";y=-5
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1          $ "          ";y=-6
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 imp:n=1 $ "          ";y=-7
c     Instrument/Control Rod Guide Tubes
26    4 -1.00 -10      24 -25        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -25        u=3 imp:n=1 $ Zr4 Clad
```

```
28    4 -1.00 11 16 -17 18 -19 24 -25 u=3 imp:n=1 $ Moderator
281   3 -6.565 (-16:17:-18:19) 24 -25 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate
c     Instrument/Control Rod Guide Tube Locations
29    4 -1.00 -10          -24 30     u=3 imp:n=1 $ water inside tube
30    3 -6.565 10 -11     -24 30     u=3 imp:n=1 $ Zr4 Clad
31    6 -8.03 11          -24 30     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
311   4 -1.00  -30                     u=3 imp:n=1 $ Water
c     Upper Tie Plate
c     Instrument/Control Rod Guide Tube Locations
33    4 -1.00 -10      25             u=3 imp:n=1 $ water inside tube
34    3 -6.565 10 -11 25             u=3 imp:n=1 $ Zr4 Clad
35    6 -8.03 11      25             u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
36    0 12 -13 14 -15 26 -31 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and guide channel
c     and above UTP.
c
40    4 -1.0    (41 -42 45 -46 26) #36 u=4  imp:n=1
400   4 -1.0    (41 -42 45 -46 26)     u=40 imp:n=1
c
c     Guide Channel side & 1 in bottom plate (mixture of H2O & SS304)
41    13 -5.51326 #36 #40 u=4  imp:n=1
410   13 -5.51326    #400 u=40 imp:n=1  $ FA #1 - Empty Channel
c
c     Make a dummy water FA in the center
c
42     0  40 -43 44 -47 27 -33 fill=40   imp:n=1
c
c     Define a row of 6 Horizontal poison pins
c     First the 6 pins
45   10 -0.99    -60  trcl=1 u=5 imp:n=1 $ B4C dens (B-10 reduced 75%)
46   6 -8.03  60 -61 trcl=1 u=5 imp:n=1 $ poison pin SS clad
47   like 45 but trcl=2 u=5 imp:n=1 $ B4C lower toler dens
48   like 46 but trcl=2 u=5 imp:n=1 $ poison pin SS clad
49   like 45 but trcl=3 u=5 imp:n=1 $ B4C lower toler dens
50   like 46 but trcl=3 u=5 imp:n=1 $ poison pin SS clad
51   like 45 but trcl=4 u=5 imp:n=1 $ B4C lower toler dens
52   like 46 but trcl=4 u=5 imp:n=1 $ poison pin SS clad
53   like 45 but trcl=5 u=5 imp:n=1 $ B4C lower toler dens
54   like 46 but trcl=5 u=5 imp:n=1 $ poison pin SS clad
55   like 45 but trcl=6 u=5 imp:n=1 $ B4C lower toler dens
56   like 46 but trcl=6 u=5 imp:n=1 $ poison pin SS clad
c     Now the row
60   0  48 -49 72 -73 30 -31 trcl=20 fill=5  imp:n=1 $ Horiz Above FA#1
61    4 -1.00 #45 #46 #47 #48 #49 #50 #51 #52 #53 #54 #55 #56
                              u=5  imp:n=1  $ water around poison pins
c     Define the rest of the horizontal rows
62   like 60 but trcl=21 imp:n=1 $ Horiz below FA#2
63   like 60 but trcl=22 imp:n=1 $ Horiz below FA#3
64   like 60 but trcl=23 imp:n=1 $ Horiz above FA#4
65   like 60 but trcl=24 imp:n=1 $ Horiz above FA#5
66   like 60 but trcl=25 imp:n=1 $ Horiz below FA#4
67   like 60 but trcl=26 imp:n=1 $ Horiz below FA#1
68   like 60 but trcl=27 imp:n=1 $ Horiz below FA#5
69   like 60 but trcl=28 imp:n=1 $ Horiz above FA#6
70   like 60 but trcl=29 imp:n=1 $ Horiz above FA#7
c
c     Define a column of 6 vertical poison pins
c     First the 6 pins
71   10 -0.99   -60  trcl=11 u=6 imp:n=1 $ B4C dens (B-10 reduced 75%)
72   6 -8.03  60 -61  trcl=11 u=6 imp:n=1 $ poison pin SS clad
73   like 71 but      trcl=12 u=6 imp:n=1 $ B4C lower toler dens
74   like 72 but      trcl=12 u=6 imp:n=1 $ poison pin SS clad
75   like 71 but      trcl=13 u=6 imp:n=1 $ B4C lower toler dens
76   like 72 but      trcl=13 u=6 imp:n=1 $ poison pin SS clad
77   like 71 but      trcl=14 u=6 imp:n=1 $ B4C lower toler dens
```

```
78   like 72 but       trcl=14 u=6 imp:n=1 $ poison pin SS clad
79   like 71 but       trcl=15 u=6 imp:n=1 $ B4C lower toler dens
80   like 72 but       trcl=15 u=6 imp:n=1 $ poison pin SS clad
81   like 71 but       trcl=16 u=6 imp:n=1 $ B4C lower toler dens
82   like 72 but       trcl=16 u=6 imp:n=1 $ poison pin SS clad
c     Now the column
83   0  44 -47 74 -75 30 -31 trcl=30 fill=6  imp:n=1 $ vert right FA#2
84    4 -1.00 #71 #72 #73 #74 #75 #76 #77 #78 #79 #80 #81 #82
                                u=6  imp:n=1 $ water around poison pins
c     Define the rest of the vertical columns
85   like 83 but trcl=31 imp:n=1 $ vert left of FA#3
86   like 83 but trcl=32 imp:n=1 $ vert rght of FA#4
87   like 83 but trcl=33 imp:n=1 $ vert left of FA#1
88   like 83 but trcl=34 imp:n=1 $ vert rght of FA#1
89   like 83 but trcl=35 imp:n=1 $ vert left of FA#5
90   like 83 but trcl=36 imp:n=1 $ vert rght of FA#6
91   like 83 but trcl=37 imp:n=1 $ vert left of FA#7
c
c     Define the 6 outer FAs
c
c     Make a unit out of the FA, water gap, and guide channel
c
100   0  40 -43 44 -47 27 -33 fill=4 trcl=121  imp:n=1
101   like 100  but trcl=122     imp:n=1  $ FA #3
102   like 100  but trcl=123     imp:n=1  $ FA #4
103   like 100  but trcl=124     imp:n=1  $ FA #5
104   like 100  but trcl=125     imp:n=1  $ FA #6
105   like 100  but trcl=126     imp:n=1  $ FA #7
c
c     Define the 4 basket support rods
106   6 -8.03 -80 27 -33       imp:n=1  $ Upper left
107   6 -8.03 -81 27 -33       imp:n=1  $ Upper right
108   6 -8.03 -82 27 -33       imp:n=1  $ Lower left
109   6 -8.03 -83 27 -33       imp:n=1  $ Lower right
c
c    Define Cask Cells
c
200   6 -8.03  27 -203 100 -101 imp:n=1 $ 317 SS Inner Shell - Radial
201   6 -8.03  202 -27     -101 imp:n=1 $ 304 SS Inner Shell - Bottom
202   6 -8.03  203 -204    -101 imp:n=1 $ 304 SS Inner Shell - Top
203   11 -18.82 (-102 201 -202):(101 -102 202 -204):(-102 204 -205)
                imp:n=1 $ Lead (union of bottom/side/top)
204   6 -8.03 (-103 200 -201):(102 -103 201 -205):(-103 205 -206)
            imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs in basket and inside Cask.
c
1000  4 -1.00  -100 27 -203 51 #100 #101 #62 #63 #83 #85 #106 #107
                            imp:n=1 $ FAs 2&3 Surrounded by water
1001  4 -1.00  -100 27 -203 50 -51 #42 #102 #103
             #60 #64 #65 #66 #67 #68 #86 #87 #88 #89
                            imp:n=1 $ FAs 1,4,5 Surrounded by water
1002  4 -1.00  -100 27 -203 -50 #104 #105 #69 #70 #90 #91 #108 #109
                            imp:n=1 $ FAs Surrounded by water
c
c     12 inch water reflector
c
2000  4 -1.00 (206:-200:103) (-207 -104 199) imp:n=1
c
c     Outside Cask.
c
3000  0 -1000 (207:-199:104) imp:n=0

c
c     Fuel Cell
c
1     cz  .45339   $ Fuel Pellet OD
2     cz  .46228   $ Zr4 Clad ID
3     cz  .53848   $ Zr4 Clad OD
```

```
4     px -0.71501  $ fuel rod cell boundary
5     px  0.71501  $ fuel rod cell boundary
6     py -0.71501  $ fuel rod cell boundary
7     py  0.71501  $ fuel rod cell boundary
c
c     Instrument Tube/Control Rod Guide Tube
c
10    cz  0.64897  $ ID
11    cz  0.69088  $ OD
c
c     Fuel Assembly
c
12    px -10.7137  $ 1/2 FA pitch
13    px  10.7137  $ 1/2 FA pitch
14    py -10.7137  $ 1/2 FA pitch
15    py  10.7137  $ 1/2 FA pitch
c
c     Zr grid inner pitch
c
16    px -0.712475 $ Zr grid cell boundary
17    px  0.712475 $ Zr grid cell boundary
18    py -0.712475 $ Zr grid cell boundary
19    py  0.712475 $ Zr grid cell boundary
c
c     Overall Fuel Height including blanket - 144 inches
c
20    pz -182.88
21    pz  182.88
c
c     Axial Blanket/enriched fuel zone [redacted] inches below top & bottom
c
22    pz [redacted]
23    pz [redacted]
c
c     Top and bottom plenum regions
c
24    pz [redacted]
25    pz [redacted]
c
c     Channel bottom plate
c
26    pz -192.151
27    pz -194.691
c
c   Lower Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Bottom of LTP
30    pz -186.953
c
c    Upper Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Top of UTP
31    pz 206.538
c
33    pz 213.512  $ Top of FA
c
c     Square Cell for Channel
c
40    px  -11.3022
41    px  -11.1125
42    px   11.1125
43    px   11.3022
44    py  -11.3022
45    py  -11.1125
46    py   11.1125
47    py   11.3022
c
```

```
c     Rectangular Cell for Basket (ignore 9 - 1" thick axial spacers)
c
48    px  -13.6771
49    px   13.6771
50    py  -13.0548
51    py   13.0548
c
c     B4C poison pins -
60   cz 0.5842   $ ID of SS304 clad
61   cz 0.635    $ OD of SS304 clad
72   py  0.0     $
73   py  1.7526  $ 1/2 pitch for horiz poison pin row (1/2 of 1.38 in)
74   px  0.0     $
75   px  2.3749  $ 1/2 pitch for veric poison pin row (1/2 of 1.87 in)
c
c    Four Basket Support Rods - 2-1/4 inch 216 SS
c
80   c/z -29.21  26.43124  2.8575
81   c/z  29.21  26.43124  2.8575
82   c/z -29.21 -26.43124  2.8575
83   c/z  29.21 -26.43124  2.8575
c
c    Cask dimensions
c
c    Radial
100  cz    47.625   $ Inner Cavity -18.75"
101  cz    48.895   $ 317 SS inner - 0.5"
102  cz    59.055   $ Cast DU      - 4"
103  cz   63.0174   $ 317 SS outer -1.56"
104  cz   93.4974   $ 12 inch side reflector
c    Axial - Bottom to Top of Cask
199  pz  -240.411   $ 12 inch bottom reflector
200  pz  -209.931   $ 304 SST      - 2"
201  pz  -204.851   $ Cast DU      - 3"
202  pz  -197.231   $ 304 SST      - 1"
203  pz   263.144   $ Cavity  -180.25"
204  pz   266.319   $ 304 SST - 1.25"
205  pz   275.844   $ Cast DU - 3.75"
206  pz   279.654   $ 304 SST -  1.5"
207  pz   310.134   $ 12 inch top reflector
1000 so 1000

c     Translations for horizontal row of 6 poison pins
tr1   -9.525  0.8763   0   $ Left
tr2   -5.715  0.8763   0   $
tr3   -1.905  0.8763   0   $
tr4    1.905  0.8763   0   $
tr5    5.715  0.8763   0   $
tr6    9.525  0.8763   0   $ Right
c     Translations for vertical row of 6 poison pins
tr11   1.18745 -9.525  0    $ Bottom
tr12   1.18745 -5.715  0    $
tr13   1.18745 -1.905  0    $
tr14   1.18745  1.905  0    $
tr15   1.18745  5.715  0    $
tr16   1.18745  9.525  0    $ Top
c     Translate horizontal poison pin rows
tr20           0  11.3022 0 $ Horiz above FA#1
tr21    -13.6771  13.0548 0 $ Horiz below FA#2
tr22     13.6771  13.0548 0 $ Horiz below FA#3
tr23    -27.3542  11.3022 0 $ Horiz above FA#4
tr24     27.3542  11.3022 0 $ Horiz above FA#5
tr25    -27.3542 -13.0548 0 $ Horiz below FA#4
tr26           0 -13.0548 0 $ Horiz below FA#1
tr27     27.3542 -13.0548 0 $ Horiz below FA#5
tr28    -13.6771 -14.8074 0 $ Horiz above FA#6
tr29     13.6771 -14.8074 0 $ Horiz above FA#7
c     Translate vertical poison pin rows
tr30     -2.3749  26.1096 0 $ vert rght of FA#2
```

```
tr31            0  26.1096 0 $ vert left of FA#3
tr32    -16.0520        0 0 $ vert rght of FA#4
tr33    -13.6771        0 0 $ vert left of FA#1
tr34     11.3022        0 0 $ vert rght of FA#1
tr35     13.6771        0 0 $ vert left of FA#5
tr36     -2.3749 -26.1096 0 $ vert rght of FA#6
tr37            0 -26.1096 0 $ vert left of FA#7
c     FA translations
tr121   -13.6771 26.1096   0   $ FA #2
tr122    13.6771 26.1096   0   $ FA #3
tr123   -27.3542 0         0   $ FA #4
tr124    27.3542 0         0   $ FA #5
tr125   -13.6771 -26.1096  0   $ FA #6
tr126    13.6771 -26.1096  0   $ FA #7
mode n
kcode  3000 1 30 220 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.65 wt% U235
m1    92235.50c -0.040987
      92238.50c -0.840458
      8016.50c  -0.118554
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 4
m3    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c     m7 is Inconel 718
m7    5000.01c     -0.006
      6000.50c      -0.08
      13027.50c      -0.8
      14000.50c     -0.35
      22000.50c     -1.15
      24000.50c       -21
      25055.50c     -0.35
      26000.55c   -11.164
      27059.50c        -1
      28000.50c       -55
      29000.50c      -0.3
      41093.50c      -5.5
      42000.50c      -3.3
c     m8 is Inconel X750
m8    6000.50c   -0.08
      13027.50c     -1
      14000.50c   -0.5
      22000.50c  -2.75
      24000.50c    -15
      25055.50c     -1
      26000.55c     -7
      27059.50c     -1
      28000.50c    -70
```

```
      29000.50c   -0.5
      41093.50c   -1.2
c     m10 is B4C poison
m10   5010.50c  -0.109602  $ B10 lower end 18.3% - 0.3% - reduced 75%
      5011.50c  -0.665732  $ B11 upper end 81.7% + 0.3%
      6000.50c  -0.224666  $ C
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
c     m12 is Air
m12   7014.50c -0.765
      8016.50c -0.235
c     m13 is Channel - 304 SS and water mixture (VF water = 0.358)
m13   6000.50c  -0.000748
      14000.50c -0.009351
      15031.50c -0.000421
      16032.50c -0.000281
      24000.50c -0.187013
      25055.50c -0.018701
      26000.55c -0.620369
      28000.50c -0.098182
      1001.50c  -0.007266
      8016.50c  -0.057669
mt4   lwtr.01t
mt13  lwtr.01t
```

MCNP Case: pso6-10

```
PWR Cask - 6 FAs  - 4.65% - 1.00 g/cc - 12 in Refl - Shift out
1     1 -10.4 -1        22 -23        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.000     1 -2 22 -23         u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   22 -23        u=1 imp:n=1 $ Zr4 Clad
4     4 -1.00  3 16 -17 18 -19 22 -23 u=1 imp:n=1 $ Moderator
401   3 -6.565 (-16:17:-18:19) 22 -23 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.4 -1        23 -21        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.000     1 -2 23 -21         u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   23 -21        u=1 imp:n=1 $ Zr4 Clad
8     4 -1.00  3 16 -17 18 -19 23 -21 u=1 imp:n=1 $ Moderator
801   3 -6.565 (-16:17:-18:19) 23 -21 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.4 -1        20 -22        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.000     1 -2 20 -22         u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   20 -22        u=1 imp:n=1 $ Zr4 Clad
12    4 -1.00  3 16 -17 18 -19 20 -22 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 20 -22 u=1 imp:n=1 $ Zr4 - Spacer
c     Plenum region - below fuel pins
13    4 -1.000     -2   24 -20         u=1 imp:n=1 $ He
14    3 -6.565  2 -3   24 -20        u=1 imp:n=1 $ Zr4 Clad
15    4 -1.00  3        24 -20         u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.000     -2   21 -25         u=1 imp:n=1 $ He
17    3 -6.565  2 -3   21 -25        u=1 imp:n=1 $ Zr4 Clad
18    4 -1.00  3        21 -25         u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  30 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
191   4 -1.00  -30                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  25                    u=1 imp:n=1 $ 304L SS in LTP
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2  fill= -7:7  -7:7 0:0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ x=-7 to x=7:y=7
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=6
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "          ";y=5
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "          ";y=4
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "          ";y=3
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "          ";y=2
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=1
          1 1 1 3 1 1 1 3 1 1 1 3 1 1 1         $ "          ";y=0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ":y=-1
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "          ";y=-2
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "          ";y=-3
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "          ";y=-4
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "          ";y=-5
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=-6
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 imp:n=1 $ "          ";y=-7
c     Instrument/Control Rod Guide Tubes
26    4 -1.00 -10       24 -25        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -25         u=3 imp:n=1 $ Zr4 Clad
28    4 -1.00 11 16 -17 18 -19 24 -25 u=3 imp:n=1 $ Moderator
281   3 -6.565 (-16:17:-18:19) 24 -25 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate
c     Instrument/Control Rod Guide Tube Locations
29    4 -1.00 -10          -24 30     u=3 imp:n=1 $ water inside tube
30    3 -6.565 10 -11     -24 30     u=3 imp:n=1 $ Zr4 Clad
31    6 -8.03 11          -24 30     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
311   4 -1.00  -30                     u=3 imp:n=1 $ Water
c     Upper Tie Plate
c     Instrument/Control Rod Guide Tube Locations
33    4 -1.00 -10       25            u=3 imp:n=1 $ water inside tube
34    3 -6.565 10 -11 25             u=3 imp:n=1 $ Zr4 Clad
35    6 -8.03 11       25            u=3 imp:n=1 $ 304L SS in UTP
```

```
c     Fuel Assembly
c
36     0 12 -13 14 -15 26 -31 u=42 fill=2 trcl=132 imp:n=1 $ FA #2
363    0 12 -13 14 -15 26 -31 u=43 fill=2 trcl=133 imp:n=1 $ FA #3
364    0 12 -13 14 -15 26 -31 u=44 fill=2 trcl=134 imp:n=1 $ FA #4
365    0 12 -13 14 -15 26 -31 u=45 fill=2 trcl=135 imp:n=1 $ FA #5
366    0 12 -13 14 -15 26 -31 u=46 fill=2 trcl=136 imp:n=1 $ FA #6
367    0 12 -13 14 -15 26 -31 u=47 fill=2 trcl=137 imp:n=1 $ FA #7
c
c     Water Gap between fuel assembly and guide channel
c     and above UTP.
c
40    4 -1.0    (41 -42 45 -46 26)      u=4  imp:n=1   $ FA #1 - Center Hole
402   4 -1.0    (41 -42 45 -46 26) #36  u=42 imp:n=1   $ FA #2
403   4 -1.0    (41 -42 45 -46 26) #363 u=43 imp:n=1   $ FA #3
404   4 -1.0    (41 -42 45 -46 26) #364 u=44 imp:n=1   $ FA #4
405   4 -1.0    (41 -42 45 -46 26) #365 u=45 imp:n=1   $ FA #5
406   4 -1.0    (41 -42 45 -46 26) #366 u=46 imp:n=1   $ FA #6
407   4 -1.0    (41 -42 45 -46 26) #367 u=47 imp:n=1   $ FA #7
c
c     Guide Channel side & 1 in bottom plate (mixture of H2O & SS304)
41    13 -5.51326      #40  u=4  imp:n=1
412   13 -5.51326 #36  #402 u=42 imp:n=1
413   13 -5.51326 #363 #403 u=43 imp:n=1
414   13 -5.51326 #364 #404 u=44 imp:n=1
415   13 -5.51326 #365 #405 u=45 imp:n=1
416   13 -5.51326 #366 #406 u=46 imp:n=1
417   13 -5.51326 #367 #407 u=47 imp:n=1
c
c     Define a row of 6 Horizontal poison pins
c     First the 6 pins
45  10 -0.99    -60  trcl=1 u=5 imp:n=1 $ B4C dens (B-10 reduced 75%)
46   6 -8.03  60 -61 trcl=1 u=5 imp:n=1 $ poison pin SS clad
47   like 45 but trcl=2 u=5 imp:n=1 $ B4C lower toler dens
48   like 46 but trcl=2 u=5 imp:n=1 $ poison pin SS clad
49   like 45 but trcl=3 u=5 imp:n=1 $ B4C lower toler dens
50   like 46 but trcl=3 u=5 imp:n=1 $ poison pin SS clad
51   like 45 but trcl=4 u=5 imp:n=1 $ B4C lower toler dens
52   like 46 but trcl=4 u=5 imp:n=1 $ poison pin SS clad
53   like 45 but trcl=5 u=5 imp:n=1 $ B4C lower toler dens
54   like 46 but trcl=5 u=5 imp:n=1 $ poison pin SS clad
55   like 45 but trcl=6 u=5 imp:n=1 $ B4C lower toler dens
56   like 46 but trcl=6 u=5 imp:n=1 $ poison pin SS clad
c     Now the row
60   0  48 -49 72 -73 30 -31 trcl=20 fill=5  imp:n=1 $ Horiz Above FA#1
61    4 -1.0    #45 #46 #47 #48 #49 #50 #51 #52 #53 #54 #55 #56
                              u=5  imp:n=1  $ water around poison pins
c     Define the rest of the horizontal rows
62   like 60 but trcl=21 imp:n=1 $ Horiz below FA#2
63   like 60 but trcl=22 imp:n=1 $ Horiz below FA#3
64   like 60 but trcl=23 imp:n=1 $ Horiz above FA#4
65   like 60 but trcl=24 imp:n=1 $ Horiz above FA#5
66   like 60 but trcl=25 imp:n=1 $ Horiz below FA#4
67   like 60 but trcl=26 imp:n=1 $ Horiz below FA#1
68   like 60 but trcl=27 imp:n=1 $ Horiz below FA#5
69   like 60 but trcl=28 imp:n=1 $ Horiz above FA#6
70   like 60 but trcl=29 imp:n=1 $ Horiz above FA#7
c
c     Define a column of 6 vertical poison pins
c     First the 6 pins
71  10 -0.99   -60  trcl=11 u=6 imp:n=1 $ B4C dens (B-10 reduced 75%)
72   6 -8.03  60 -61  trcl=11 u=6 imp:n=1 $ poison pin SS clad
73   like 71 but      trcl=12 u=6 imp:n=1 $ B4C lower toler dens
74   like 72 but      trcl=12 u=6 imp:n=1 $ poison pin SS clad
75   like 71 but      trcl=13 u=6 imp:n=1 $ B4C lower toler dens
76   like 72 but      trcl=13 u=6 imp:n=1 $ poison pin SS clad
77   like 71 but      trcl=14 u=6 imp:n=1 $ B4C lower toler dens
78   like 72 but      trcl=14 u=6 imp:n=1 $ poison pin SS clad
79   like 71 but      trcl=15 u=6 imp:n=1 $ B4C lower toler dens
```

```
80    like 72 but      trcl=15 u=6 imp:n=1 $ poison pin SS clad
81    like 71 but      trcl=16 u=6 imp:n=1 $ B4C lower toler dens
82    like 72 but      trcl=16 u=6 imp:n=1 $ poison pin SS clad
c      Now the column
83    0  44 -47 74 -75 30 -31 trcl=30 fill=6  imp:n=1 $ vert right FA#2
84     4 -1.0    #71 #72 #73 #74 #75 #76 #77 #78 #79 #80 #81 #82
                              u=6  imp:n=1 $ water around poison pins
c      Define the rest of the vertical columns
85    like 83 but trcl=31 imp:n=1 $ vert left of FA#3
86    like 83 but trcl=32 imp:n=1 $ vert rght of FA#4
87    like 83 but trcl=33 imp:n=1 $ vert left of FA#1
88    like 83 but trcl=34 imp:n=1 $ vert rght of FA#1
89    like 83 but trcl=35 imp:n=1 $ vert left of FA#5
90    like 83 but trcl=36 imp:n=1 $ vert rght of FA#6
91    like 83 but trcl=37 imp:n=1 $ vert left of FA#7
c
c      Make a dummy water FA in the center
c
42      0  40 -43 44 -47 27 -33 fill=4 imp:n=1
c
c      Define the 6 Outer FAs
c      Make a unit out of the FA, water gap, and guide channel
c
100     0  40 -43 44 -47 27 -33 fill=42 trcl=121  imp:n=1 $ FA #2
101     0  40 -43 44 -47 27 -33 fill=43 trcl=122  imp:n=1 $ FA #3
102     0  40 -43 44 -47 27 -33 fill=44 trcl=123  imp:n=1 $ FA #4
103     0  40 -43 44 -47 27 -33 fill=45 trcl=124  imp:n=1 $ FA #5
104     0  40 -43 44 -47 27 -33 fill=46 trcl=125  imp:n=1 $ FA #6
105     0  40 -43 44 -47 27 -33 fill=47 trcl=126  imp:n=1 $ FA #7
c      Define the 4 basket support rods
106    6 -8.03 -80 27 -33       imp:n=1  $ Upper left
107    6 -8.03 -81 27 -33       imp:n=1  $ Upper right
108    6 -8.03 -82 27 -33       imp:n=1  $ Lower left
109    6 -8.03 -83 27 -33       imp:n=1  $ Lower right
c
c     Define Cask Cells
c
200    6 -8.03  27 -203 100 -101 imp:n=1 $ 317 SS Inner Shell - Radial
201    6 -8.03  202 -27     -101 imp:n=1 $ 304 SS Inner Shell - Bottom
202    6 -8.03  203 -204    -101 imp:n=1 $ 304 SS Inner Shell - Top
203    11 -18.82 (-102 201 -202):(101 -102 202 -204):(-102 204 -205)
                 imp:n=1 $ Lead (union of bottom/side/top)
204    6 -8.03 (-103 200 -201):(102 -103 201 -205):(-103 205 -206)
             imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c      Water outside FAs in basket and inside Cask.
c
1000   4 -1.00  -100 27 -203 51 #100 #101 #62 #63 #83 #85 #106 #107
                            imp:n=1 $ FAs 2&3 Surrounded by water
1001   4 -1.00  -100 27 -203 50 -51 #42 #102 #103
              #60 #64 #65 #66 #67 #68 #86 #87 #88 #89
                            imp:n=1 $ FAs 1,4,5 Surrounded by water
1002   4 -1.00  -100 27 -203 -50 #104 #105 #69 #70 #90 #91 #108 #109
                            imp:n=1 $ FAs Surrounded by water
c
c      12 inch water reflector
c
2000   4 -1.00 (206:-200:103) (-207 -104 199) imp:n=1
c
c      Outside Cask.
c
3000   0 -1000 (207:-199:104) imp:n=0

c
c      Fuel Cell
c
1      cz  .45339   $ Fuel Pellet OD
2      cz  .46228   $ Zr4 Clad ID
3      cz  .53848   $ Zr4 Clad OD
```

```
4     px -0.71501  $ fuel rod cell boundary
5     px  0.71501  $ fuel rod cell boundary
6     py -0.71501  $ fuel rod cell boundary
7     py  0.71501  $ fuel rod cell boundary
c
c     Instrument Tube/Control Rod Guide Tube
c
10    cz  0.64897  $ ID
11    cz  0.69088  $ OD
c
c     Fuel Assembly
c
12    px -10.7137  $ 1/2 FA pitch
13    px  10.7137  $ 1/2 FA pitch
14    py -10.7137  $ 1/2 FA pitch
15    py  10.7137  $ 1/2 FA pitch
c
c     Zr grid inner pitch
c
16    px -0.712475 $ Zr grid cell boundary
17    px  0.712475 $ Zr grid cell boundary
18    py -0.712475 $ Zr grid cell boundary
19    py  0.712475 $ Zr grid cell boundary
c
c     Overall Fuel Height including blanket - 144 inches
c
20    pz -182.88
21    pz  182.88
c
c     Axial Blanket/enriched fuel zone [redacted] inches below top & bottom
c
22    pz [redacted]
23    pz [redacted]
c
c     Top and bottom plenum regions
c
24    pz [redacted]
25    pz [redacted]
c
c     Channel bottom plate
c
26    pz -192.151
27    pz -194.691
c
c   Lower Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Bottom of LTP
30    pz -186.953
c
c    Upper Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Top of UTP
31    pz 206.538
c
33    pz 213.512  $ Top of FA
c
c     Square Cell for Channel
c
40    px  -11.3816
41    px  -11.1919
42    px   11.1919
43    px   11.3816
44    py  -11.3816
45    py  -11.1919
46    py   11.1919
47    py   11.3816
c
```

```
c     Rectangular Cell for Basket (ignore 9 - 1" thick axial spacers)
c
48    px  -13.6771
49    px   13.6771
50    py  -13.0548
51    py   13.0548
c
c     B4C poison pins -
60   cz 0.5842    $ ID of SS304 clad
61   cz 0.635     $ OD of SS304 clad
72   py 0.0397  $
73   py 1.7129  $ 1/2 pitch for horiz poison pin row (1/2 of 1.38 in)
74   px 0.0397  $
75   px 2.3352  $ 1/2 pitch for veric poison pin row (1/2 of 1.87 in)
c
c    Four Basket Support Rods - 2-1/4 inch 216 SS
c
80   c/z -29.21  26.43124  2.8575
81   c/z  29.21  26.43124  2.8575
82   c/z -29.21 -26.43124  2.8575
83   c/z  29.21 -26.43124  2.8575
c
c    Cask dimensions
c
c    Radial
100  cz    47.625   $ Inner Cavity -18.75"
101  cz    48.895   $ 317 SS inner - 0.5"
102  cz    59.055   $ Cast DU      - 4"
103  cz   63.0174   $ 317 SS outer -1.56"
104  cz   93.4974   $ 12 inch side reflector
c    Axial - Bottom to Top of Cask
199  pz  -240.0411  $ 12 inch bottom reflector
200  pz  -209.931   $ 304 SST      - 2"
201  pz  -204.851   $ Cast DU      - 3"
202  pz  -197.231   $ 304 SST      - 1"
203  pz   263.144   $ Cavity  -180.25"
204  pz   266.319   $ 304 SST - 1.25"
205  pz   275.844   $ Cast DU - 3.75"
206  pz   279.654   $ 304 SST -  1.5"
207  pz   310.134   $ 12 inch top reflector
1000 so 1000

c     Translations for horizontal row of 6 poison pins
tr1   -9.525  0.8763   0   $ Left
tr2   -5.715  0.8763   0   $
tr3   -1.905  0.8763   0   $
tr4    1.905  0.8763   0   $
tr5    5.715  0.8763   0   $
tr6    9.525  0.8763   0   $ Right
c     Translations for vertical row of 6 poison pins
tr11   1.18745 -9.525  0    $ Bottom
tr12   1.18745 -5.715  0    $
tr13   1.18745 -1.905  0    $
tr14   1.18745  1.905  0    $
tr15   1.18745  5.715  0    $
tr16   1.18745  9.525  0    $ Top
c     Translate horizontal poison pin rows
tr20     0.0000  11.3419     0 $ Horiz above FA#1
tr21   -13.6771  13.0151     0 $ Horiz below FA#2
tr22    13.6771  13.0151     0 $ Horiz below FA#3
tr23   -27.3542  11.3419     0 $ Horiz above FA#4
tr24    27.3542  11.3419     0 $ Horiz above FA#5
tr25   -27.3542 -13.0945     0 $ Horiz below FA#4
tr26     0.0000 -13.0945     0 $ Horiz below FA#1
tr27    27.3542 -13.0945     0 $ Horiz below FA#5
tr28   -13.6771 -14.7677     0 $ Horiz above FA#6
tr29    13.6771 -14.7677     0 $ Horiz above FA#7
c     Translate vertical poison pin rows
tr30    -2.3352  26.1096   0 $ vert rght of FA#2
```

```
tr31     -0.0397  26.1096   0 $ vert left of FA#3
tr32    -16.0123   0.0000   0 $ vert rght of FA#4
tr33    -13.7168   0.0000   0 $ vert left of FA#1
tr34     11.3419   0.0000   0 $ vert rght of FA#1
tr35     13.6374   0.0000   0 $ vert left of FA#5
tr36     -2.3352 -26.1096   0 $ vert rght of FA#6
tr37     -0.0397 -26.1096   0 $ vert left of FA#7
c      FA translations
tr121    -13.6771 26.1096   0   $ FA #2
tr122     13.6771 26.1096   0   $ FA #3
tr123    -27.3542 0         0   $ FA #4
tr124     27.3542 0         0   $ FA #5
tr125    -13.6771 -26.1096  0   $ FA #6
tr126     13.6771 -26.1096  0   $ FA #7
c      Shift FA within basket channel
tr132 -0.478  0.478 0   $ FA #2
tr133  0.478  0.478 0   $ FA #3
tr134 -0.478  0     0   $ FA #4
tr135  0.478  0     0   $ FA #5
tr136 -0.478 -0.478 0   $ FA #6
tr137  0.478 -0.478 0   $ FA #7
mode n
kcode  3000 1 30 220 50000
print -128
prdmp j -120 j 3
c      m1 is UO2 fuel - Enriched to 4.65 wt% U235
m1     92235.50c -0.040987
       92238.50c -0.840458
       8016.50c  -0.118554
c      m2 is He
m2     2004.50c -1.0
c      m3 is Zircaloy 4
m3     40000.60c  -98.18
       8016.50c    -0.12
       24000.50c   -0.10
       26000.55c   -0.20
       50000.35c   -1.40
c      m4 is water
m4     1001.50c 0.666700 8016.50c 0.333300
c      m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5     92235.50c -0.0062672
       92238.50c -0.875206
       8016.50c  -0.118528
c      m6 is 304L SS
m6     6000.50c     -0.03
       14000.50c       -1
       15031.50c   -0.045
       16032.50c    -0.03
       24000.50c      -20
       25055.50c       -2
       26000.55c  -64.895
       28000.50c      -12
c      m7 is Inconel 718
m7     5000.01c     -0.006
       6000.50c      -0.08
       13027.50c      -0.8
       14000.50c     -0.35
       22000.50c     -1.15
       24000.50c       -21
       25055.50c     -0.35
       26000.55c   -11.164
       27059.50c        -1
       28000.50c       -55
       29000.50c      -0.3
       41093.50c      -5.5
       42000.50c      -3.3
c      m8 is Inconel X750
m8     6000.50c   -0.08
       13027.50c     -1
```

```
        14000.50c   -0.5
        22000.50c  -2.75
        24000.50c    -15
        25055.50c     -1
        26000.55c     -7
        27059.50c     -1
        28000.50c    -70
        29000.50c   -0.5
        41093.50c   -1.2
c       m10 is B4C poison
m10     5010.50c  -0.109602  $ B10 lower end 18.3% - 0.3% - reduced 75%
        5011.50c  -0.665732  $ B11 upper end 81.7% + 0.3%
        6000.50c  -0.224666  $ C
c       m11 is Depleted Uranium
m11     92235.50c 0.000106128
        92238.50c 0.0475275
c       m12 is Air
m12     7014.50c -0.765
        8016.50c -0.235
c       m13 is Channel - 304 SS and water mixture (VF water = 0.358)
m13     6000.50c  -0.000748
        14000.50c -0.009351
        15031.50c -0.000421
        16032.50c -0.000281
        24000.50c -0.187013
        25055.50c -0.018701
        26000.55c -0.620369
        28000.50c -0.098182
        1001.50c  -0.007266
        8016.50c  -0.057669
mt4     lwtr.01t
mt13    lwtr.01t
```

```
MCNP Case: ifp6-70

PWR Cask - 6 FAs (Center H20 Hole) - 4.65% - 0.700 g/cc - 12 in Refl
1     1 -10.4 -1       22 -23        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -0.7000     1 -2 22 -23        u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   22 -23        u=1 imp:n=1 $ Zr4 Clad
4     4 -0.700  3 16 -17 18 -19 22 -23 u=1 imp:n=1 $ Moderator
401   3 -6.565 (-16:17:-18:19) 22 -23 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.4 -1       23 -21        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -0.7000     1 -2 23 -21        u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   23 -21        u=1 imp:n=1 $ Zr4 Clad
8     4 -0.700  3 16 -17 18 -19 23 -21 u=1 imp:n=1 $ Moderator
801   3 -6.565 (-16:17:-18:19) 23 -21 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.4 -1       20 -22        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -0.7000     1 -2 20 -22        u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   20 -22        u=1 imp:n=1 $ Zr4 Clad
12    4 -0.700  3 16 -17 18 -19 20 -22 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 20 -22 u=1 imp:n=1 $ Zr4 - Spacer
c     Plenum region - below fuel pins
13    4 -0.7000     -2   24 -20        u=1 imp:n=1 $ He
14    3 -6.565  2 -3   24 -20        u=1 imp:n=1 $ Zr4 Clad
15    4 -0.700  3        24 -20        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -0.7000     -2   21 -25        u=1 imp:n=1 $ He
17    3 -6.565  2 -3   21 -25        u=1 imp:n=1 $ Zr4 Clad
18    4 -0.700  3        21 -25        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  30 -24                 u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
191   4 -0.700  -30                     u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  25                     u=1 imp:n=1 $ 304L SS in LTP
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2  fill= -7:7  -7:7 0:0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ x=-7 to x=7:y=7
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "         ";y=6
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "         ";y=5
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "         ";y=4
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "         ";y=3
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "         ";y=2
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "         ";y=1
          1 1 1 3 1 1 1 3 1 1 1 3 1 1 1         $ "         ";y=0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "         ":y=-1
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "         ";y=-2
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "         ";y=-3
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "         ";y=-4
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "         ";y=-5
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "         ";y=-6
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 imp:n=1 $ "         ";y=-7
c     Instrument/Control Rod Guide Tubes
26    4 -0.700 -10      24 -25        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -25        u=3 imp:n=1 $ Zr4 Clad
28    4 -0.700 11 16 -17 18 -19 24 -25 u=3 imp:n=1 $ Moderator
281   3 -6.565 (-16:17:-18:19) 24 -25 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate
c     Instrument/Control Rod Guide Tube Locations
29    4 -0.700 -10         -24 30     u=3 imp:n=1 $ water inside tube
30    3 -6.565 10 -11    -24 30     u=3 imp:n=1 $ Zr4 Clad
31    6 -8.03 11         -24 30     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
311   4 -0.700  -30                     u=3 imp:n=1 $ Water
c     Upper Tie Plate
c     Instrument/Control Rod Guide Tube Locations
33    4 -0.700 -10      25            u=3 imp:n=1 $ water inside tube
34    3 -6.565 10 -11 25            u=3 imp:n=1 $ Zr4 Clad
```

```
35    6 -8.03 11      25            u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
36    0 12 -13 14 -15 26 -31 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and guide channel
c     and above UTP.
c
40    4 -0.70    (41 -42 45 -46 26) #36 u=4  imp:n=1
400   4 -0.70    (41 -42 45 -46 26)     u=40 imp:n=1
c
c     Guide Channel side & 1 in bottom plate (mixture of H2O & SS304)
41    13 -5.40586 #36 #40 u=4  imp:n=1
410   13 -5.40586    #400 u=40 imp:n=1  $ FA #1 - Empty Channel
c
c     Make a dummy water FA in the center
c
42     0  40 -43 44 -47 27 -33 fill=40   imp:n=1
c
c     Define a row of 6 Horizontal poison pins
c     First the 6 pins
45   10 -0.99    -60  trcl=1 u=5 imp:n=1 $ B4C dens (B-10 reduced 75%)
46   6 -8.03  60 -61 trcl=1 u=5 imp:n=1 $ poison pin SS clad
47   like 45 but trcl=2 u=5 imp:n=1 $ B4C lower toler dens
48   like 46 but trcl=2 u=5 imp:n=1 $ poison pin SS clad
49   like 45 but trcl=3 u=5 imp:n=1 $ B4C lower toler dens
50   like 46 but trcl=3 u=5 imp:n=1 $ poison pin SS clad
51   like 45 but trcl=4 u=5 imp:n=1 $ B4C lower toler dens
52   like 46 but trcl=4 u=5 imp:n=1 $ poison pin SS clad
53   like 45 but trcl=5 u=5 imp:n=1 $ B4C lower toler dens
54   like 46 but trcl=5 u=5 imp:n=1 $ poison pin SS clad
55   like 45 but trcl=6 u=5 imp:n=1 $ B4C lower toler dens
56   like 46 but trcl=6 u=5 imp:n=1 $ poison pin SS clad
c     Now the row
60   0  48 -49 72 -73 30 -31 trcl=20 fill=5  imp:n=1 $ Horiz Above FA#1
61    4 -0.700 #45 #46 #47 #48 #49 #50 #51 #52 #53 #54 #55 #56
                              u=5  imp:n=1  $ water around poison pins
c     Define the rest of the horizontal rows
62   like 60 but trcl=21 imp:n=1 $ Horiz below FA#2
63   like 60 but trcl=22 imp:n=1 $ Horiz below FA#3
64   like 60 but trcl=23 imp:n=1 $ Horiz above FA#4
65   like 60 but trcl=24 imp:n=1 $ Horiz above FA#5
66   like 60 but trcl=25 imp:n=1 $ Horiz below FA#4
67   like 60 but trcl=26 imp:n=1 $ Horiz below FA#1
68   like 60 but trcl=27 imp:n=1 $ Horiz below FA#5
69   like 60 but trcl=28 imp:n=1 $ Horiz above FA#6
70   like 60 but trcl=29 imp:n=1 $ Horiz above FA#7
c
c     Define a column of 6 vertical poison pins
c     First the 6 pins
71   10 -0.99   -60  trcl=11 u=6 imp:n=1 $ B4C dens (B-10 reduced 75%)
72   6 -8.03  60 -61  trcl=11 u=6 imp:n=1 $ poison pin SS clad
73   like 71 but      trcl=12 u=6 imp:n=1 $ B4C lower toler dens
74   like 72 but      trcl=12 u=6 imp:n=1 $ poison pin SS clad
75   like 71 but      trcl=13 u=6 imp:n=1 $ B4C lower toler dens
76   like 72 but      trcl=13 u=6 imp:n=1 $ poison pin SS clad
77   like 71 but      trcl=14 u=6 imp:n=1 $ B4C lower toler dens
78   like 72 but      trcl=14 u=6 imp:n=1 $ poison pin SS clad
79   like 71 but      trcl=15 u=6 imp:n=1 $ B4C lower toler dens
80   like 72 but      trcl=15 u=6 imp:n=1 $ poison pin SS clad
81   like 71 but      trcl=16 u=6 imp:n=1 $ B4C lower toler dens
82   like 72 but      trcl=16 u=6 imp:n=1 $ poison pin SS clad
c     Now the column
83   0  44 -47 74 -75 30 -31 trcl=30 fill=6  imp:n=1 $ vert right FA#2
84    4 -0.700 #71 #72 #73 #74 #75 #76 #77 #78 #79 #80 #81 #82
                              u=6  imp:n=1 $ water around poison pins
c     Define the rest of the vertical columns
85   like 83 but trcl=31 imp:n=1 $ vert left of FA#3
86   like 83 but trcl=32 imp:n=1 $ vert rght of FA#4
87   like 83 but trcl=33 imp:n=1 $ vert left of FA#1
```

```
88   like 83 but trcl=34 imp:n=1 $ vert rght of FA#1
89   like 83 but trcl=35 imp:n=1 $ vert left of FA#5
90   like 83 but trcl=36 imp:n=1 $ vert rght of FA#6
91   like 83 but trcl=37 imp:n=1 $ vert left of FA#7
c
c     Define the 6 outer FAs
c
c     Make a unit out of the FA, water gap, and guide channel
c
100   0  40 -43 44 -47 27 -33 fill=4 trcl=121  imp:n=1
101   like 100  but trcl=122     imp:n=1  $ FA #3
102   like 100  but trcl=123     imp:n=1  $ FA #4
103   like 100  but trcl=124     imp:n=1  $ FA #5
104   like 100  but trcl=125     imp:n=1  $ FA #6
105   like 100  but trcl=126     imp:n=1  $ FA #7
c
c     Define the 4 basket support rods
106   6 -8.03 -80 27 -33       imp:n=1  $ Upper left
107   6 -8.03 -81 27 -33       imp:n=1  $ Upper right
108   6 -8.03 -82 27 -33       imp:n=1  $ Lower left
109   6 -8.03 -83 27 -33       imp:n=1  $ Lower right
c
c    Define Cask Cells
c
200   6 -8.03  27 -203 100 -101 imp:n=1 $ 317 SS Inner Shell - Radial
201   6 -8.03  202 -27     -101 imp:n=1 $ 304 SS Inner Shell - Bottom
202   6 -8.03  203 -204    -101 imp:n=1 $ 304 SS Inner Shell - Top
203   11 -18.82 (-102 201 -202):(101 -102 202 -204):(-102 204 -205)
                 imp:n=1 $ Lead (union of bottom/side/top)
204   6 -8.03 (-103 200 -201):(102 -103 201 -205):(-103 205 -206)
            imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs in basket and inside Cask.
c
1000  4 -0.700  -100 27 -203 51 #100 #101 #62 #63 #83 #85 #106 #107
                          imp:n=1 $ FAs 2&3 Surrounded by water
1001  4 -0.700  -100 27 -203 50 -51 #42 #102 #103
             #60 #64 #65 #66 #67 #68 #86 #87 #88 #89
                          imp:n=1 $ FAs 1,4,5 Surrounded by water
1002  4 -0.700  -100 27 -203 -50 #104 #105 #69 #70 #90 #91 #108 #109
                          imp:n=1 $ FAs Surrounded by water
c
c     12 inch water reflector
c
2000  4 -1.00 (206:-200:103) (-207 -104 199) imp:n=1
c
c     Outside Cask.
c
3000  0 -1000 (207:-199:104) imp:n=0

c
c     Fuel Cell
c
1     cz  .45339   $ Fuel Pellet OD
2     cz  .46228   $ Zr4 Clad ID
3     cz  .53848   $ Zr4 Clad OD
4     px -0.71501  $ fuel rod cell boundary
5     px  0.71501  $ fuel rod cell boundary
6     py -0.71501  $ fuel rod cell boundary
7     py  0.71501  $ fuel rod cell boundary
c
c     Instrument Tube/Control Rod Guide Tube
c
10    cz  0.64897  $ ID
11    cz  0.69088  $ OD
c
c     Fuel Assembly
c
12    px -10.7137  $ 1/2 FA pitch
```

```
13    px  10.7137  $ 1/2 FA pitch
14    py -10.7137  $ 1/2 FA pitch
15    py  10.7137  $ 1/2 FA pitch
c
c     Zr grid inner pitch
c
16    px -0.712475 $ Zr grid cell boundary
17    px  0.712475 $ Zr grid cell boundary
18    py -0.712475 $ Zr grid cell boundary
19    py  0.712475 $ Zr grid cell boundary
c
c     Overall Fuel Height including blanket - 144 inches
c
20    pz -182.88
21    pz  182.88
c
c     Axial Blanket/enriched fuel zone [redacted] inches below top & bottom
c
22    pz [redacted]
23    pz [redacted]
c
c     Top and bottom plenum regions
c
24    pz [redacted]
25    pz [redacted]
c
c     Channel bottom plate
c
26    pz -192.151
27    pz -194.691
c
c   Lower Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Bottom of LTP
30    pz -186.953
c
c    Upper Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Top of UTP
31    pz 206.538
c
33    pz 213.512  $ Top of FA
c
c     Square Cell for Channel
c
40    px  -11.3022
41    px  -11.1125
42    px   11.1125
43    px   11.3022
44    py  -11.3022
45    py  -11.1125
46    py   11.1125
47    py   11.3022
c
c     Rectangular Cell for Basket (ignore 9 - 1" thick axial spacers)
c
48    px  -13.6771
49    px   13.6771
50    py  -13.0548
51    py   13.0548
c
c     B4C poison pins -
60   cz 0.5842   $ ID of SS304 clad
61   cz 0.635    $ OD of SS304 clad
72   py  0.0     $
73   py  1.7526  $ 1/2 pitch for horiz poison pin row (1/2 of 1.38 in)
74   px  0.0     $
```

```
75   px  2.3749  $ 1/2 pitch for veric poison pin row (1/2 of 1.87 in)
c
c    Four Basket Support Rods - 2-1/4 inch 216 SS
c
80   c/z -29.21  26.43124  2.8575
81   c/z  29.21  26.43124  2.8575
82   c/z -29.21 -26.43124  2.8575
83   c/z  29.21 -26.43124  2.8575
c
c    Cask dimensions
c
c    Radial
100  cz    47.625   $ Inner Cavity -18.75"
101  cz    48.895   $ 317 SS inner - 0.5"
102  cz    59.055   $ Cast DU      - 4"
103  cz   63.0174   $ 317 SS outer -1.56"
104  cz   93.4974   $ 12 inch side reflector
c    Axial - Bottom to Top of Cask
199  pz  -240.411   $ 12 inch bottom reflector
200  pz  -209.931   $ 304 SST      - 2"
201  pz  -204.851   $ Cast DU      - 3"
202  pz  -197.231   $ 304 SST      - 1"
203  pz   263.144   $ Cavity  -180.25"
204  pz   266.319   $ 304 SST - 1.25"
205  pz   275.844   $ Cast DU - 3.75"
206  pz   279.654   $ 304 SST -  1.5"
207  pz   310.134   $ 12 inch top reflector
1000 so 1000

c     Translations for horizontal row of 6 poison pins
tr1   -9.525  0.8763   0   $ Left
tr2   -5.715  0.8763   0   $
tr3   -1.905  0.8763   0   $
tr4    1.905  0.8763   0   $
tr5    5.715  0.8763   0   $
tr6    9.525  0.8763   0   $ Right
c     Translations for vertical row of 6 poison pins
tr11   1.18745 -9.525  0    $ Bottom
tr12   1.18745 -5.715  0    $
tr13   1.18745 -1.905  0    $
tr14   1.18745  1.905  0    $
tr15   1.18745  5.715  0    $
tr16   1.18745  9.525  0    $ Top
c     Translate horizontal poison pin rows
tr20           0  11.3022 0 $ Horiz above FA#1
tr21    -13.6771  13.0548 0 $ Horiz below FA#2
tr22     13.6771  13.0548 0 $ Horiz below FA#3
tr23    -27.3542  11.3022 0 $ Horiz above FA#4
tr24     27.3542  11.3022 0 $ Horiz above FA#5
tr25    -27.3542 -13.0548 0 $ Horiz below FA#4
tr26           0 -13.0548 0 $ Horiz below FA#1
tr27     27.3542 -13.0548 0 $ Horiz below FA#5
tr28    -13.6771 -14.8074 0 $ Horiz above FA#6
tr29     13.6771 -14.8074 0 $ Horiz above FA#7
c     Translate vertical poison pin rows
tr30    -2.3749  26.1096 0 $ vert rght of FA#2
tr31           0  26.1096 0 $ vert left of FA#3
tr32    -16.0520        0 0 $ vert rght of FA#4
tr33    -13.6771        0 0 $ vert left of FA#1
tr34     11.3022        0 0 $ vert rght of FA#1
tr35     13.6771        0 0 $ vert left of FA#5
tr36     -2.3749 -26.1096 0 $ vert rght of FA#6
tr37           0 -26.1096 0 $ vert left of FA#7
c     FA translations
tr121   -13.6771 26.1096   0   $ FA #2
tr122    13.6771 26.1096   0   $ FA #3
tr123   -27.3542 0         0   $ FA #4
tr124    27.3542 0         0   $ FA #5
tr125   -13.6771 -26.1096  0   $ FA #6
```

```
tr126    13.6771 -26.1096  0   $ FA #7
mode n
kcode  3000 1 30  80 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.65 wt% U235
m1    92235.50c -0.040987
      92238.50c -0.840458
      8016.50c  -0.118554
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 4
m3    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c     m7 is Inconel 718
m7    5000.01c     -0.006
      6000.50c      -0.08
      13027.50c      -0.8
      14000.50c     -0.35
      22000.50c     -1.15
      24000.50c       -21
      25055.50c     -0.35
      26000.55c   -11.164
      27059.50c        -1
      28000.50c       -55
      29000.50c      -0.3
      41093.50c      -5.5
      42000.50c      -3.3
c     m8 is Inconel X750
m8    6000.50c   -0.08
      13027.50c     -1
      14000.50c   -0.5
      22000.50c  -2.75
      24000.50c    -15
      25055.50c     -1
      26000.55c     -7
      27059.50c     -1
      28000.50c    -70
      29000.50c   -0.5
      41093.50c   -1.2
c     m10 is B4C poison
m10   5010.50c  -0.109602  $ B10 lower end 18.3% - 0.3% - reduced 75%
      5011.50c  -0.665732  $ B11 upper end 81.7% + 0.3%
      6000.50c  -0.224666  $ C
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
c     m12 is Air
m12   7014.50c -0.765
      8016.50c -0.235
c     m13 is Channel - 304 SS and water mixture (VF water = 0.358)
```

```
m13    6000.50c  -0.000763
       14000.50c -0.009536
       15031.50c -0.000429
       16032.50c -0.000286
       24000.50c -0.190729
       25055.50c -0.019073
       26000.55c -0.632694
       28000.50c -0.100133
       1001.50c  -0.005187
       8016.50c  -0.041170
mt4    lwtr.01t
mt13   lwtr.01t
```

```
MCNP Case: pso6i11a

PWR 6 FAs 4.65%, CTMT/INT- 1.0/1.0 -Inf Hex- 2 cm - Shifted Out - Inf T/B Refl
1     1 -10.4 -1       22 -23        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.0         1 -2 22 -23        u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   22 -23        u=1 imp:n=1 $ Zr4 Clad
4     4 -1.0     3 16 -17 18 -19 22 -23 u=1 imp:n=1 $ Moderator
401   3 -6.565 (-16:17:-18:19) 22 -23 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.4 -1       23 -21        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.0         1 -2 23 -21        u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   23 -21        u=1 imp:n=1 $ Zr4 Clad
8     4 -1.0     3 16 -17 18 -19 23 -21 u=1 imp:n=1 $ Moderator
801   3 -6.565 (-16:17:-18:19) 23 -21 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.4 -1       20 -22        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.0         1 -2 20 -22        u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   20 -22        u=1 imp:n=1 $ Zr4 Clad
12    4 -1.0     3 16 -17 18 -19 20 -22 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 20 -22 u=1 imp:n=1 $ Zr4 - Spacer
c     Plenum region - below fuel pins
13    4 -1.0         -2   24 -20        u=1 imp:n=1 $ He
14    3 -6.565  2 -3   24 -20        u=1 imp:n=1 $ Zr4 Clad
15    4 -1.0     3        24 -20        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.0         -2   21 -25        u=1 imp:n=1 $ He
17    3 -6.565  2 -3   21 -25        u=1 imp:n=1 $ Zr4 Clad
18    4 -1.0     3        21 -25        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  30 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
191   4 -1.0     -30                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  25                    u=1 imp:n=1 $ 304L SS in LTP
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2  fill= -7:7  -7:7 0:0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ x=-7 to x=7:y=7
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=6
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "          ";y=5
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "          ";y=4
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "          ";y=3
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "          ";y=2
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=1
          1 1 1 3 1 1 1 3 1 1 1 3 1 1 1         $ "          ";y=0
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ":y=-1
          1 1 3 1 1 1 1 1 1 1 1 1 3 1 1         $ "          ";y=-2
          1 1 1 1 3 1 1 1 1 1 3 1 1 1 1         $ "          ";y=-3
          1 1 1 1 1 1 1 3 1 1 1 1 1 1 1         $ "          ";y=-4
          1 1 3 1 1 3 1 1 1 3 1 1 3 1 1         $ "          ";y=-5
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1         $ "          ";y=-6
          1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 imp:n=1 $ "          ";y=-7
c     Instrument/Control Rod Guide Tubes
26    4 -1.0    -10      24 -25        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -25        u=3 imp:n=1 $ Zr4 Clad
28    4 -1.0    11 16 -17 18 -19 24 -25 u=3 imp:n=1 $ Moderator
281   3 -6.565 (-16:17:-18:19) 24 -25 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate
c     Instrument/Control Rod Guide Tube Locations
29    4 -1.0    -10         -24 30     u=3 imp:n=1 $ water inside tube
30    3 -6.565 10 -11    -24 30     u=3 imp:n=1 $ Zr4 Clad
31    6 -8.03 11         -24 30     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above channel bottom -below fuel pins
311   4 -1.0     -30                    u=3 imp:n=1 $ Water
c     Upper Tie Plate
c     Instrument/Control Rod Guide Tube Locations
33    4 -1.0    -10      25            u=3 imp:n=1 $ water inside tube
34    3 -6.565 10 -11 25            u=3 imp:n=1 $ Zr4 Clad
35    6 -8.03 11      25            u=3 imp:n=1 $ 304L SS in UTP
```

```
c     Fuel Assembly
c  36     0 12 -13 14 -15 26 -31 u=42  trcl=132 imp:n=1 $ FA #2
c  363    0 12 -13 14 -15 26 -31 u=43  trcl=133 imp:n=1 $ FA #3
c  364    0 12 -13 14 -15 26 -31 u=44  trcl=134 imp:n=1 $ FA #4
c  365    0 12 -13 14 -15 26 -31 u=45  trcl=135 imp:n=1 $ FA #5
c  366    0 12 -13 14 -15 26 -31 u=46  trcl=136 imp:n=1 $ FA #6
c  367    0 12 -13 14 -15 26 -31 u=47  trcl=137 imp:n=1 $ FA #7
36     0 12 -13 14 -15 26 -31 u=42 fill=2 trcl=132 imp:n=1 $ FA #2
363    0 12 -13 14 -15 26 -31 u=43 fill=2 trcl=133 imp:n=1 $ FA #3
364    0 12 -13 14 -15 26 -31 u=44 fill=2 trcl=134 imp:n=1 $ FA #4
365    0 12 -13 14 -15 26 -31 u=45 fill=2 trcl=135 imp:n=1 $ FA #5
366    0 12 -13 14 -15 26 -31 u=46 fill=2 trcl=136 imp:n=1 $ FA #6
367    0 12 -13 14 -15 26 -31 u=47 fill=2 trcl=137 imp:n=1 $ FA #7
c
c     Water Gap between fuel assembly and guide channel
c     and above UTP.
c
40    4 -1.0     (41 -42 45 -46 26)       u=4  imp:n=1   $ FA #1 - Center Hole
402   4 -1.0     (41 -42 45 -46 26) #36   u=42 imp:n=1   $ FA #2
403   4 -1.0     (41 -42 45 -46 26) #363 u=43 imp:n=1   $ FA #3
404   4 -1.0     (41 -42 45 -46 26) #364 u=44 imp:n=1   $ FA #4
405   4 -1.0     (41 -42 45 -46 26) #365 u=45 imp:n=1   $ FA #5
406   4 -1.0     (41 -42 45 -46 26) #366 u=46 imp:n=1   $ FA #6
407   4 -1.0     (41 -42 45 -46 26) #367 u=47 imp:n=1   $ FA #7
c
c     Guide Channel side & 1 in bottom plate (mixture of H2O & SS304)
41    13 -5.51326       #40  u=4  imp:n=1
412   13 -5.51326 #36   #402 u=42 imp:n=1
413   13 -5.51326 #363  #403 u=43 imp:n=1
414   13 -5.51326 #364  #404 u=44 imp:n=1
415   13 -5.51326 #365  #405 u=45 imp:n=1
416   13 -5.51326 #366  #406 u=46 imp:n=1
417   13 -5.51326 #367  #407 u=47 imp:n=1
c
c     Define a row of 6 Horizontal poison pins
c     First the 6 pins
45  10 -0.99    -60  trcl=1 u=5 imp:n=1 $ B4C dens (B-10 reduced 75%)
46   6 -8.03  60 -61 trcl=1 u=5 imp:n=1 $ poison pin SS clad
47   like 45 but trcl=2 u=5 imp:n=1 $ B4C lower toler dens
48   like 46 but trcl=2 u=5 imp:n=1 $ poison pin SS clad
49   like 45 but trcl=3 u=5 imp:n=1 $ B4C lower toler dens
50   like 46 but trcl=3 u=5 imp:n=1 $ poison pin SS clad
51   like 45 but trcl=4 u=5 imp:n=1 $ B4C lower toler dens
52   like 46 but trcl=4 u=5 imp:n=1 $ poison pin SS clad
53   like 45 but trcl=5 u=5 imp:n=1 $ B4C lower toler dens
54   like 46 but trcl=5 u=5 imp:n=1 $ poison pin SS clad
55   like 45 but trcl=6 u=5 imp:n=1 $ B4C lower toler dens
56   like 46 but trcl=6 u=5 imp:n=1 $ poison pin SS clad
c     Now the row
60   0  48 -49 72 -73 30 -31 trcl=20 fill=5  imp:n=1 $ Horiz Above FA#1
61    4 -1.0    #45 #46 #47 #48 #49 #50 #51 #52 #53 #54 #55 #56
                              u=5  imp:n=1  $ water around poison pins
c     Define the rest of the horizontal rows
62   like 60 but trcl=21 imp:n=1 $ Horiz below FA#2
63   like 60 but trcl=22 imp:n=1 $ Horiz below FA#3
64   like 60 but trcl=23 imp:n=1 $ Horiz above FA#4
65   like 60 but trcl=24 imp:n=1 $ Horiz above FA#5
66   like 60 but trcl=25 imp:n=1 $ Horiz below FA#4
67   like 60 but trcl=26 imp:n=1 $ Horiz below FA#1
68   like 60 but trcl=27 imp:n=1 $ Horiz below FA#5
69   like 60 but trcl=28 imp:n=1 $ Horiz above FA#6
70   like 60 but trcl=29 imp:n=1 $ Horiz above FA#7
c
c     Define a column of 6 vertical poison pins
c     First the 6 pins
71  10 -0.99   -60  trcl=11 u=6 imp:n=1 $ B4C dens (B-10 reduced 75%)
72   6 -8.03  60 -61  trcl=11 u=6 imp:n=1 $ poison pin SS clad
73   like 71 but      trcl=12 u=6 imp:n=1 $ B4C lower toler dens
74   like 72 but      trcl=12 u=6 imp:n=1 $ poison pin SS clad
```

```
75   like 71 but      trcl=13 u=6 imp:n=1 $ B4C lower toler dens
76   like 72 but      trcl=13 u=6 imp:n=1 $ poison pin SS clad
77   like 71 but      trcl=14 u=6 imp:n=1 $ B4C lower toler dens
78   like 72 but      trcl=14 u=6 imp:n=1 $ poison pin SS clad
79   like 71 but      trcl=15 u=6 imp:n=1 $ B4C lower toler dens
80   like 72 but      trcl=15 u=6 imp:n=1 $ poison pin SS clad
81   like 71 but      trcl=16 u=6 imp:n=1 $ B4C lower toler dens
82   like 72 but      trcl=16 u=6 imp:n=1 $ poison pin SS clad
c     Now the column
83   0  44 -47 74 -75 30 -31 trcl=30 fill=6  imp:n=1 $ vert right FA#2
84    4 -1.0    #71 #72 #73 #74 #75 #76 #77 #78 #79 #80 #81 #82
                              u=6  imp:n=1 $ water around poison pins
c     Define the rest of the vertical columns
85   like 83 but trcl=31 imp:n=1 $ vert left of FA#3
86   like 83 but trcl=32 imp:n=1 $ vert rght of FA#4
87   like 83 but trcl=33 imp:n=1 $ vert left of FA#1
88   like 83 but trcl=34 imp:n=1 $ vert rght of FA#1
89   like 83 but trcl=35 imp:n=1 $ vert left of FA#5
90   like 83 but trcl=36 imp:n=1 $ vert rght of FA#6
91   like 83 but trcl=37 imp:n=1 $ vert left of FA#7
c
c     Make a dummy water FA in the center
c
42     0  40 -43 44 -47 27 -33 fill=4 imp:n=1
c
c     Define the 6 Outer FAs
c     Make a unit out of the FA, water gap, and guide channel
c
100    0  40 -43 44 -47 27 -33 fill=42 trcl=121  imp:n=1 $ FA #2
101    0  40 -43 44 -47 27 -33 fill=43 trcl=122  imp:n=1 $ FA #3
102    0  40 -43 44 -47 27 -33 fill=44 trcl=123  imp:n=1 $ FA #4
103    0  40 -43 44 -47 27 -33 fill=45 trcl=124  imp:n=1 $ FA #5
104    0  40 -43 44 -47 27 -33 fill=46 trcl=125  imp:n=1 $ FA #6
105    0  40 -43 44 -47 27 -33 fill=47 trcl=126  imp:n=1 $ FA #7
c
c     Define the 4 basket support rods
106   6 -8.03 -80 27 -33       imp:n=1  $ Upper left
107   6 -8.03 -81 27 -33       imp:n=1  $ Upper right
108   6 -8.03 -82 27 -33       imp:n=1  $ Lower left
109   6 -8.03 -83 27 -33       imp:n=1  $ Lower right
c
c    Define Cask Cells
c
200   6 -8.03  27 -203 100 -101 imp:n=1 $ 317 SS Inner Shell - Radial
201   6 -8.03  202 -27     -101 imp:n=1 $ 304 SS Inner Shell - Bottom
202   6 -8.03  203 -204    -101 imp:n=1 $ 304 SS Inner Shell - Top
203   11 -18.82 (-102 201 -202):(101 -102 202 -204):(-102 204 -205)
                 imp:n=1 $ Lead (union of bottom/side/top)
204   6 -8.03 (-103 200 -201):(102 -103 201 -205):(-103 205 -206)
             imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs in basket and inside Cask.
c
1000  4 -1.0     -100 27 -203 51 #100 #101 #62 #63 #83 #85 #106 #107
                           imp:n=1 $ FAs 2&3 Surrounded by water
1001  4 -1.0     -100 27 -203 50 -51 #42 #102 #103
              #60 #64 #65 #66 #67 #68 #86 #87 #88 #89
                           imp:n=1 $ FAs 1,4,5 Surrounded by water
1002  4 -1.0     -100 27 -203 -50 #104 #105 #69 #70 #90 #91 #108 #109
                           imp:n=1 $ FAs Surrounded by water
c
c     1 cm water reflector
c     Water around cask
c
2000  4 -1.0       (-52 53 -54 55 -56 57 58 -59) (206:-200:103) imp:n=1
c
2001  0      (52:-53:54:-55:56:-57:-58:59)  imp:n=0

c
```

```
c     Fuel Cell
c
1     cz  .45339   $ Fuel Pellet OD
2     cz  .46228   $ Zr4 Clad ID
3     cz  .53848   $ Zr4 Clad OD
4     px -0.71501  $ fuel rod cell boundary
5     px  0.71501  $ fuel rod cell boundary
6     py -0.71501  $ fuel rod cell boundary
7     py  0.71501  $ fuel rod cell boundary
c
c     Instrument Tube/Control Rod Guide Tube
c
10    cz  0.64897  $ ID
11    cz  0.69088  $ OD
c
c     Fuel Assembly
c
12    px -10.7137  $ 1/2 FA pitch
13    px  10.7137  $ 1/2 FA pitch
14    py -10.7137  $ 1/2 FA pitch
15    py  10.7137  $ 1/2 FA pitch
c
c     Zr grid inner pitch
c
16    px -0.712475 $ Zr grid cell boundary
17    px  0.712475 $ Zr grid cell boundary
18    py -0.712475 $ Zr grid cell boundary
19    py  0.712475 $ Zr grid cell boundary
c
c     Overall Fuel Height including blanket - 144 inches
c
20    pz -182.88
21    pz  182.88
c
c     Axial Blanket/enriched fuel zone [redacted] inches below top & bottom
c
22    pz [redacted]
23    pz [redacted]
c
c     Top and bottom plenum regions
c
24    pz [redacted]
25    pz [redacted]
c
c     Channel bottom plate
c
26    pz -192.151
27    pz -194.691
c
c   Lower Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Bottom of LTP
30    pz -186.953
c
c    Upper Tie Plate - use FA px/py (8.424 in pitch vs 8.436 in for FA)
c
c     Smear mass over rectangle for now
c     Top of UTP
31    pz 206.538
c
33    pz 213.512  $ Top of FA
c
c     Square Cell for Channel
c
40    px  -11.3816
41    px  -11.1919
42    px   11.1919
43    px   11.3816
```

```
44     py  -11.3816
45     py  -11.1919
46     py   11.1919
47     py   11.3816
c
c      Rectangular Cell for Basket (ignore 9 - 1" thick axial spacers)
c
48     px  -13.6771
49     px   13.6771
50     py  -13.0548
51     py   13.0548
c
c      Hexagonal Cell Surrounding Cask for Infinite array
c
c        inner hex surfaces bounding lattice, (n-0.5)*p*cos30
*52    p    0.8660254   -0.5   0.0     64.000
*53    p    0.8660254   -0.5   0.0    -64.000
*54    p    0.8660254    0.5   0.0     64.000
*55    p    0.8660254    0.5   0.0    -64.000
*56    py   64.000
*57    py  -64.000
*58    pz    -211.000  $  2 cm bottom pitch
*59    pz     280.654  $  2 cm top pitch
c
c      B4C poison pins -
60    cz 0.5842     $ ID of SS304 clad
61    cz 0.635      $ OD of SS304 clad
72    py 0.0397  $
73    py 1.7129  $ 1/2 pitch for horiz poison pin row (1/2 of 1.38 in)
74    px 0.0397  $
75    px 2.3352  $ 1/2 pitch for veric poison pin row (1/2 of 1.87 in)
c
c     Four Basket Support Rods - 2-1/4 inch 216 SS
c
80    c/z -29.21  26.43124  2.8575
81    c/z  29.21  26.43124  2.8575
82    c/z -29.21 -26.43124  2.8575
83    c/z  29.21 -26.43124  2.8575
c
c     Cask dimensions
c
c     Radial
100   cz    47.625   $ Inner Cavity -18.75"
101   cz    48.895   $ 317 SS inner - 0.5"
102   cz    59.055   $ Cast DU      - 4"
103   cz   63.0174   $ 317 SS outer -1.56"
104   cz   93.4974   $ 12 inch side reflector
c     Axial - Bottom to Top of Cask
200   pz  -209.931   $ 304 SST      - 2"
201   pz  -204.851   $ Cast DU      - 3"
202   pz  -197.231   $ 304 SST      - 1"
203   pz   263.144   $ Cavity  -180.25"
204   pz   266.319   $ 304 SST - 1.25"
205   pz   275.844   $ Cast DU - 3.75"
206   pz   279.654   $ 304 SST -  1.5"
1000  so 1000

c      Translations for horizontal row of 6 poison pins
tr1    -9.525  0.8763   0   $ Left
tr2    -5.715  0.8763   0   $
tr3    -1.905  0.8763   0   $
tr4     1.905  0.8763   0   $
tr5     5.715  0.8763   0   $
tr6     9.525  0.8763   0   $ Right
c      Translations for vertical row of 6 poison pins
tr11    1.18745 -9.525  0    $ Bottom
tr12    1.18745 -5.715  0    $
tr13    1.18745 -1.905  0    $
tr14    1.18745  1.905  0    $
```

```
tr15   1.18745  5.715  0    $
tr16   1.18745  9.525  0    $ Top
c     Translate horizontal poison pin rows
tr20     0.0000  11.3419     0 $ Horiz above FA#1
tr21   -13.6771  13.0151     0 $ Horiz below FA#2
tr22    13.6771  13.0151     0 $ Horiz below FA#3
tr23   -27.3542  11.3419     0 $ Horiz above FA#4
tr24    27.3542  11.3419     0 $ Horiz above FA#5
tr25   -27.3542 -13.0945     0 $ Horiz below FA#4
tr26     0.0000 -13.0945     0 $ Horiz below FA#1
tr27    27.3542 -13.0945     0 $ Horiz below FA#5
tr28   -13.6771 -14.7677     0 $ Horiz above FA#6
tr29    13.6771 -14.7677     0 $ Horiz above FA#7
c     Translate vertical poison pin rows
tr30    -2.3352  26.1096   0 $ vert rght of FA#2
tr31    -0.0397  26.1096   0 $ vert left of FA#3
tr32   -16.0123   0.0000   0 $ vert rght of FA#4
tr33   -13.7168   0.0000   0 $ vert left of FA#1
tr34    11.3419   0.0000   0 $ vert rght of FA#1
tr35    13.6374   0.0000   0 $ vert left of FA#5
tr36    -2.3352 -26.1096   0 $ vert rght of FA#6
tr37    -0.0397 -26.1096   0 $ vert left of FA#7
c     FA translations
tr121   -13.6771 26.1096   0   $ FA #2
tr122    13.6771 26.1096   0   $ FA #3
tr123   -27.3542 0         0   $ FA #4
tr124    27.3542 0         0   $ FA #5
tr125   -13.6771 -26.1096  0   $ FA #6
tr126    13.6771 -26.1096  0   $ FA #7
c     Shift FA within basket channel
tr132 -0.478  0.478 0   $ FA #2
tr133  0.478  0.478 0   $ FA #3
tr134 -0.478  0     0   $ FA #4
tr135  0.478  0     0   $ FA #5
tr136 -0.478 -0.478 0   $ FA #6
tr137  0.478 -0.478 0   $ FA #7
mode n
kcode  3000 1 30 240 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.65 wt% U235
m1    92235.50c -0.040987
      92238.50c -0.840458
      8016.50c  -0.118554
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 4
m3    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c     m7 is Inconel 718
m7    5000.01c     -0.006
```

```
        6000.50c      -0.08
        13027.50c      -0.8
        14000.50c     -0.35
        22000.50c     -1.15
        24000.50c       -21
        25055.50c     -0.35
        26000.55c   -11.164
        27059.50c        -1
        28000.50c       -55
        29000.50c      -0.3
        41093.50c      -5.5
        42000.50c      -3.3
c       m8 is Inconel X750
m8      6000.50c   -0.08
        13027.50c     -1
        14000.50c   -0.5
        22000.50c  -2.75
        24000.50c    -15
        25055.50c     -1
        26000.55c     -7
        27059.50c     -1
        28000.50c    -70
        29000.50c   -0.5
        41093.50c   -1.2
c       m10 is B4C poison
m10     5010.50c  -0.109602  $ B10 lower end 18.3% - 0.3% - reduced 75%
        5011.50c  -0.665732  $ B11 upper end 81.7% + 0.3%
        6000.50c  -0.224666  $ C
c       m11 is Depleted Uranium
m11     92235.50c 0.000106128
        92238.50c 0.0475275
c       m12 is Air
m12     7014.50c -0.765
        8016.50c -0.235
c       m13 is Channel - 304 SS and water mixture (VF water = 0.358)
m13     1001.50c   -0.007266
        6000.50c   -0.000748
        8016.50c   -0.057669
        14000.50c  -0.009351
        15031.50c  -0.000421
        16032.50c  -0.000281
        24000.50c  -0.187013
        25055.50c  -0.018701
        26000.55c  -0.620369
        28000.50c  -0.098182
mt4     lwtr.01t
mt13    lwtr.01t
```

D-6.9-2 Example MCNP Input Files for the IF-300 Cask with GE BWR Fuel

Note: The highlighted information in these input files is proprietary information to General Electric.

```
MCNP Case: ge8ina

GE 8 - 8x8 - 4.25% U-235, 98% TD - 1 g/cc H2O - Infinite Array
1     1 -10.741 -1       20 -21        u=1 imp:n=1 $ Enriched uo2 fuel
2     2 -0.000178 1 -2 20 -21        u=1 imp:n=1 $ gap - He
3     3 -6.565  2 -3   20 -21        u=1 imp:n=1 $ Zr2 Clad
4     4 -1.0  3 16 -17 18 -19 20 -21 u=1 imp:n=1 $ Moderator
401   9 -6.565 (-16:17:-18:19) 20 -21 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.741 -1       21 -23        u=1 imp:n=1 $ Natural uo2 fuel
6     2 -0.000178 1 -2 21 -23        u=1 imp:n=1 $ gap - He
7     3 -6.565  2 -3   21 -23        u=1 imp:n=1 $ Zr2 Clad
8     4 -1.0  3 16 -17 18 -19 21 -23 u=1 imp:n=1 $ Moderator
801   9 -6.565 (-16:17:-18:19) 21 -23 u=1 imp:n=1 $ Zr4 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.741 -1       22 -20        u=1 imp:n=1 $ Natural uo2 fuel
10    2 -0.000178 1 -2 22 -20        u=1 imp:n=1 $ gap - He
11    3 -6.565  2 -3   22 -20        u=1 imp:n=1 $ Zr2 Clad
12    4 -1.0  3 16 -17 18 -19 22 -20 u=1 imp:n=1 $ Moderator
121   9 -6.565 (-16:17:-18:19) 22 -20 u=1 imp:n=1 $ Zr4 - Spacer
c     Plenum region - below fuel pins
13    2 -0.000178 -2   24 -22        u=1 imp:n=1 $ He
14    3 -6.565  2 -3   24 -22        u=1 imp:n=1 $ Zr2 Clad
15    4 -1.0  3        24 -22        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    2 -0.000178 -2   23 -28        u=1 imp:n=1 $ He
17    3 -6.565  2 -3   23 -28        u=1 imp:n=1 $ Zr2 Clad
18    4 -1.0  3        23 -28        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  25 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate -below fuel pins
191   4 -1.0  -25                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  28 -29                u=1 imp:n=1 $ 304L SS in UTP
c     Water above Upper tie plate -above fuel pins
201   4 -1.0   29                    u=1 imp:n=1 $ Water
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2 trcl=(-0.8128 -0.8128 0)
                        fill=  -4:3 -4:3 0:0
          1 1 1 1 1 1 1 1          $ x=-4 to x=3:y=-4
          1 1 1 1 1 1 1 1          $ "          ";y=-3
          1 1 1 1 1 1 1 1          $ "          ";y=-2
          1 1 1 5 3 1 1 1          $ "          ";y=-1
          1 1 1 3 5 1 1 1          $ "          ":y=0
          1 1 1 1 1 1 1 1          $ "          ";y=1
          1 1 1 1 1 1 1 1          $ "          ";y=2
          1 1 1 1 1 1 1 1  imp:n=1 $ "          ";y=3
c     Water Rod
26    4 -1.0 -10       24 -28        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -28         u=3 imp:n=1 $ Zr2 Clad
28    4 -1.0 11 16 -17 18 -19 24 -28 u=3 imp:n=1 $ Moderator
29    9 -6.565 (-16:17:-18:19) 24 -28 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
30    6 -8.03             -24 25     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
31    4 -1.0  -25                     u=3 imp:n=1 $ Water
```

```
c     Water above Upper tie plate/above FA Top -above water rods
32    4 -1.0   29                      u=3 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
33    6 -8.03          28 -29        u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Rod converted to Water Rod
34    4 -1.0 -2        24 -28        u=5 imp:n=1 $ water inside tube
35    3 -6.565 2  -3  24 -28         u=5 imp:n=1 $ Zr2 Clad
36    4 -1.0 3  16 -17 18 -19 24 -28 u=5 imp:n=1 $ Moderator
37    9 -6.565 (-16:17:-18:19) 24 -28 u=5 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
38    6 -8.03             -24 25     u=5 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
39    4 -1.0  -25                      u=5 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
40    4 -1.0   29                      u=5 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
41    6 -8.03          28 -29        u=5 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
42    0 12 -13 14 -15 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and channel
c     and above UTP/below LTP.
c
43    4 -1.0 (41 -42 45 -46) (-12:13:-14:15) u=4 imp:n=1
c
c     Zr4 Channel
c
44    9 -6.565 (-41:42:-45:46) u=4 imp:n=1
c
c     Make a unit out of the FA, water gap, and guide channel
c
45    0  40 -43 44 -47 26 -27 fill=4 imp:n=1
c
c     Outside FA
c
c     Water 12" above/below
c     Water between FAs and 12" above/below
100  4 -1.0  (-40:43:-44:47:-26:27) (48 -49 50 -51 30 -31) imp:n=1
2000  0 -48:49:-50:51:-30:31  imp:n=0

c
c     Fuel Cell
c
1     cz   0.52197    $ Fuel Pellet OR
2     cz   0.53213    $ Zr2 Clad IR
3     cz   0.61341    $ Zr2 Clad OR
c
c     Be sure to change translation on fill card for different lattice pitch
c
4     px  -0.81280    $ fuel rod cell boundary
5     px   0.81280    $ fuel rod cell boundary
6     py  -0.81280    $ fuel rod cell boundary
7     py   0.81280    $ fuel rod cell boundary
c
c     Water Rod
c
10    cz  0.67437   $ IR
11    cz  0.75057   $ OR
c
c     Fuel Lattice dimension
c
12    px  -6.5023 $ 1/2 Fuel lattice pitch
13    px   6.5023 $ 1/2 Fuel lattice pitch
14    py  -6.5023 $ 1/2 Fuel lattice pitch
15    py   6.5023 $ 1/2 Fuel lattice pitch
c
c     Zr grid inner pitch (calc using grid wgt & active fuel length)
c
```

```
16    px -0.810924  $ Zr grid cell boundary
17    px  0.810924  $ Zr grid cell boundary
18    py -0.810924  $ Zr grid cell boundary
19    py  0.810924  $ Zr grid cell boundary
c
c     Axial Blanket - [redacted] inches on top/bottom
c
20    pz [redacted]
21    pz [redacted]
c
c     Overall Fuel Height including blanket - 150. inches
c
22    pz -190.500
23    pz  190.500
c
c     Bottom endplug penetration "plenum" region = [redacted] in.
c     Bottom of axial blanket is this distance above top of LTP
c
24    pz [redacted]      $ Top of LTP
c
c     Smear mass over rectangle for now for LTP
25    pz -195.548      $ Bottom of LTP
c
c     Assembly length = [redacted] in
c
26    pz [redacted]      $ 1/2 length
27    pz [redacted]
c
c     Top plenum length ( [redacted]
c     Distance from top blanket to bottom of LTP
c
28    pz [redacted]
c
c    Upper Tie Plate - use FA lattice px/py
c
c     Smear mass over rectangle for now
c     Top of UTP
29    pz  216.059
c
c     12 in reflector below bottom of FA
30    pz -254.203
c     12 in reflector above top of FA
31    pz  254.203
c
c     Square Cell for Channel
c
40    px  -6.90626
41    px  -6.70306
42    px   6.70306
43    px   6.90626
44    py  -6.90626
45    py  -6.70306
46    py   6.70306
47    py   6.90626
c
c     Rectangular Cell for Water outside channel -
c     approximate average spacing of channeled FAs in BWR basket
c
*48    px   -9.00000
*49    px    9.00000
*50    py   -9.00000
*51    py    9.00000
1000 so 1000

mode n
kcode  1000 1.2 20 200 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.25 wt% U235
```

```
m1     92235.50c -0.037462
       92238.50c -0.843990
       8016.50c  -0.118548
c      m2 is He
m2     2004.50c -1.0
c      m3 is Zircaloy 2
m3     40000.60c  -98.23
       8016.50c    -0.12
       24000.50c   -0.10
       26000.55c   -0.10
       28000.50c   -0.05
       50000.35c   -1.40
c      m4 is water
m4     1001.50c 0.666700 8016.50c 0.333300
mt4    lwtr.01t
c      m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5     92235.50c -0.006347
       92238.50c -0.875151
       8016.50c  -0.118502
c      m6 is 304L SS
m6     6000.50c     -0.03
       14000.50c       -1
       15031.50c   -0.045
       16032.50c    -0.03
       24000.50c      -20
       25055.50c       -2
       26000.55c  -64.895
       28000.50c      -12
c  c      m7 is Inconel 718
c  m7     5000.01c     -0.006
c         6000.50c      -0.08
c         13027.50c      -0.8
c         14000.50c     -0.35
c         22000.50c     -1.15
c         24000.50c       -21
c         25055.50c     -0.35
c         26000.55c   -11.164
c         27059.50c        -1
c         28000.50c       -55
c         29000.50c      -0.3
c         41093.50c      -5.5
c         42000.50c      -3.3
c  c      m8 is Inconel X750
c  m8     6000.50c   -0.08
c         13027.50c     -1
c         14000.50c   -0.5
c         22000.50c  -2.75
c         24000.50c    -15
c         25055.50c     -1
c         26000.55c     -7
c         27059.50c     -1
c         28000.50c    -70
c         29000.50c   -0.5
c         41093.50c   -1.2
c      m9 is Zircaloy 4
m9     40000.60c  -98.18
       8016.50c    -0.12
       24000.50c   -0.10
       26000.55c   -0.20
       50000.35c   -1.40
```

```
MCNP Case: ifb810

BWR - GE8 - 4.25% - CTMT- 1.00 g/cc - Single Cask - 12 in Reflector
1     1 -10.741 -1       20 -21        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.0000 1 -2 20 -21             u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   20 -21        u=1 imp:n=1 $ Zr2 Clad
4     4 -1.0000  3 16 -17 18 -19 20 -21 u=1 imp:n=1 $ Moderator
444   3 -6.565 (-16:17:-18:19) 20 -21 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.741 -1       21 -23        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.0000 1 -2 21 -23             u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   21 -23        u=1 imp:n=1 $ Zr2 Clad
8     4 -1.0000  3 16 -17 18 -19 21 -23 u=1 imp:n=1 $ Moderator
888   3 -6.565 (-16:17:-18:19) 21 -23 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.741 -1       22 -20        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.0000 1 -2 22 -20             u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   22 -20        u=1 imp:n=1 $ Zr2 Clad
12    4 -1.0000  3 16 -17 18 -19 22 -20 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 22 -20 u=1 imp:n=1 $ Zr2 - Spacer
c     Plenum region - below fuel pins
13    4 -1.0000 -2   24 -22        u=1 imp:n=1 $ H2O
14    3 -6.565  2 -3   24 -22        u=1 imp:n=1 $ Zr2 Clad
15    4 -1.0000  3        24 -22        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.0000 -2   23 -28        u=1 imp:n=1 $ H2O
17    3 -6.565  2 -3   23 -28        u=1 imp:n=1 $ Zr2 Clad
18    4 -1.0000  3        23 -28        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  25 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate -below fuel pins
191   4 -1.0000  -25                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  28 -29                u=1 imp:n=1 $ 304L SS in UTP
c     Water above Upper tie plate -above fuel pins
221   4 -1.0000   29                    u=1 imp:n=1 $ Water
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2 trcl=(-0.8128 -0.8128 0)
                        fill=  -4:3 -4:3 0:0
          1 1 1 1 1 1 1 1          $ x=-4 to x=3:y=-4
          1 1 1 1 1 1 1 1          $ "         ";y=-3
          1 1 1 1 1 1 1 1          $ "         ";y=-2
          1 1 1 5 3 1 1 1          $ "         ";y=-1
          1 1 1 3 5 1 1 1          $ "         ";y=0
          1 1 1 1 1 1 1 1          $ "         ";y=1
          1 1 1 1 1 1 1 1          $ "         ";y=2
          1 1 1 1 1 1 1 1  imp:n=1 $ "         ";y=3
c     Water Rod
26    4 -1.0000 -10      24 -28        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -28        u=3 imp:n=1 $ Zr2 Clad
28    4 -1.0000 11 16 -17 18 -19 24 -28 u=3 imp:n=1 $ Moderator
29    9 -6.565 (-16:17:-18:19) 24 -28 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
30    6 -8.03            -24 25     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
31    4 -1.0000  -25                    u=3 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
32    4 -1.0000   29                    u=3 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
33    6 -8.03         28 -29        u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Rod converted to Water Rod
34    4 -1.0000 -2       24 -28        u=5 imp:n=1 $ water inside tube
35    3 -6.565 2  -3  24 -28        u=5 imp:n=1 $ Zr2 Clad
36    4 -1.0000 3  16 -17 18 -19 24 -28 u=5 imp:n=1 $ Moderator
37    9 -6.565 (-16:17:-18:19) 24 -28 u=5 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
38    6 -8.03            -24 25     u=5 imp:n=1 $ 304L SS in LTP
```

```
c     Water below Lower tie plate/above FA bottom -below water rods
39    4 -1.0000  -25                    u=5 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
40    4 -1.0000   29                    u=5 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
41    6 -8.03         28 -29        u=5 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
42    0 12 -13 14 -15 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and channel
c     and above UTP/below LTP.
c
43    4 -1.0000 (41 -42 45 -46) (-12:13:-14:15) u=4 imp:n=1
c
c     Zr4 Channel
c
44    9 -6.565 (-41:42:-45:46) u=4 imp:n=1
c
c     Make a unit out of the FA, water gap, and guide channel
c
45    0  40 -43 44 -47 26 -27 fill=4 imp:n=1
c
c     Define the other 16 FAs
100   like 45 but trcl=101    imp:n=1  $ FA #1
101   like 45 but trcl=102    imp:n=1  $ FA #2
102   like 45 but trcl=103    imp:n=1  $ FA #3
103   like 45 but trcl=104    imp:n=1  $ FA #4
104   like 45 but trcl=105    imp:n=1  $ FA #5
105   like 45 but trcl=106    imp:n=1  $ FA #6
106   like 45 but trcl=107    imp:n=1  $ FA #7
107   like 45 but trcl=108    imp:n=1  $ FA #8
108   like 45 but trcl=109    imp:n=1  $ FA #10
109   like 45 but trcl=110    imp:n=1  $ FA #11
110   like 45 but trcl=111    imp:n=1  $ FA #12
111   like 45 but trcl=112    imp:n=1  $ FA #13
112   like 45 but trcl=113    imp:n=1  $ FA #14
113   like 45 but trcl=114    imp:n=1  $ FA #15
114   like 45 but trcl=115    imp:n=1  $ FA #16
115   like 45 but trcl=116    imp:n=1  $ FA #17
c
c     Define the 4 basket support rods
c
116   6 -8.03 -150 104 -125       imp:n=1  $ Upper left
117   6 -8.03 -151 104 -125       imp:n=1  $ Upper right
118   6 -8.03 -152 104 -125       imp:n=1  $ Lower left
119   6 -8.03 -153 104 -125       imp:n=1  $ Lower right
c
c    Define Boron Plate Cells - Bottom to top with steel in between
c    for spacer disc.  Note - B-10 loading reduced to 75%.
c
c    Bottom
200   6 -8.03  -106        u=7     imp:n=1 $ SS spacer disc 1
201  10 -7.739  106 -107   u=7     imp:n=1 $ Boron plate 1
202   6 -8.03   107 -108   u=7     imp:n=1 $ SS spacer disc 2
203  10 -7.739  108 -109   u=7     imp:n=1 $ Boron plate 2
204   6 -8.03   109 -110   u=7     imp:n=1 $ SS spacer disc 3
205  10 -7.739  110 -111   u=7     imp:n=1 $ Boron plate 3
206   6 -8.03   111 -112   u=7     imp:n=1 $ SS spacer disc 4
207  10 -7.739  112 -113   u=7     imp:n=1 $ Boron plate 4
208   6 -8.03   113 -114   u=7     imp:n=1 $ SS spacer disc 5
209  10 -7.739  114 -115   u=7     imp:n=1 $ Boron plate 5
210   6 -8.03   115 -116   u=7     imp:n=1 $ SS spacer disc 6
211  10 -7.739  116 -117   u=7     imp:n=1 $ Boron plate 6
212   6 -8.03   117 -118   u=7     imp:n=1 $ SS spacer disc 7
213  10 -7.739  118 -119   u=7     imp:n=1 $ Boron plate 7
214   6 -8.03   119 -120   u=7     imp:n=1 $ SS spacer disc 8
215  10 -7.739  120 -121   u=7     imp:n=1 $ Boron plate 8
216   6 -8.03   121 -122   u=7     imp:n=1 $ SS spacer disc 9
217  10 -7.739  122 -123   u=7     imp:n=1 $ Boron plate 9
```

```
218   6 -8.03   123       u=7     imp:n=1 $ Top spacer disc
c    Top
c
c    Long Horizontal Boron Plates
c
300   0  105 -124 200 -201 202 -203  trcl=1 fill=7 imp:n=1
301   like 300 but                   trcl=2 fill=7 imp:n=1
c
c    Short Horizontal Boron Plates
c
302   0  105 -124 204 -205 206 -207  trcl=3 fill=7 imp:n=1
303   like 302 but                   trcl=4 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
304   0  105 -124 208 -209 210 -211  trcl=5 fill=7 imp:n=1
305   like 304 but                   trcl=6 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
306   0  105 -124 212 -213 214 -215  trcl=7 fill=7 imp:n=1
307   like 306 but                   trcl=8 fill=7 imp:n=1
c    Define Cask Cells
c
400   6 -8.03 300 -301 104 -126 imp:n=1 $ 317 SS Inner Shell - Radial
401   6 -8.03 -301    103  -104 imp:n=1 $ 304 SS Inner Shell - Bottom
402   6 -8.03 -301    126  -127 imp:n=1 $ 317 SS Inner Shell - Top
403   11 -18.82 (-302 102 -103):(301 -302 103 -127):(-302 127 -128)
                imp:n=1 $ Depleted U (union of bottom/side/top)
404   6 -8.03 (-303 101 -102):(302 -303 102 -128):(-303 128 -129)
             imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs/basket and inside Cask.
c
1000  4 -1.0000 -300 70 104 -126 #100 #101 #102 #103 #104 #105 #116 #117
             #300 #302 #306 imp:n=1 $ Back half section
1001  4 -1.0000 -300 -70 104 -126 #45 #106 #107 #108 #109 #110 #111
                  #112 #113 #114 #115       #118 #119
                  #301 #303 #304 #305 #307
                          imp:n=1 $ Front half section
c
c     Outside Cask.
c     5 cm  water reflector around cask
2000  4 -1.0 (100 -130 -304) (303:-101:129) imp:n=1
c     5 cm to 12 in water reflector around cask
2001  4 -1.0 ( 99 -131 -305) (304:-100:130) imp:n=1
c
2002  0  305:-99:131 imp:n=0

c
c     Fuel Cell
c
1     cz   0.52197    $ Fuel Pellet OR
2     cz   0.53213    $ Zr2 Clad IR
3     cz   0.61341    $ Zr2 Clad OR
c
c     Be sure to change translation on fill card for different lattice pitch
c
4     px  -0.81280    $ fuel rod cell boundary
5     px   0.81280    $ fuel rod cell boundary
6     py  -0.81280    $ fuel rod cell boundary
7     py   0.81280    $ fuel rod cell boundary
c
c     Water Rod
c
10    cz  0.67437   $ IR
11    cz  0.75057   $ OR
c
c     Fuel Lattice dimension
```

```
c
12    px  -6.5023 $ 1/2 Fuel lattice pitch
13    px   6.5023 $ 1/2 Fuel lattice pitch
14    py  -6.5023 $ 1/2 Fuel lattice pitch
15    py   6.5023 $ 1/2 Fuel lattice pitch
c
c     Zr grid inner pitch (calc using grid wgt & active fuel length)
c
16    px -0.810924  $ Zr grid cell boundary
17    px  0.810924  $ Zr grid cell boundary
18    py -0.810924  $ Zr grid cell boundary
19    py  0.810924  $ Zr grid cell boundary
c
c     Axial Blanket - [redacted] inches on top/bottom
c
20    pz [redacted]
21    pz [redacted]
c
c     Overall Fuel Height including blanket - 150. inches
c
22    pz -190.500
23    pz  190.500
c
c     Bottom endplug penetration "plenum" region = [redacted] in.
c     Bottom of axial blanket is this distance above top of LTP
c
24    pz [redacted]      $ Top of LTP
c
c     Smear mass over rectangle for now for LTP
25    pz -195.548      $ Bottom of LTP
c
c     Assembly length = [redacted] in
c
26    pz [redacted]      $ 1/2 length
27    pz [redacted]
c
c     Top plenum length ( [redacted]
c     Distance from top blanket to bottom of LTP
c
28    pz [redacted]
c
c    Upper Tie Plate - use FA lattice px/py
c
c     Smear mass over rectangle for now
c     Top of UTP
29    pz  216.059
c
c     Square Cell for Channel
c
40    px  -6.90626
41    px  -6.70306
42    px   6.70306
43    px   6.90626
44    py  -6.90626
45    py  -6.70306
46    py   6.70306
47    py   6.90626
c
70    py   8.65       $ Plane to split cask from front to back
c
c     Axial planes for the cask and the boron poison plates
c
99   pz    -270.396  $ 12" of water reflector - bottom
100  pz    -244.916  $ 5 cm   water reflector - bottom
101  pz    -239.916  $ 304 SST - 2"
102  pz    -234.836  $ Cast DU - 3"
103  pz    -227.216  $ 304 SST - 1"
104  pz    -224.676  $ bot fuel support (Assume bottom of channel is
105  pz    -214.084  $ Bot Disc 1        bottom of cavity)
```

```
106  pz    -209.004  $ Top Disc 1
107  pz    -158.153  $ Top PP   1
108  pz    -153.073  $ Top Disc 2
109  pz    -106.972  $ Top PP   2
110  pz    -101.892  $ Top Disc 3
111  pz     -55.7909 $ Top PP   3
112  pz     -50.7109 $ Top Disc 4
113  pz      -4.6099 $ Top PP   4
114  pz       0.4701 $ Top Disc 5
115  pz      46.5711 $ Top PP   5
116  pz      51.6511 $ Top Disc 6
117  pz      97.7521 $ Top PP   6
118  pz     102.8321 $ Top Disc 7
119  pz     148.9331 $ Top PP   7
120  pz     154.0131 $ Top Disc 8
121  pz     186.0425 $ Top PP   8
122  pz     191.1225 $ Top Disc 9
123  pz     210.6297 $ Top PP   9
124  pz     215.7097 $ Top Disc10
125  pz     230.6449 $ Top bask
126  pz     233.1595 $ Top of Cavity
127  pz     236.3345 $ 304 SST - 1.25"
128  pz     245.8595 $ Cast DU - 3.75"
129  pz     249.6695 $ 304 SST - 1.5"
130  pz     254.6695 $ 5 cm   water reflector
131  pz     280.1495 $ 12" of water reflector
c
c   3.03" Support Rods for Basket
c
150  c/z -22.5425  33.02     3.8481
151  c/z  22.5425  33.02     3.8481
152  c/z -22.5425 -33.02     3.8481
153  c/z  22.5425 -33.02     3.8481
c
c   Define Boron Plate Dimensions for x-y plane
c
c   Long Horizontal Plate
c
200  px -41.275  $ Left end
201  px  41.275  $ Right end
202  py -0.3175  $ Back  end
203  py  0.3175  $ Front end
c
c   Shorter Horizontal Plate
c
204  px -32.385  $ Left end
205  px  32.385  $ Right end
206  py -0.3175  $ Back  end
207  py  0.3175  $ Front end
c
c   Vertical Plate - adjacent to center FA
c
208  px -0.47625 $ Left end
209  px  0.47625 $ Right end
210  py -8.4200  $ Back  end
211  py  8.4200  $ Front end
c
c   Vertical Plate - below center FA
c
212  px -0.47625 $ Left end
213  px  0.47625 $ Right end
214  py -8.09625 $ Back  end
215  py  8.09625 $ Front end
c
c    Cask dimensions
c
c    Radial
300  cz    47.625   $ Inner Cavity -18.75"
301  cz    48.895   $ 317 SS inner - 0.5"
```

```
302  cz    59.055    $ Cast DU      - 4"
303  cz   63.0174    $ 317 SS outer -1.56"
304  cz   68.0174    $ 5 cm   water reflector
305  cz   93.4974    $ 12" of water reflector
1000 so 1000

c    Poison Plate translations
tr1      0   9.1694    0   $ Long Horizontal - Back
tr2      0  -9.1694    0   $ Long Horizontal - Front
tr3      0  26.87955   0   $ Short Horizontal - Back
tr4      0 -26.87955   0   $ Short Horizontal - Front
tr5     -8.59790  0    0   $ Vertical - adj to center FA - Left
tr6      8.59790  0    0   $ Vertical - adj to center FA - Right
tr7      0  18.3388    0   $ Vertical - 2nd row - Back
tr8      0 -18.3388    0   $ Vertical - 2nd row - Front
c     FA translations
tr101   -8.60552  35.4203   0   $ FA #1
tr102    8.60552  35.4203   0   $ FA #2
tr103  -25.81402  18.3388   0   $ FA #3
tr104   -8.60552  18.3388   0   $ FA #4
tr105    8.60552  18.3388   0   $ FA #5
tr106   25.81402  18.3388   0   $ FA #6
tr107   -34.4043   0        0   $ FA #7
tr108   -17.1958   0        0   $ FA #8
tr109    17.1958   0        0   $ FA #10
tr110    34.4043   0        0   $ FA #11
tr111  -25.81402 -18.3388   0   $ FA #12
tr112   -8.60552 -18.3388   0   $ FA #13
tr113    8.60552 -18.3388   0   $ FA #14
tr114   25.81402 -18.3388   0   $ FA #15
tr115   -8.60552 -35.4203   0   $ FA #16
tr116    8.60552 -35.4203   0   $ FA #17
mode n
kcode  3000 1 30 300 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.25 wt% U235
m1    92235.50c -0.037461
      92238.50c -0.843965
      8016.50c  -0.118575
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 2
m3    40000.60c  -98.23
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.10
      28000.50c   -0.05
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c  c     m7 is Inconel 718
c  m7    5000.01c     -0.006
c        6000.50c      -0.08
c        13027.50c      -0.8
c        14000.50c     -0.35
```

```
c        22000.50c     -1.15
c        24000.50c       -21
c        25055.50c     -0.35
c        26000.55c   -11.164
c        27059.50c        -1
c        28000.50c       -55
c        29000.50c      -0.3
c        41093.50c      -5.5
c        42000.50c      -3.3
c  c     m8 is Inconel X750
c  m8    6000.50c   -0.08
c        13027.50c     -1
c        14000.50c   -0.5
c        22000.50c  -2.75
c        24000.50c    -15
c        25055.50c     -1
c        26000.55c     -7
c        27059.50c     -1
c        28000.50c    -70
c        29000.50c   -0.5
c        41093.50c   -1.2
c     m9 is Zircaloy 4
m9    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m10 is Neutrosorb poison plates
m10   5010.50c   -0.007069   $ B10 - reduced to 75%
      5011.50c   -0.000602   $ B11
      24000.50c  -0.190452   $ Cr
      25055.50c  -0.010024   $ Mn
      26000.55c  -0.656558   $ Fe
      28000.50c  -0.135295   $ Ni
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
mt4   lwtr.01t
```

```
MCNP Case: bsi810

BWR - GE8 - 4.25% - CTMT-1.0 g/cc - Single Cask - 12 in Refl - Shifted Inward
1     1 -10.741 -1       20 -21        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.0 1 -2 20 -21             u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   20 -21        u=1 imp:n=1 $ Zr2 Clad
4     4 -1.0  3 16 -17 18 -19 20 -21 u=1 imp:n=1 $ Moderator
444   3 -6.565 (-16:17:-18:19) 20 -21 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.741 -1       21 -23        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.0 1 -2 21 -23             u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   21 -23        u=1 imp:n=1 $ Zr2 Clad
8     4 -1.0  3 16 -17 18 -19 21 -23 u=1 imp:n=1 $ Moderator
888   3 -6.565 (-16:17:-18:19) 21 -23 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.741 -1       22 -20        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.0 1 -2 22 -20             u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   22 -20        u=1 imp:n=1 $ Zr2 Clad
12    4 -1.0  3 16 -17 18 -19 22 -20 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 22 -20 u=1 imp:n=1 $ Zr2 - Spacer
c     Plenum region - below fuel pins
13    4 -1.0 -2   24 -22        u=1 imp:n=1 $ H2O
14    3 -6.565  2 -3   24 -22        u=1 imp:n=1 $ Zr2 Clad
15    4 -1.0  3        24 -22        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.0 -2   23 -28        u=1 imp:n=1 $ H2O
17    3 -6.565  2 -3   23 -28        u=1 imp:n=1 $ Zr2 Clad
18    4 -1.0  3        23 -28        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  25 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate -below fuel pins
191   4 -1.0  -25                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  28 -29                u=1 imp:n=1 $ 304L SS in UTP
c     Water above Upper tie plate -above fuel pins
221   4 -1.0   29                    u=1 imp:n=1 $ Water
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2 trcl=(-0.8128 -0.8128 0)
                        fill=  -4:3 -4:3 0:0
          1 1 1 1 1 1 1 1          $ x=-4 to x=3:y=-4
          1 1 1 1 1 1 1 1          $ "         ";y=-3
          1 1 1 1 1 1 1 1          $ "         ";y=-2
          1 1 1 5 3 1 1 1          $ "         ";y=-1
          1 1 1 3 5 1 1 1          $ "         ":y=0
          1 1 1 1 1 1 1 1          $ "         ";y=1
          1 1 1 1 1 1 1 1          $ "         ";y=2
          1 1 1 1 1 1 1 1  imp:n=1 $ "         ";y=3
c     Water Rod
26    4 -1.0 -10      24 -28        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -28        u=3 imp:n=1 $ Zr2 Clad
28    4 -1.0 11 16 -17 18 -19 24 -28 u=3 imp:n=1 $ Moderator
29    9 -6.565 (-16:17:-18:19) 24 -28 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
30    6 -8.03            -24 25     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
31    4 -1.0  -25                    u=3 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
32    4 -1.0   29                    u=3 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
33    6 -8.03         28 -29        u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Rod converted to Water Rod
34    4 -1.0 -2       24 -28        u=5 imp:n=1 $ water inside tube
35    3 -6.565 2  -3  24 -28        u=5 imp:n=1 $ Zr2 Clad
36    4 -1.0 3  16 -17 18 -19 24 -28 u=5 imp:n=1 $ Moderator
37    9 -6.565 (-16:17:-18:19) 24 -28 u=5 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
```

```
38    6 -8.03            -24 25     u=5 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
39    4 -1.0  -25                     u=5 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
40    4 -1.0   29                     u=5 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
41    6 -8.03         28 -29        u=5 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
42    0 12 -13 14 -15 fill=2 u=4 imp:n=1
c
c     Water Gap between fuel assembly and channel
c     and above UTP/below LTP.
c
43    4 -1.0 (41 -42 45 -46) (-12:13:-14:15) u=4 imp:n=1
c
c     Zr4 Channel
c
44    9 -6.565 (-41:42:-45:46) u=4 imp:n=1
c
c     Make a unit out of the FA, water gap, and guide channel
c
45    0  40 -43 44 -47 26 -27 fill=4 imp:n=1
c
c     Define the other 16 FAs
100   like 45 but trcl=101    imp:n=1  $ FA #1
101   like 45 but trcl=102    imp:n=1  $ FA #2
102   like 45 but trcl=103    imp:n=1  $ FA #3
103   like 45 but trcl=104    imp:n=1  $ FA #4
104   like 45 but trcl=105    imp:n=1  $ FA #5
105   like 45 but trcl=106    imp:n=1  $ FA #6
106   like 45 but trcl=107    imp:n=1  $ FA #7
107   like 45 but trcl=108    imp:n=1  $ FA #8
108   like 45 but trcl=109    imp:n=1  $ FA #10
109   like 45 but trcl=110    imp:n=1  $ FA #11
110   like 45 but trcl=111    imp:n=1  $ FA #12
111   like 45 but trcl=112    imp:n=1  $ FA #13
112   like 45 but trcl=113    imp:n=1  $ FA #14
113   like 45 but trcl=114    imp:n=1  $ FA #15
114   like 45 but trcl=115    imp:n=1  $ FA #16
115   like 45 but trcl=116    imp:n=1  $ FA #17
c
c     Define the 4 basket support rods
c
116   6 -8.03 -150 104 -125       imp:n=1  $ Upper left
117   6 -8.03 -151 104 -125       imp:n=1  $ Upper right
118   6 -8.03 -152 104 -125       imp:n=1  $ Lower left
119   6 -8.03 -153 104 -125       imp:n=1  $ Lower right
c
c    Define Boron Plate Cells - Bottom to top with steel in between
c    for spacer disc.  Note - B-10 loading reduced to 75%.
c
c    Bottom
200   6 -8.03  -106        u=7     imp:n=1 $ SS spacer disc 1
201  10 -7.739  106 -107   u=7     imp:n=1 $ Boron plate 1
202   6 -8.03   107 -108   u=7     imp:n=1 $ SS spacer disc 2
203  10 -7.739  108 -109   u=7     imp:n=1 $ Boron plate 2
204   6 -8.03   109 -110   u=7     imp:n=1 $ SS spacer disc 3
205  10 -7.739  110 -111   u=7     imp:n=1 $ Boron plate 3
206   6 -8.03   111 -112   u=7     imp:n=1 $ SS spacer disc 4
207  10 -7.739  112 -113   u=7     imp:n=1 $ Boron plate 4
208   6 -8.03   113 -114   u=7     imp:n=1 $ SS spacer disc 5
209  10 -7.739  114 -115   u=7     imp:n=1 $ Boron plate 5
210   6 -8.03   115 -116   u=7     imp:n=1 $ SS spacer disc 6
211  10 -7.739  116 -117   u=7     imp:n=1 $ Boron plate 6
212   6 -8.03   117 -118   u=7     imp:n=1 $ SS spacer disc 7
213  10 -7.739  118 -119   u=7     imp:n=1 $ Boron plate 7
214   6 -8.03   119 -120   u=7     imp:n=1 $ SS spacer disc 8
215  10 -7.739  120 -121   u=7     imp:n=1 $ Boron plate 8
216   6 -8.03   121 -122   u=7     imp:n=1 $ SS spacer disc 9
```

```
217  10 -7.739  122 -123  u=7     imp:n=1 $ Boron plate 9
218   6 -8.03   123       u=7     imp:n=1 $ Top spacer disc
c    Top
c
c    Long Horizontal Boron Plates
c
300   0  105 -124 200 -201 202 -203  trcl=1 fill=7 imp:n=1
301   like 300 but                   trcl=2 fill=7 imp:n=1
c
c    Short Horizontal Boron Plates
c
302   0  105 -124 204 -205 206 -207  trcl=3 fill=7 imp:n=1
303   like 302 but                   trcl=4 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
304   0  105 -124 208 -209 210 -211  trcl=5 fill=7 imp:n=1
305   like 304 but                   trcl=6 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
306   0  105 -124 212 -213 214 -215  trcl=7 fill=7 imp:n=1
307   like 306 but                   trcl=8 fill=7 imp:n=1
c    Define Cask Cells
c
400   6 -8.03 300 -301 104 -126 imp:n=1 $ 317 SS Inner Shell - Radial
401   6 -8.03 -301    103  -104 imp:n=1 $ 304 SS Inner Shell - Bottom
402   6 -8.03 -301    126  -127 imp:n=1 $ 317 SS Inner Shell - Top
403   11 -18.82 (-302 102 -103):(301 -302 103 -127):(-302 127 -128)
                 imp:n=1 $ Depleted U (union of bottom/side/top)
404   6 -8.03 (-303 101 -102):(302 -303 102 -128):(-303 128 -129)
            imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs/basket and inside Cask.
c
1000  4 -1.0 -300 70 104 -126 #100 #101 #102 #103 #104 #105 #116 #117
             #300 #302 #306 imp:n=1 $ Back half section
1001  4 -1.0 -300 -70 104 -126 #45 #106 #107 #108 #109 #110 #111
                  #112 #113 #114 #115       #118 #119
                  #301 #303 #304 #305 #307
                          imp:n=1 $ Front half section
c
c     Outside Cask.
c     5 cm  water reflector around cask
2000  4 -1.0 (100 -130 -304) (303:-101:129) imp:n=1
c     5 cm to 12 in water reflector around cask
2001  4 -1.0 ( 99 -131 -305) (304:-100:130) imp:n=1
c
2002  0  305:-99:131 imp:n=0

c
c     Fuel Cell
c
1     cz   0.52197    $ Fuel Pellet OR
2     cz   0.53213    $ Zr2 Clad IR
3     cz   0.61341    $ Zr2 Clad OR
c
c     Be sure to change translation on fill card for different lattice pitch
c
4     px  -0.81280    $ fuel rod cell boundary
5     px   0.81280    $ fuel rod cell boundary
6     py  -0.81280    $ fuel rod cell boundary
7     py   0.81280    $ fuel rod cell boundary
c
c     Water Rod
c
10    cz  0.67437   $ IR
11    cz  0.75057   $ OR
c
```

```
c     Fuel Lattice dimension
c
12    px  -6.5023 $ 1/2 Fuel lattice pitch
13    px   6.5023 $ 1/2 Fuel lattice pitch
14    py  -6.5023 $ 1/2 Fuel lattice pitch
15    py   6.5023 $ 1/2 Fuel lattice pitch
c
c     Zr grid inner pitch (calc using grid wgt & active fuel length)
c
16    px -0.810924  $ Zr grid cell boundary
17    px  0.810924  $ Zr grid cell boundary
18    py -0.810924  $ Zr grid cell boundary
19    py  0.810924  $ Zr grid cell boundary
c
c     Axial Blanket - [redacted] inches on top/bottom
c
20    pz [redacted]
21    pz [redacted]
c
c     Overall Fuel Height including blanket - 150. inches
c
22    pz -190.500
23    pz  190.500
c
c     Bottom endplug penetration "plenum" region = [redacted] in.
c     Bottom of axial blanket is this distance above top of LTP
c
24    pz [redacted]      $ Top of LTP
c
c     Smear mass over rectangle for now for LTP
25    pz -195.548      $ Bottom of LTP
c
c     Assembly length = [redacted] in
c
26    pz [redacted]      $ 1/2 length
27    pz [redacted]
c
c     Top plenum length ( [redacted]
c     Distance from top blanket to bottom of LTP
c
28    pz [redacted]
c
c    Upper Tie Plate - use FA lattice px/py
c
c     Smear mass over rectangle for now
c     Top of UTP
29    pz  216.059
c
c     Square Cell for Channel
c
40    px  -6.90626
41    px  -6.70306
42    px   6.70306
43    px   6.90626
44    py  -6.90626
45    py  -6.70306
46    py   6.70306
47    py   6.90626
c
70    py   8.65       $ Plane to split cask from front to back
c
c     Axial planes for the cask and the boron poison plates
c
99   pz    -270.396  $ 12" of water reflector - bottom
100  pz    -244.916  $ 5 cm   water reflector - bottom
101  pz    -239.916  $ 304 SST - 2"
102  pz    -234.836  $ Cast DU - 3"
103  pz    -227.216  $ 304 SST - 1"
104  pz    -224.676  $ bot fuel support (Assume bottom of channel is
```

```
105  pz    -214.084  $ Bot Disc 1        bottom of cavity)
106  pz    -209.004  $ Top Disc 1
107  pz    -158.153  $ Top PP   1
108  pz    -153.073  $ Top Disc 2
109  pz    -106.972  $ Top PP   2
110  pz    -101.892  $ Top Disc 3
111  pz     -55.7909 $ Top PP   3
112  pz     -50.7109 $ Top Disc 4
113  pz      -4.6099 $ Top PP   4
114  pz       0.4701 $ Top Disc 5
115  pz      46.5711 $ Top PP   5
116  pz      51.6511 $ Top Disc 6
117  pz      97.7521 $ Top PP   6
118  pz     102.8321 $ Top Disc 7
119  pz     148.9331 $ Top PP   7
120  pz     154.0131 $ Top Disc 8
121  pz     186.0425 $ Top PP   8
122  pz     191.1225 $ Top Disc 9
123  pz     210.6297 $ Top PP   9
124  pz     215.7097 $ Top Disc10
125  pz     230.6449 $ Top bask
126  pz     233.1595 $ Top of Cavity
127  pz     236.3345 $ 304 SST - 1.25"
128  pz     245.8595 $ Cast DU - 3.75"
129  pz     249.6695 $ 304 SST - 1.5"
130  pz     254.6695 $ 5 cm   water reflector
131  pz     280.1495 $ 12" of water reflector
c
c   3.03" Support Rods for Basket
c
150  c/z -22.5425  33.02     3.8481
151  c/z  22.5425  33.02     3.8481
152  c/z -22.5425 -33.02     3.8481
153  c/z  22.5425 -33.02     3.8481
c
c   Define Boron Plate Dimensions for x-y plane
c
c   Long Horizontal Plate
c
200  px -41.275  $ Left end
201  px  41.275  $ Right end
202  py -0.3175  $ Back  end
203  py  0.3175  $ Front end
c
c   Shorter Horizontal Plate
c
204  px -32.385  $ Left end
205  px  32.385  $ Right end
206  py -0.3175  $ Back  end
207  py  0.3175  $ Front end
c
c   Vertical Plate - adjacent to center FA
c
208  px -0.47625 $ Left end
209  px  0.47625 $ Right end
210  py -8.4200  $ Back  end
211  py  8.4200  $ Front end
c
c   Vertical Plate - below center FA
c
212  px -0.47625 $ Left end
213  px  0.47625 $ Right end
214  py -8.09625 $ Back  end
215  py  8.09625 $ Front end
c
c    Cask dimensions
c
c    Radial
300  cz    47.625   $ Inner Cavity -18.75"
```

```
301  cz    48.895    $ 317 SS inner - 0.5"
302  cz    59.055    $ Cast DU      - 4"
303  cz   63.0174    $ 317 SS outer -1.56"
304  cz   68.0174    $ 5 cm   water reflector
305  cz   93.4974    $ 12" of water reflector
1000 so 1000

c    Poison Plate translations
tr1      0   9.1694     0   $ Long Horizontal - Back
tr2      0  -9.1694     0   $ Long Horizontal - Front
tr3      0  26.87955    0   $ Short Horizontal - Back
tr4      0 -26.87955    0   $ Short Horizontal - Front
tr5     -8.59790  0     0   $ Vertical - adj to center FA - Left
tr6      8.59790  0     0   $ Vertical - adj to center FA - Right
tr7      0  18.3388     0   $ Vertical - 2nd row - Back
tr8      0 -18.3388     0   $ Vertical - 2nd row - Front
c     FA translations
tr101   -7.92552     34.7403   0   $ FA #1
tr102    7.92552     34.7403   0   $ FA #2
tr103  -25.13402     17.6588   0   $ FA #3
tr104   -7.92552     17.6588   0   $ FA #4
tr105    7.92552     17.6588   0   $ FA #5
tr106   25.13402     17.6588   0   $ FA #6
tr107  -33.7243        0       0   $ FA #7
tr108  -16.5158        0       0   $ FA #8
tr109   16.5158        0       0   $ FA #10
tr110   33.7243        0       0   $ FA #11
tr111  -25.13402    -17.6588   0   $ FA #12
tr112   -7.92552    -17.6588   0   $ FA #13
tr113    7.92552    -17.6588   0   $ FA #14
tr114   25.13402    -17.6588   0   $ FA #15
tr115   -7.92552    -34.7403   0   $ FA #16
tr116    7.92552    -34.7403   0   $ FA #17
mode n
kcode  3000 1 30 300 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.25 wt% U235
m1    92235.50c -0.037461
      92238.50c -0.843965
      8016.50c  -0.118575
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 2
m3    40000.60c  -98.23
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.10
      28000.50c   -0.05
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c  c     m7 is Inconel 718
c  m7    5000.01c     -0.006
c        6000.50c      -0.08
c        13027.50c      -0.8
```

```
c        14000.50c     -0.35
c        22000.50c     -1.15
c        24000.50c       -21
c        25055.50c     -0.35
c        26000.55c   -11.164
c        27059.50c        -1
c        28000.50c       -55
c        29000.50c      -0.3
c        41093.50c      -5.5
c        42000.50c      -3.3
c  c     m8 is Inconel X750
c  m8    6000.50c   -0.08
c        13027.50c     -1
c        14000.50c   -0.5
c        22000.50c  -2.75
c        24000.50c    -15
c        25055.50c     -1
c        26000.55c     -7
c        27059.50c     -1
c        28000.50c    -70
c        29000.50c   -0.5
c        41093.50c   -1.2
c     m9 is Zircaloy 4
m9    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m10 is Neutrosorb poison plates
m10   5010.50c   -0.007069   $ B10 - reduced to 75%
      5011.50c   -0.000602   $ B11
      24000.50c  -0.190452   $ Cr
      25055.50c  -0.010024   $ Mn
      26000.55c  -0.656558   $ Fe
      28000.50c  -0.135295   $ Ni
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
mt4   lwtr.01t
```

```
MCNP Case: ifb870

BWR - GE8 - 4.25% - CTMT- 0.70 g/cc - Single Cask - 12 in Reflector
1     1 -10.741 -1       20 -21        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -.70000 1 -2 20 -21             u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   20 -21        u=1 imp:n=1 $ Zr2 Clad
4     4 -.70000  3 16 -17 18 -19 20 -21 u=1 imp:n=1 $ Moderator
444   3 -6.565 (-16:17:-18:19) 20 -21 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.741 -1       21 -23        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -.70000 1 -2 21 -23             u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   21 -23        u=1 imp:n=1 $ Zr2 Clad
8     4 -.70000  3 16 -17 18 -19 21 -23 u=1 imp:n=1 $ Moderator
888   3 -6.565 (-16:17:-18:19) 21 -23 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.741 -1       22 -20        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -.70000 1 -2 22 -20             u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   22 -20        u=1 imp:n=1 $ Zr2 Clad
12    4 -.70000  3 16 -17 18 -19 22 -20 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 22 -20 u=1 imp:n=1 $ Zr2 - Spacer
c     Plenum region - below fuel pins
13    4 -.70000 -2   24 -22        u=1 imp:n=1 $ H2O
14    3 -6.565  2 -3   24 -22        u=1 imp:n=1 $ Zr2 Clad
15    4 -.70000  3        24 -22        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -.70000 -2   23 -28        u=1 imp:n=1 $ H2O
17    3 -6.565  2 -3   23 -28        u=1 imp:n=1 $ Zr2 Clad
18    4 -.70000  3        23 -28        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  25 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate -below fuel pins
191   4 -.70000  -25                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  28 -29                u=1 imp:n=1 $ 304L SS in UTP
c     Water above Upper tie plate -above fuel pins
221   4 -.70000   29                    u=1 imp:n=1 $ Water
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2 trcl=(-0.8128 -0.8128 0)
                        fill=  -4:3 -4:3 0:0
          1 1 1 1 1 1 1 1          $ x=-4 to x=3:y=-4
          1 1 1 1 1 1 1 1          $ "         ";y=-3
          1 1 1 1 1 1 1 1          $ "         ";y=-2
          1 1 1 5 3 1 1 1          $ "         ";y=-1
          1 1 1 3 5 1 1 1          $ "         ":y=0
          1 1 1 1 1 1 1 1          $ "         ";y=1
          1 1 1 1 1 1 1 1          $ "         ";y=2
          1 1 1 1 1 1 1 1  imp:n=1 $ "         ";y=3
c     Water Rod
26    4 -.70000 -10      24 -28        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -28        u=3 imp:n=1 $ Zr2 Clad
28    4 -.70000 11 16 -17 18 -19 24 -28 u=3 imp:n=1 $ Moderator
29    9 -6.565 (-16:17:-18:19) 24 -28 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
30    6 -8.03            -24 25     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
31    4 -.70000  -25                    u=3 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
32    4 -.70000   29                    u=3 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
33    6 -8.03         28 -29        u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Rod converted to Water Rod
34    4 -.70000 -2       24 -28        u=5 imp:n=1 $ water inside tube
35    3 -6.565 2  -3  24 -28        u=5 imp:n=1 $ Zr2 Clad
36    4 -.70000 3  16 -17 18 -19 24 -28 u=5 imp:n=1 $ Moderator
37    9 -6.565 (-16:17:-18:19) 24 -28 u=5 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
```

```
38    6 -8.03              -24 25     u=5 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
39    4 -.70000  -25                    u=5 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
40    4 -.70000   29                    u=5 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
41    6 -8.03          28 -29        u=5 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
42    0 12 -13 14 -15 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and channel
c     and above UTP/below LTP.
c
43    4 -.70000 (41 -42 45 -46) (-12:13:-14:15) u=4 imp:n=1
c
c     Zr4 Channel
c
44    9 -6.565 (-41:42:-45:46) u=4 imp:n=1
c
c     Make a unit out of the FA, water gap, and guide channel
c
45    0  40 -43 44 -47 26 -27 fill=4 imp:n=1
c
c     Define the other 16 FAs
100   like 45 but trcl=101    imp:n=1  $ FA #1
101   like 45 but trcl=102    imp:n=1  $ FA #2
102   like 45 but trcl=103    imp:n=1  $ FA #3
103   like 45 but trcl=104    imp:n=1  $ FA #4
104   like 45 but trcl=105    imp:n=1  $ FA #5
105   like 45 but trcl=106    imp:n=1  $ FA #6
106   like 45 but trcl=107    imp:n=1  $ FA #7
107   like 45 but trcl=108    imp:n=1  $ FA #8
108   like 45 but trcl=109    imp:n=1  $ FA #10
109   like 45 but trcl=110    imp:n=1  $ FA #11
110   like 45 but trcl=111    imp:n=1  $ FA #12
111   like 45 but trcl=112    imp:n=1  $ FA #13
112   like 45 but trcl=113    imp:n=1  $ FA #14
113   like 45 but trcl=114    imp:n=1  $ FA #15
114   like 45 but trcl=115    imp:n=1  $ FA #16
115   like 45 but trcl=116    imp:n=1  $ FA #17
c
c     Define the 4 basket support rods
c
116   6 -8.03 -150 104 -125       imp:n=1  $ Upper left
117   6 -8.03 -151 104 -125       imp:n=1  $ Upper right
118   6 -8.03 -152 104 -125       imp:n=1  $ Lower left
119   6 -8.03 -153 104 -125       imp:n=1  $ Lower right
c
c    Define Boron Plate Cells - Bottom to top with steel in between
c    for spacer disc.  Note - B-10 loading reduced to 75%.
c
c    Bottom
200   6 -8.03  -106        u=7     imp:n=1 $ SS spacer disc 1
201  10 -7.739  106 -107   u=7     imp:n=1 $ Boron plate 1
202   6 -8.03   107 -108   u=7     imp:n=1 $ SS spacer disc 2
203  10 -7.739  108 -109   u=7     imp:n=1 $ Boron plate 2
204   6 -8.03   109 -110   u=7     imp:n=1 $ SS spacer disc 3
205  10 -7.739  110 -111   u=7     imp:n=1 $ Boron plate 3
206   6 -8.03   111 -112   u=7     imp:n=1 $ SS spacer disc 4
207  10 -7.739  112 -113   u=7     imp:n=1 $ Boron plate 4
208   6 -8.03   113 -114   u=7     imp:n=1 $ SS spacer disc 5
209  10 -7.739  114 -115   u=7     imp:n=1 $ Boron plate 5
210   6 -8.03   115 -116   u=7     imp:n=1 $ SS spacer disc 6
211  10 -7.739  116 -117   u=7     imp:n=1 $ Boron plate 6
212   6 -8.03   117 -118   u=7     imp:n=1 $ SS spacer disc 7
213  10 -7.739  118 -119   u=7     imp:n=1 $ Boron plate 7
214   6 -8.03   119 -120   u=7     imp:n=1 $ SS spacer disc 8
215  10 -7.739  120 -121   u=7     imp:n=1 $ Boron plate 8
216   6 -8.03   121 -122   u=7     imp:n=1 $ SS spacer disc 9
```

```
217  10 -7.739  122 -123  u=7     imp:n=1 $ Boron plate 9
218   6 -8.03   123       u=7     imp:n=1 $ Top spacer disc
c    Top
c
c    Long Horizontal Boron Plates
c
300   0  105 -124 200 -201 202 -203  trcl=1 fill=7 imp:n=1
301   like 300 but                   trcl=2 fill=7 imp:n=1
c
c    Short Horizontal Boron Plates
c
302   0  105 -124 204 -205 206 -207  trcl=3 fill=7 imp:n=1
303   like 302 but                   trcl=4 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
304   0  105 -124 208 -209 210 -211  trcl=5 fill=7 imp:n=1
305   like 304 but                   trcl=6 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
306   0  105 -124 212 -213 214 -215  trcl=7 fill=7 imp:n=1
307   like 306 but                   trcl=8 fill=7 imp:n=1
c    Define Cask Cells
c
400   6 -8.03 300 -301 104 -126 imp:n=1 $ 317 SS Inner Shell - Radial
401   6 -8.03 -301    103  -104 imp:n=1 $ 304 SS Inner Shell - Bottom
402   6 -8.03 -301    126  -127 imp:n=1 $ 317 SS Inner Shell - Top
403   11 -18.82 (-302 102 -103):(301 -302 103 -127):(-302 127 -128)
                 imp:n=1 $ Depleted U (union of bottom/side/top)
404   6 -8.03 (-303 101 -102):(302 -303 102 -128):(-303 128 -129)
            imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs/basket and inside Cask.
c
1000  4 -.70000 -300 70 104 -126 #100 #101 #102 #103 #104 #105 #116 #117
             #300 #302 #306 imp:n=1 $ Back half section
1001  4 -.70000 -300 -70 104 -126 #45 #106 #107 #108 #109 #110 #111
                  #112 #113 #114 #115       #118 #119
                  #301 #303 #304 #305 #307
                          imp:n=1 $ Front half section
c
c     Outside Cask.
c     5 cm  water reflector around cask
2000  4 -1.0 (100 -130 -304) (303:-101:129) imp:n=1
c     5 cm to 12 in water reflector around cask
2001  4 -1.0 ( 99 -131 -305) (304:-100:130) imp:n=1
c
2002  0  305:-99:131 imp:n=0

c
c     Fuel Cell
c
1     cz   0.52197    $ Fuel Pellet OR
2     cz   0.53213    $ Zr2 Clad IR
3     cz   0.61341    $ Zr2 Clad OR
c
c     Be sure to change translation on fill card for different lattice pitch
c
4     px  -0.81280    $ fuel rod cell boundary
5     px   0.81280    $ fuel rod cell boundary
6     py  -0.81280    $ fuel rod cell boundary
7     py   0.81280    $ fuel rod cell boundary
c
c     Water Rod
c
10    cz  0.67437   $ IR
11    cz  0.75057   $ OR
c
```

```
c     Fuel Lattice dimension
c
12    px  -6.5023 $ 1/2 Fuel lattice pitch
13    px   6.5023 $ 1/2 Fuel lattice pitch
14    py  -6.5023 $ 1/2 Fuel lattice pitch
15    py   6.5023 $ 1/2 Fuel lattice pitch
c
c     Zr grid inner pitch (calc using grid wgt & active fuel length)
c
16    px -0.810924  $ Zr grid cell boundary
17    px  0.810924  $ Zr grid cell boundary
18    py -0.810924  $ Zr grid cell boundary
19    py  0.810924  $ Zr grid cell boundary
c
c     Axial Blanket - [redacted] inches on top/bottom
c
20    pz [redacted]
21    pz [redacted]
c
c     Overall Fuel Height including blanket - 150. inches
c
22    pz -190.500
23    pz  190.500
c
c     Bottom endplug penetration "plenum" region = [redacted] in.
c     Bottom of axial blanket is this distance above top of LTP
c
24    pz [redacted]      $ Top of LTP
c
c     Smear mass over rectangle for now for LTP
25    pz -195.548      $ Bottom of LTP
c
c     Assembly length = [redacted] in
c
26    pz [redacted]     $ 1/2 length
27    pz [redacted]
c
c     Top plenum length ( [redacted]
c     Distance from top blanket to bottom of LTP
c
28    pz [redacted]
c
c    Upper Tie Plate - use FA lattice px/py
c
c     Smear mass over rectangle for now
c     Top of UTP
29    pz  216.059
c
c     Square Cell for Channel
c
40    px  -6.90626
41    px  -6.70306
42    px   6.70306
43    px   6.90626
44    py  -6.90626
45    py  -6.70306
46    py   6.70306
47    py   6.90626
c
70    py   8.65       $ Plane to split cask from front to back
c
c     Axial planes for the cask and the boron poison plates
c
99   pz    -270.396  $ 12" of water reflector - bottom
100  pz    -244.916  $ 5 cm   water reflector - bottom
101  pz    -239.916  $ 304 SST - 2"
102  pz    -234.836  $ Cast DU - 3"
103  pz    -227.216  $ 304 SST - 1"
104  pz    -224.676  $ bot fuel support (Assume bottom of channel is
```

```
105  pz    -214.084  $ Bot Disc 1        bottom of cavity)
106  pz    -209.004  $ Top Disc 1
107  pz    -158.153  $ Top PP   1
108  pz    -153.073  $ Top Disc 2
109  pz    -106.972  $ Top PP   2
110  pz    -101.892  $ Top Disc 3
111  pz     -55.7909 $ Top PP   3
112  pz     -50.7109 $ Top Disc 4
113  pz      -4.6099 $ Top PP   4
114  pz       0.4701 $ Top Disc 5
115  pz      46.5711 $ Top PP   5
116  pz      51.6511 $ Top Disc 6
117  pz      97.7521 $ Top PP   6
118  pz     102.8321 $ Top Disc 7
119  pz     148.9331 $ Top PP   7
120  pz     154.0131 $ Top Disc 8
121  pz     186.0425 $ Top PP   8
122  pz     191.1225 $ Top Disc 9
123  pz     210.6297 $ Top PP   9
124  pz     215.7097 $ Top Disc10
125  pz     230.6449 $ Top bask
126  pz     233.1595 $ Top of Cavity
127  pz     236.3345 $ 304 SST - 1.25"
128  pz     245.8595 $ Cast DU - 3.75"
129  pz     249.6695 $ 304 SST - 1.5"
130  pz     254.6695 $ 5 cm   water reflector
131  pz     280.1495 $ 12" of water reflector
c
c   3.03" Support Rods for Basket
c
150  c/z -22.5425  33.02     3.8481
151  c/z  22.5425  33.02     3.8481
152  c/z -22.5425 -33.02     3.8481
153  c/z  22.5425 -33.02     3.8481
c
c   Define Boron Plate Dimensions for x-y plane
c
c   Long Horizontal Plate
c
200  px -41.275  $ Left end
201  px  41.275  $ Right end
202  py -0.3175  $ Back  end
203  py  0.3175  $ Front end
c
c   Shorter Horizontal Plate
c
204  px -32.385  $ Left end
205  px  32.385  $ Right end
206  py -0.3175  $ Back  end
207  py  0.3175  $ Front end
c
c   Vertical Plate - adjacent to center FA
c
208  px -0.47625 $ Left end
209  px  0.47625 $ Right end
210  py -8.4200  $ Back  end
211  py  8.4200  $ Front end
c
c   Vertical Plate - below center FA
c
212  px -0.47625 $ Left end
213  px  0.47625 $ Right end
214  py -8.09625 $ Back  end
215  py  8.09625 $ Front end
c
c    Cask dimensions
c
c    Radial
300  cz    47.625   $ Inner Cavity -18.75"
```

```
301  cz    48.895    $ 317 SS inner - 0.5"
302  cz    59.055    $ Cast DU      - 4"
303  cz   63.0174    $ 317 SS outer -1.56"
304  cz   68.0174    $ 5 cm   water reflector
305  cz   93.4974    $ 12" of water reflector
1000 so 1000

c    Poison Plate translations
tr1      0   9.1694    0   $ Long Horizontal - Back
tr2      0  -9.1694    0   $ Long Horizontal - Front
tr3      0  26.87955   0   $ Short Horizontal - Back
tr4      0 -26.87955   0   $ Short Horizontal - Front
tr5     -8.59790  0    0   $ Vertical - adj to center FA - Left
tr6      8.59790  0    0   $ Vertical - adj to center FA - Right
tr7      0  18.3388    0   $ Vertical - 2nd row - Back
tr8      0 -18.3388    0   $ Vertical - 2nd row - Front
c     FA translations
tr101   -8.60552  35.4203   0   $ FA #1
tr102    8.60552  35.4203   0   $ FA #2
tr103  -25.81402  18.3388   0   $ FA #3
tr104   -8.60552  18.3388   0   $ FA #4
tr105    8.60552  18.3388   0   $ FA #5
tr106   25.81402  18.3388   0   $ FA #6
tr107   -34.4043   0        0   $ FA #7
tr108   -17.1958   0        0   $ FA #8
tr109    17.1958   0        0   $ FA #10
tr110    34.4043   0        0   $ FA #11
tr111  -25.81402 -18.3388   0   $ FA #12
tr112   -8.60552 -18.3388   0   $ FA #13
tr113    8.60552 -18.3388   0   $ FA #14
tr114   25.81402 -18.3388   0   $ FA #15
tr115   -8.60552 -35.4203   0   $ FA #16
tr116    8.60552 -35.4203   0   $ FA #17
mode n
kcode  3000 1 20 80 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.25 wt% U235
m1    92235.50c -0.037461
      92238.50c -0.843965
      8016.50c  -0.118575
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 2
m3    40000.60c  -98.23
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.10
      28000.50c   -0.05
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c  c     m7 is Inconel 718
c  m7    5000.01c     -0.006
c        6000.50c      -0.08
c        13027.50c      -0.8
```

```
c        14000.50c     -0.35
c        22000.50c     -1.15
c        24000.50c       -21
c        25055.50c     -0.35
c        26000.55c   -11.164
c        27059.50c        -1
c        28000.50c       -55
c        29000.50c      -0.3
c        41093.50c      -5.5
c        42000.50c      -3.3
c  c     m8 is Inconel X750
c  m8    6000.50c   -0.08
c        13027.50c     -1
c        14000.50c   -0.5
c        22000.50c  -2.75
c        24000.50c    -15
c        25055.50c     -1
c        26000.55c     -7
c        27059.50c     -1
c        28000.50c    -70
c        29000.50c   -0.5
c        41093.50c   -1.2
c     m9 is Zircaloy 4
m9    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m10 is Neutrosorb poison plates
m10   5010.50c   -0.007069   $ B10 - reduced to 75%
      5011.50c   -0.000602   $ B11
      24000.50c  -0.190452   $ Cr
      25055.50c  -0.010024   $ Mn
      26000.55c  -0.656558   $ Fe
      28000.50c  -0.135295   $ Ni
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
mt4   lwtr.01t
```

MCNP Case: bsi8i17b

```
GE8 - 4.25%  CTMT- 1.0 g/cc,INTRSP- 0.7 g/cc - Inf Hex - 6 cm - Shifted In
1     1 -10.741 -1       20 -21        u=1 imp:n=1 $ Enriched uo2 fuel
2     4 -1.0 1 -2 20 -21             u=1 imp:n=1 $ gap - H2O
3     3 -6.565  2 -3   20 -21        u=1 imp:n=1 $ Zr2 Clad
4     4 -1.0  3 16 -17 18 -19 20 -21 u=1 imp:n=1 $ Moderator
444   3 -6.565 (-16:17:-18:19) 20 -21 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Top
5     5 -10.741 -1       21 -23        u=1 imp:n=1 $ Natural uo2 fuel
6     4 -1.0 1 -2 21 -23             u=1 imp:n=1 $ gap - H2O
7     3 -6.565  2 -3   21 -23        u=1 imp:n=1 $ Zr2 Clad
8     4 -1.0  3 16 -17 18 -19 21 -23 u=1 imp:n=1 $ Moderator
888   3 -6.565 (-16:17:-18:19) 21 -23 u=1 imp:n=1 $ Zr2 - Spacer
c     Natural Uranium blanket - Bottom
9     5 -10.741 -1       22 -20        u=1 imp:n=1 $ Natural uo2 fuel
10    4 -1.0 1 -2 22 -20             u=1 imp:n=1 $ gap - H2O
11    3 -6.565  2 -3   22 -20        u=1 imp:n=1 $ Zr2 Clad
12    4 -1.0  3 16 -17 18 -19 22 -20 u=1 imp:n=1 $ Moderator
121   3 -6.565 (-16:17:-18:19) 22 -20 u=1 imp:n=1 $ Zr2 - Spacer
c     Plenum region - below fuel pins
13    4 -1.0 -2   24 -22        u=1 imp:n=1 $ H2O
14    3 -6.565  2 -3   24 -22        u=1 imp:n=1 $ Zr2 Clad
15    4 -1.0  3        24 -22        u=1 imp:n=1 $ Moderator
c     Plenum region - above fuel pins
16    4 -1.0 -2   23 -28        u=1 imp:n=1 $ H2O
17    3 -6.565  2 -3   23 -28        u=1 imp:n=1 $ Zr2 Clad
18    4 -1.0  3        23 -28        u=1 imp:n=1 $ Moderator
c     Rest of Lower tie plate - below fuel pins
19    6 -8.03  25 -24                u=1 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate -below fuel pins
191   4 -1.0  -25                    u=1 imp:n=1 $ Water
c     Rest of Upper tie plate - above fuel pins
20    6 -8.03  28 -29                u=1 imp:n=1 $ 304L SS in UTP
c     Water above Upper tie plate -above fuel pins
221   4 -1.0   29                    u=1 imp:n=1 $ Water
c     Lattice of Cells - Top of water above UTP to water below LTP
25    0 4 -5 6 -7  lat=1 u=2 trcl=(-0.8128 -0.8128 0)
                        fill=  -4:3 -4:3 0:0
          1 1 1 1 1 1 1 1          $ x=-4 to x=3:y=-4
          1 1 1 1 1 1 1 1          $ "         ";y=-3
          1 1 1 1 1 1 1 1          $ "         ";y=-2
          1 1 1 5 3 1 1 1          $ "         ";y=-1
          1 1 1 3 5 1 1 1          $ "         ":y=0
          1 1 1 1 1 1 1 1          $ "         ";y=1
          1 1 1 1 1 1 1 1          $ "         ";y=2
          1 1 1 1 1 1 1 1  imp:n=1 $ "         ";y=3
c     Water Rod
26    4 -1.0 -10      24 -28        u=3 imp:n=1 $ water inside tube
27    3 -6.565 10 -11 24 -28        u=3 imp:n=1 $ Zr2 Clad
28    4 -1.0 11 16 -17 18 -19 24 -28 u=3 imp:n=1 $ Moderator
29    9 -6.565 (-16:17:-18:19) 24 -28 u=3 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
30    6 -8.03            -24 25     u=3 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
31    4 -1.0  -25                    u=3 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
32    4 -1.0   29                    u=3 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
33    6 -8.03         28 -29        u=3 imp:n=1 $ 304L SS in UTP
c     Fuel Rod converted to Water Rod
34    4 -1.0 -2       24 -28        u=5 imp:n=1 $ water inside tube
35    3 -6.565 2  -3  24 -28        u=5 imp:n=1 $ Zr2 Clad
36    4 -1.0 3  16 -17 18 -19 24 -28 u=5 imp:n=1 $ Moderator
37    9 -6.565 (-16:17:-18:19) 24 -28 u=5 imp:n=1 $ Zr4 - Spacer
c     Lower Tie Plate - model as solid rectangular plate.
c     Water Rod
```

```
38    6 -8.03              -24 25     u=5 imp:n=1 $ 304L SS in LTP
c     Water below Lower tie plate/above FA bottom -below water rods
39    4 -1.0  -25                     u=5 imp:n=1 $ Water
c     Water above Upper tie plate/above FA Top -above water rods
40    4 -1.0   29                     u=5 imp:n=1 $ Water
c     Upper Tie Plate - model as solid rectangular plate.
41    6 -8.03          28 -29        u=5 imp:n=1 $ 304L SS in UTP
c     Fuel Assembly
42    0 12 -13 14 -15 u=4 fill=2 imp:n=1
c
c     Water Gap between fuel assembly and channel
c     and above UTP/below LTP.
c
43    4 -1.0 (41 -42 45 -46) (-12:13:-14:15) u=4 imp:n=1
c
c     Zr4 Channel
c
44    9 -6.565 (-41:42:-45:46) u=4 imp:n=1
c
c     Make a unit out of the FA, water gap, and guide channel
c
45    0  40 -43 44 -47 26 -27 fill=4 imp:n=1
c
c     Define the other 16 FAs
100   like 45 but trcl=101    imp:n=1  $ FA #1
101   like 45 but trcl=102    imp:n=1  $ FA #2
102   like 45 but trcl=103    imp:n=1  $ FA #3
103   like 45 but trcl=104    imp:n=1  $ FA #4
104   like 45 but trcl=105    imp:n=1  $ FA #5
105   like 45 but trcl=106    imp:n=1  $ FA #6
106   like 45 but trcl=107    imp:n=1  $ FA #7
107   like 45 but trcl=108    imp:n=1  $ FA #8
108   like 45 but trcl=109    imp:n=1  $ FA #10
109   like 45 but trcl=110    imp:n=1  $ FA #11
110   like 45 but trcl=111    imp:n=1  $ FA #12
111   like 45 but trcl=112    imp:n=1  $ FA #13
112   like 45 but trcl=113    imp:n=1  $ FA #14
113   like 45 but trcl=114    imp:n=1  $ FA #15
114   like 45 but trcl=115    imp:n=1  $ FA #16
115   like 45 but trcl=116    imp:n=1  $ FA #17
c
c     Define the 4 basket support rods
c
116   6 -8.03 -150 104 -125       imp:n=1  $ Upper left
117   6 -8.03 -151 104 -125       imp:n=1  $ Upper right
118   6 -8.03 -152 104 -125       imp:n=1  $ Lower left
119   6 -8.03 -153 104 -125       imp:n=1  $ Lower right
c
c    Define Boron Plate Cells - Bottom to top with steel in between
c    for spacer disc.  Note - B-10 loading reduced to 75%.
c
c    Bottom
200   6 -8.03  -106       u=7     imp:n=1 $ SS spacer disc 1
201  10 -7.739  106 -107  u=7     imp:n=1 $ Boron plate 1
202   6 -8.03   107 -108  u=7     imp:n=1 $ SS spacer disc 2
203  10 -7.739  108 -109  u=7     imp:n=1 $ Boron plate 2
204   6 -8.03   109 -110  u=7     imp:n=1 $ SS spacer disc 3
205  10 -7.739  110 -111  u=7     imp:n=1 $ Boron plate 3
206   6 -8.03   111 -112  u=7     imp:n=1 $ SS spacer disc 4
207  10 -7.739  112 -113  u=7     imp:n=1 $ Boron plate 4
208   6 -8.03   113 -114  u=7     imp:n=1 $ SS spacer disc 5
209  10 -7.739  114 -115  u=7     imp:n=1 $ Boron plate 5
210   6 -8.03   115 -116  u=7     imp:n=1 $ SS spacer disc 6
211  10 -7.739  116 -117  u=7     imp:n=1 $ Boron plate 6
212   6 -8.03   117 -118  u=7     imp:n=1 $ SS spacer disc 7
213  10 -7.739  118 -119  u=7     imp:n=1 $ Boron plate 7
214   6 -8.03   119 -120  u=7     imp:n=1 $ SS spacer disc 8
215  10 -7.739  120 -121  u=7     imp:n=1 $ Boron plate 8
216   6 -8.03   121 -122  u=7     imp:n=1 $ SS spacer disc 9
```

```
217  10 -7.739  122 -123  u=7     imp:n=1 $ Boron plate 9
218   6 -8.03   123       u=7     imp:n=1 $ Top spacer disc
c    Top
c
c    Long Horizontal Boron Plates
c
300   0  105 -124 200 -201 202 -203  trcl=1 fill=7 imp:n=1
301   like 300 but                   trcl=2 fill=7 imp:n=1
c
c    Short Horizontal Boron Plates
c
302   0  105 -124 204 -205 206 -207  trcl=3 fill=7 imp:n=1
303   like 302 but                   trcl=4 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
304   0  105 -124 208 -209 210 -211  trcl=5 fill=7 imp:n=1
305   like 304 but                   trcl=6 fill=7 imp:n=1
c
c    Vertical Boron Plates - next to center FA
c
306   0  105 -124 212 -213 214 -215  trcl=7 fill=7 imp:n=1
307   like 306 but                   trcl=8 fill=7 imp:n=1
c    Define Cask Cells
c
400   6 -8.03 300 -301 104 -126 imp:n=1 $ 317 SS Inner Shell - Radial
401   6 -8.03 -301    103  -104 imp:n=1 $ 304 SS Inner Shell - Bottom
402   6 -8.03 -301    126  -127 imp:n=1 $ 317 SS Inner Shell - Top
403  11 -18.82 (-302 102 -103):(301 -302 103 -127):(-302 127 -128)
                imp:n=1 $ Depleted U (union of bottom/side/top)
404   6 -8.03 (-303 101 -102):(302 -303 102 -128):(-303 128 -129)
             imp:n=1 $ 304 SST outer shell (union of bottom/side/top)
c
c     Water outside FAs/basket and inside Cask.
c
1000  4 -1.0 -300 70 104 -126 #100 #101 #102 #103 #104 #105 #116 #117
              #300 #302 #306 imp:n=1 $ Back half section
1001  4 -1.0 -300 -70 104 -126 #45 #106 #107 #108 #109 #110 #111
                   #112 #113 #114 #115       #118 #119
                   #301 #303 #304 #305 #307
                           imp:n=1 $ Front half section
c
c     Outside Cask.
c     Water around cask
2000  4 -0.7 (-50 51 -52 53 -54 55 56 -57) (303:-101:129) imp:n=1
c
2001  0      (50:-51:52:-53:54:-55:-56:57)  imp:n=1

c
c     Fuel Cell
c
1     cz   0.52197    $ Fuel Pellet OR
2     cz   0.53213    $ Zr2 Clad IR
3     cz   0.61341    $ Zr2 Clad OR
c
c     Be sure to change translation on fill card for different lattice pitch
c
4     px  -0.81280    $ fuel rod cell boundary
5     px   0.81280    $ fuel rod cell boundary
6     py  -0.81280    $ fuel rod cell boundary
7     py   0.81280    $ fuel rod cell boundary
c
c     Water Rod
c
10    cz  0.67437   $ IR
11    cz  0.75057   $ OR
c
c     Fuel Lattice dimension
c
```

```
12    px  -6.5023 $ 1/2 Fuel lattice pitch
13    px   6.5023 $ 1/2 Fuel lattice pitch
14    py  -6.5023 $ 1/2 Fuel lattice pitch
15    py   6.5023 $ 1/2 Fuel lattice pitch
c
c     Zr grid inner pitch (calc using grid wgt & active fuel length)
c
16    px -0.810924  $ Zr grid cell boundary
17    px  0.810924  $ Zr grid cell boundary
18    py -0.810924  $ Zr grid cell boundary
19    py  0.810924  $ Zr grid cell boundary
c
c     Axial Blanket - [redacted] inches on top/bottom
c
20    pz [redacted]
21    pz [redacted]
c
c     Overall Fuel Height including blanket - 150. inches
c
22    pz -190.500
23    pz  190.500
c
c     Bottom endplug penetration "plenum" region = [redacted] in.
c     Bottom of axial blanket is this distance above top of LTP
c
24    pz [redacted]      $ Top of LTP
c
c     Smear mass over rectangle for now for LTP
25    pz -195.548      $ Bottom of LTP
c
c     Assembly length = [redacted] in
c
26    pz [redacted]      $ 1/2 length
27    pz [redacted]
c
c     Top plenum length ( [redacted]
c     Distance from top blanket to bottom of LTP
c
28    pz [redacted]
c
c    Upper Tie Plate - use FA lattice px/py
c
c     Smear mass over rectangle for now
c     Top of UTP
29    pz  216.059
c
c     Square Cell for Channel
c
40    px  -6.90626
41    px  -6.70306
42    px   6.70306
43    px   6.90626
44    py  -6.90626
45    py  -6.70306
46    py   6.70306
47    py   6.90626
c
c     Hexagonal Cell Surrounding Cask for Infinite array
c
c       inner hex surfaces bounding lattice, (n-0.5)*p*cos30
*50   p    0.8660254   -0.5   0.0     66.000
*51   p    0.8660254   -0.5   0.0    -66.000
*52   p    0.8660254    0.5   0.0     66.000
*53   p    0.8660254    0.5   0.0    -66.000
*54   py   66.000
*55   py  -66.000
*56    pz   -243.000
*57    pz    253.000
c
```

```
70    py   8.65        $ Plane to split cask from front to back
c
c     Axial planes for the cask and the boron poison plates
c
101  pz    -239.916  $ 304 SST - 2"
102  pz    -234.836  $ Cast DU - 3"
103  pz    -227.216  $ 304 SST - 1"
104  pz    -224.676  $ bot fuel support (Assume bottom of channel is
105  pz    -214.084  $ Bot Disc 1        bottom of cavity)
106  pz    -209.004  $ Top Disc 1
107  pz    -158.153  $ Top PP   1
108  pz    -153.073  $ Top Disc 2
109  pz    -106.972  $ Top PP   2
110  pz    -101.892  $ Top Disc 3
111  pz     -55.7909 $ Top PP   3
112  pz     -50.7109 $ Top Disc 4
113  pz      -4.6099 $ Top PP   4
114  pz       0.4701 $ Top Disc 5
115  pz      46.5711 $ Top PP   5
116  pz      51.6511 $ Top Disc 6
117  pz      97.7521 $ Top PP   6
118  pz     102.8321 $ Top Disc 7
119  pz     148.9331 $ Top PP   7
120  pz     154.0131 $ Top Disc 8
121  pz     186.0425 $ Top PP   8
122  pz     191.1225 $ Top Disc 9
123  pz     210.6297 $ Top PP   9
124  pz     215.7097 $ Top Disc10
125  pz     230.6449 $ Top bask
126  pz     233.1595 $ Top of Cavity
127  pz     236.3345 $ 304 SST - 1.25"
128  pz     245.8595 $ Cast DU - 3.75"
129  pz     249.6695 $ 304 SST - 1.5"
c
c   3.03" Support Rods for Basket
c
150  c/z -22.5425  33.02     3.8481
151  c/z  22.5425  33.02     3.8481
152  c/z -22.5425 -33.02     3.8481
153  c/z  22.5425 -33.02     3.8481
c
c   Define Boron Plate Dimensions for x-y plane
c
c   Long Horizontal Plate
c
200  px -41.275  $ Left end
201  px  41.275  $ Right end
202  py -0.3175  $ Back  end
203  py  0.3175  $ Front end
c
c   Shorter Horizontal Plate
c
204  px -32.385  $ Left end
205  px  32.385  $ Right end
206  py -0.3175  $ Back  end
207  py  0.3175  $ Front end
c
c   Vertical Plate - adjacent to center FA
c
208  px -0.47625 $ Left end
209  px  0.47625 $ Right end
210  py -8.4200  $ Back  end
211  py  8.4200  $ Front end
c
c   Vertical Plate - below center FA
c
212  px -0.47625 $ Left end
213  px  0.47625 $ Right end
214  py -8.09625 $ Back  end
```

```
215  py  8.09625 $ Front end
c
c    Cask dimensions
c
c    Radial
300  cz    47.625   $ Inner Cavity -18.75"
301  cz    48.895   $ 317 SS inner - 0.5"
302  cz    59.055   $ Cast DU      - 4"
303  cz   63.0174   $ 317 SS outer -1.56"

c    Poison Plate translations
tr1      0   9.1694    0   $ Long Horizontal - Back
tr2      0  -9.1694    0   $ Long Horizontal - Front
tr3      0  26.87955   0   $ Short Horizontal - Back
tr4      0 -26.87955   0   $ Short Horizontal - Front
tr5     -8.59790  0    0   $ Vertical - adj to center FA - Left
tr6      8.59790  0    0   $ Vertical - adj to center FA - Right
tr7      0  18.3388    0   $ Vertical - 2nd row - Back
tr8      0 -18.3388    0   $ Vertical - 2nd row - Front
c     FA translations - Shifted inward
tr101   -7.92552     34.7403   0   $ FA #1
tr102    7.92552     34.7403   0   $ FA #2
tr103  -25.13402     17.6588   0   $ FA #3
tr104   -7.92552     17.6588   0   $ FA #4
tr105    7.92552     17.6588   0   $ FA #5
tr106   25.13402     17.6588   0   $ FA #6
tr107  -33.7243        0       0   $ FA #7
tr108  -16.5158        0       0   $ FA #8
tr109   16.5158        0       0   $ FA #10
tr110   33.7243        0       0   $ FA #11
tr111  -25.13402    -17.6588   0   $ FA #12
tr112   -7.92552    -17.6588   0   $ FA #13
tr113    7.92552    -17.6588   0   $ FA #14
tr114   25.13402    -17.6588   0   $ FA #15
tr115   -7.92552    -34.7403   0   $ FA #16
tr116    7.92552    -34.7403   0   $ FA #17
mode n
kcode  3000 1 30 200 50000
print -128
prdmp j -120 j 3
c     m1 is UO2 fuel - Enriched to 4.25 wt% U235
m1    92235.50c -0.037461
      92238.50c -0.843965
      8016.50c  -0.118575
c     m2 is He
m2    2004.50c -1.0
c     m3 is Zircaloy 2
m3    40000.60c  -98.23
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.10
      28000.50c   -0.05
      50000.35c   -1.40
c     m4 is water
m4    1001.50c 0.666700 8016.50c 0.333300
c     m5 is Natural UO2 blanket fuel - 0.72 wt% U235
m5    92235.50c -0.0062672
      92238.50c -0.875206
      8016.50c  -0.118528
c     m6 is 304L SS
m6    6000.50c     -0.03
      14000.50c       -1
      15031.50c   -0.045
      16032.50c    -0.03
      24000.50c      -20
      25055.50c       -2
      26000.55c  -64.895
      28000.50c      -12
c  c     m7 is Inconel 718
```

```
c  m7    5000.01c     -0.006
c        6000.50c      -0.08
c        13027.50c      -0.8
c        14000.50c     -0.35
c        22000.50c     -1.15
c        24000.50c       -21
c        25055.50c     -0.35
c        26000.55c   -11.164
c        27059.50c        -1
c        28000.50c       -55
c        29000.50c      -0.3
c        41093.50c      -5.5
c        42000.50c      -3.3
c  c     m8 is Inconel X750
c  m8    6000.50c   -0.08
c        13027.50c     -1
c        14000.50c   -0.5
c        22000.50c  -2.75
c        24000.50c    -15
c        25055.50c     -1
c        26000.55c     -7
c        27059.50c     -1
c        28000.50c    -70
c        29000.50c   -0.5
c        41093.50c   -1.2
c     m9 is Zircaloy 4
m9    40000.60c  -98.18
      8016.50c    -0.12
      24000.50c   -0.10
      26000.55c   -0.20
      50000.35c   -1.40
c     m10 is Neutrosorb poison plates
m10   5010.50c   -0.007069   $ B10 - reduced to 75%
      5011.50c   -0.000602   $ B11
      24000.50c  -0.190452   $ Cr
      25055.50c  -0.010024   $ Mn
      26000.55c  -0.656558   $ Fe
      28000.50c  -0.135295   $ Ni
c     m11 is Depleted Uranium
m11   92235.50c 0.000106128
      92238.50c 0.0475275
c     m12 is Air
m12   7014.50c -0.765
      8016.50c -0.235
mt4   lwtr.01t
```

D-7.0 CONCLUSIONS

D-7.1 SPC PWR Fuel from Robinson

Table D-7.1-1 summarizes the comparisons of the key evaluation parameters for the analysis-basis fuel versus the SPC PWR fuel with a higher burnup and enrichment. Tables D-7.1-2 and D-7.1-3 compare the NCT and HAC dose rates for the current licensed design against the estimated values for the IF-300 cask loaded with 6 SPC PWR fuel assemblies. These results demonstrate that the SPC PWR fuel from Robinson with a burnup of 50 GWD/MTU, and a cooling time of 5 years can be safely transported in the IF-300 shipping cask. A six fuel assembly loading containing any combination of SPC PWR fuel from Robinson with a burnup of 50 GWD/MTU, an initial enrichment between 3.45 and 4.65 wt% ^{235}U, and a cooling time of 5 years, and/or the analysis-basis fuel assemblies will not exceed any of the values that form the basis for the current IF-300 shipping cask C of C considering heat load, shielding, and releases from the cask. The higher burnup of these assemblies, when combined with longer cooling times and lower initial uranium loading, results in all parameters, with the exception of the total neutron source strength, being equal to or less than the currently approved operating envelope of the IF-300 shipping cask. Although the neutron dose rates are higher than the analysis-basis values, the total neutron plus gamma dose rates are below the 10 CFR 71 limits and satisfy the limits stated in the existing C of C. Section 6.0 demonstrates that the If-300 cask loaded with six 4.65 wt% ^{235}U SPC PWR fuel assemblies in the peripheral basket locations satisfies all of the criticality safety criteria contained in 10 CFR 71.

Table D-7.1-1

Comparison of Key Evaluation Parameters for SPC 15x15 PWR Fuel With an Exposure of 50 GWD/MTU and a 5 Year Cooling Time and the Analysis-Basis Values

PARAMETER	ANALYSIS BASIS	SIX SPC PWR FAS	MARGIN, %
NEUTRON SOURCE (NEUTRON/S/CASK)	1.87E+09	4.08E+09	-218
GAMMA SOURCE (GAMMA/S/CASK)	7.90E+16	5.54E+16	30
DECAY HEAT (BTU/H/CASK)	40,000	28,608	28
RELEASABLE ^{85}KR (Ci/CASK)	13,086	9,216	30
RELEASABLE CRUD (Ci/CASK)	7,518	2,970	60
TOTAL RELEASABLE RESIDUAL FISSION PRODUCT MOLES	0.5	0.31	38
	(Ci OF ^{60}CO/KG COBALT)	(Ci OF ^{60}CO/KG COBALT)	
HARDWARE ACTIVATION	1.42E+04	1.33E+04	6

Table D-7.1-2

Estimate of NCT 2 meter Dose Rates for SPC 15x15 PWR Fuel With an Exposure of 50 GWD/MTU and a 5 Year Cooling Time

LOCATION	CURRENT LICENSED DESIGN, mrem/h			SPC PWR FUEL WITH 50 GWD/MTU		
	GAMMA	NEUTRON	TOTAL	GAMMA[1]	NEUTRON[2]	TOTAL
TOP AXIAL CL	2.82	1.80	4.62	2.82	4.59	7.41
BOTTOM AXIAL CL	0.95	2.97	3.92	0.95	7.57	8.52
RADIAL CL	2.33	0.71	3.04	2.33	1.81	4.14
TOP NOZZLE	8.5	0.92	9.42	NA	NA	<10
10 CFR 71 LIMIT	NA	NA	10	NA	NA	10

[1] As documented in Table D-7.1-1, the gamma dose source terms and hence the dose rates are lower for 5 year cooled 50 GWD/MTU burnup fuel, hence the same values are conservatively used.

[2] Estimated neutron dose rate conservatively based on 2.55 times CSAR neutron dose rate per Section D-5.1-2.

Table D-7.1-3

Estimate of 1 meter Accident Condition Dose Rates for SPC 15x15 PWR Fuel With an Exposure of 50 GWD/MTU and a 5 Year Cooling Time

LOCATION	CURRENT LICENSED DESIGN (CSAR 1995), mrem/h			SPC PWR FUEL WITH 50 GWD/MTU mrem/h		
	GAMMA	NEUTRON	TOTAL	GAMMA[1]	NEUTRON[2]	TOTAL
RADIAL CL	18.10	163.06	181.16	18.10	415.80	433.90
10 CFR 71 LIMIT	NA	NA	1000	NA	NA	1000

[1] As documented in Table D-7.1-1, the gamma dose source terms and hence the dose rates are lower for 5 year cooled 50 GWD/MTU burnup fuel, hence the same values are conservatively used.

[2] Estimated neutron dose rate conservatively based on 2.55 times CSAR neutron dose rate per Section D-5.1-2.

D-7.2 GE BWR Fuel from Brunswick

Table D-7.2-1 summarizes the comparisons of the key evaluation parameters for the analysis-basis fuel versus the GE BWR fuel with a higher burnup and enrichment. Tables D-7.2-2 and D-7.2-3 compare the

NCT and HAC dose rates for the current licensed design against the estimated values for the IF-300 cask loaded with 17 GE BWR fuel assemblies. These results demonstrate that the GE BWR fuel from Brunswick with a burnup of 45 GWD/MTU, and a cooling time of 4 years can be safely transported in the IF-300 shipping cask. A seventeen fuel assembly loading containing any combination of GE BWR fuel from Brunswick with a burnup of 45 GWD/MTU, an initial enrichment between 3.19 and 4.25 wt% ^{235}U, and a cooling time of 4 years, and/or the analysis-basis fuel assemblies will not exceed any of the values that form the basis for the current IF-300 shipping cask C of C considering heat load, shielding, and releases from the cask. The higher burnup of these assemblies, when combined with longer cooling times and lower initial uranium loading, results in all parameters, with the exception of the total neutron source strength, being equal to or less than the currently approved operating envelope of the IF-300 shipping cask. Although the neutron dose rates are higher than the analysis-basis values, the total neutron plus gamma dose rates are below the 10 CFR 71 limits and satisfy the limits stated in the existing C of C. Section 6.0 demonstrates that the If-300 cask loaded with seventeen 4.25 wt% ^{235}U GE BWR fuel assemblies satisfies all of the criticality safety criteria in 10 CFR 71.

Table D-7.2-1

Comparison of Key Evaluation Parameters for BWR Fuel With an Exposure of 45 GWD/MTU and a 4 Year Cooling Time and the Analysis-Basis Values

PARAMETER	ANALYSIS BASIS	SEVENTEEN BWR FAS	MARGIN, %
NEUTRON SOURCE (NEUTRON/S/CASK)	1.87E+09	5.02E+09	-268
GAMMA SOURCE (GAMMA/S/CASK)	7.90E+16	7.06E+16	11
DECAY HEAT (BTU/H/CASK)	40,000	36,091	10
RELEASABLE ^{85}KR (Ci/CASK)	13,086	9,928	24
RELEASABLE CRUD (Ci/CASK)	7,518	3,689	51
TOTAL RELEASABLE RESIDUAL FISSION PRODUCT MOLES	0.5	0.35	30
	(Ci of ^{60}Co/kg Cobalt)	(Ci of ^{60}Co/kg Cobalt)	
HARDWARE ACTIVATION	1.31E+04	1.29E+04	1.5

Table D-7.2-2

Estimate of 2 meter Dose Rates for BWR Fuel With an Exposure of 45 GWD/MTU and a 4 Year Cooling Time

LOCATION	CURRENT LICENSED DESIGN, mrem/h			BWR FUEL WITH 45 GWD/MTU		
	GAMMA	NEUTRON	TOTAL	GAMMA[1]	NEUTRON[2]	TOTAL
TOP AXIAL CL	2.82	1.80	4.62	2.82	4.82	7.64
BOTTOM AXIAL CL	0.95	2.97	3.92	0.95	7.96	8.91
RADIAL CL	2.33	0.71	3.04	2.33	1.90	4.23
TOP NOZZLE	8.5	0.92	9.42	NA	NA	<10
10 CFR 71 LIMIT	NA	NA	10	NA	NA	10

[1] As documented in Table D-7.2-1, the gamma dose source terms and hence the dose rates are lower for 4 year cooled 45 GWD/MTU burnup fuel, hence the same values are conservatively used.

[2] Estimated neutron dose rate based on 2.68 times CSAR neutron dose rate per Section D-5.2-2.

Table D-7.2-3

Estimate of 1 meter Accident Condition Dose Rates for BWR Fuel With an Exposure of 45 GWD/MTU and a 4 Year Cooling Time

LOCATION	CURRENT LICENSED DESIGN (CSAR 1995), mrem/h			BWR FUEL WITH 45 GWD/MTU mrem/h		
	GAMMA	NEUTRON	TOTAL	GAMMA[1]	NEUTRON[2]	TOTAL
RADIAL CL	18.10	163.06	181.16	18.10	437.00	455.10
10 CFR 71 LIMIT	NA	NA	1000	NA	NA	1000

[1] As documented in Table D-7.2-1, the gamma dose source terms and hence the dose rates are lower for 4 year cooled 45 GWD/MTU burnup fuel, hence the same values are conservatively used.

[2] Estimated neutron dose rate based on 2.68 times CSAR neutron dose rate per Section D-5.2-2.

D-8.0 REFERENCES

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D-9.1 - Appendix - ORIGEN2 FILES FOR PWR FUEL

ORIGEN2 File: SPC PWR Fuel - 4.65 wt% ^{235}U for 50 GWD/MTU - Maximum Enrichment

```
-1

-1

-1
RDA      ##########################################################
RDA      ##   IF300 HIGH BURNUP/ENRICHMENT PWR FUEL              ##
RDA      ##   Input Filename: PWR465UE          ORIGEN2 VER2.1   ##
RDA      ##   Creation Date:        1/05/99                      ##
RDA      ##   Fuel Type:          4.65% W 15X15 ANF PWR          ##
RDA      ##   Burnup:50000 MWd/MTIHM, SP.POWER = 40MW/MTU        ##
RDA      ##   Cycle Burnup: 17.5, 17.5, 15K,  PWRUE  xsect lib ##
RDA      ##   CPL-WEIGHT,IRR HISTORY,FLX FACT=DOE/RW 0184,RV1  ##
RDA      ##########################################################
LIP      0  0  0
LIB      0 1 2 3      604      605      606   9  0  0  1  39
PHO      101  102  103  10
RDA     READ UNIT AMOUNTS OF FUEL AND FUEL ASSEMBLY MATERIALS
RDA     -1 = FRESH PWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA     -2 = FRESH ZIRCALOY COMPOSITION (1 KG)
RDA     -3 = FRESH SS 304 COMPOSITION (1 KG)
RDA     -4 = FRESH INCONEL-X750 COMPOSITION (1 KG)
RDA     -5 = FRESH INCONEL-718 COMPOSITION (1 KG)
TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL MAT'LS
RDA     READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP     -1   1  -1  -1  1  1
RDA     READ ZIRCALOY COMPOSITION (1.0 KG)
INP     -2   1  -1  -1  1  1
RDA     READ SS304 COMPOSITION (1.0 KG)
INP     -3   1  -1  -1  1  1
RDA     READ INCONEL X750 COMPOSITION (1.0 KG)
INP     -4   1  -1  -1  1  1
RDA     READ INCONEL 718 COMPOSITION (1.0 KG)
INP     -5   1  -1  -1  1  1
RDA      MIX TOP, PLENUM, IN-CORE, AND BOTTOM MIXTURES
RDA      MIX TOP ZONE
MOV            -3        1        0    6.381  SS304
ADD            -4        1        0    0.024  INCONEL-X750
ADD            -5        1        0    0.672  INCONEL-718
RDA      MIX PLENUM ZONE
MOV            -4        2        0    3.019  INCONEL-X750
ADD            -2        2        0    7.551  ZIRCALOY-4
RDA      MIX IN-CORE ZONE WITHOUT UO2
MOV            -5        3        0    0.112  INCONEL-718
ADD            -2        3        0   133.927 ZIRCALOY-4
RDA      MIX BOTTOM ZONE
MOV            -3        4        0    4.459  SS304
RDA      MOVE MIXTURES INTO SCRATCH VECTORS
MOV            -1       -5        0      1.0  IN CORE U ONLY
MOV             1       -1        0      1.0  TOP ZONE
MOV             2       -2        0      1.0  PLENUM ZONE
MOV             3       -3        0      1.0  INCORE W/O UO2
MOV             4       -4        0      1.0  BOTTOM NOZZLE
RDA     IRRADIATION OF ONE METRIC TON OF PWRU FUEL AT 100% POWER
BUP
IRP    75        40.0  -5   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRP    150       40.0   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRP    225       40.0   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRP    300       40.0   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRP    375       40.0   4   5   4  0   BURNUP=15,000 MWD/MTIHM
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IRP    437.5     40.0   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRP    618.5     40.0   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRP    693.5     40.0   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRP    768.5     40.0   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRP    843.5     40.0   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRP    918.5     40.0  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRP    981       40.0  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRP    1162      40.0  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRP    1237      40.0   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRP    1312      40.0   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRP    1387      40.0   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRP    1462      40.0   4   5   4   0   BURNUP=50,000 MWD/MTIHM
BUP
RDA    -5  = IRRADIATED UO2 FUEL AT DISCHARGE
MOV       5   -5      0      [redacted]
RDA
RDA     IRRADIATION OF INCORE MATERIAL WITHOUT UO2 AT 100% FLUX
IRF    75.0      -1.0  -3   1   4   2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -1.0   1   2   4   0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -1.0   2   3   4   0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -1.0   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRF    375       -1.0   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -1.0   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRF    618.5     -1.0   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -1.0   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -1.0   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -1.0   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -1.0  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRF    981       -1.0  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRF    1162      -1.0  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -1.0   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -1.0   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -1.0   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRF    1462      -1.0   4  -3   4   0   BURNUP=50,000 MWD/MTIHM
RDA
RDA    -3 = IRRADIATED INCORE MATERIAL WITHOUT UO2
RDA
RDA     IRRADIATION OF TOP NOZZLE MATERIAL AT 10% FLUX
RDA
IRF     75.0     -0.1  -1   1   4   2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -0.1   1   2   4   0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -0.1   2   3   4   0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -0.1   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRF    375       -0.1   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -0.1   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRF    618.5     -0.1   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -0.1   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -0.1   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -0.1   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -0.1  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRF    981       -0.1  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRF    1162      -0.1  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -0.1   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -0.1   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -0.1   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRF    1462      -0.1   4  -1   4   0   BURNUP=50,000 MWD/MTIHM
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The highlighted data is proprietary information to Siemens Power Corporation.

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RDA
RDA     -1 = IRRADIATED TOP NOZZLE MATERIAL
RDA
RDA      IRRADIATION OF PLENUM ZONE MATERIAL AT 20% FLUX
RDA
IRF      75.0      -0.2  -2   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRF     150        -0.2   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRF     225        -0.2   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRF     300        -0.2   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRF     375        -0.2   4   5   4  0   BURNUP=15,000 MWD/MTIHM
IRF     437.5      -0.2   5   5   4  0   BURNUP=17,500 MWD/MTIHM
DEC     543.5             5   6   4  0   DECAY FOR 106.0 DAYS
IRF     618.5      -0.2   6   7   4  0   BURNUP=20,500 MWD/MTIHM
IRF     693.5      -0.2   7   8   4  0   BURNUP=23,500 MWD/MTIHM
IRF     768.5      -0.2   8   9   4  0   BURNUP=26,500 MWD/MTIHM
IRF     843.5      -0.2   9  10   4  0   BURNUP=29,500 MWD/MTIHM
IRF     918.5      -0.2  10  11   4  0   BURNUP=32,500 MWD/MTIHM
IRF     981        -0.2  11  11   4  0   BURNUP=35,000 MWD/MTIHM
DEC     1087             11  12   4  0   DECAY FOR 106.0 DAYS
IRF     1162       -0.2  12   1   4  0   BURNUP=38,000 MWD/MTIHM
IRF     1237       -0.2   1   2   4  0   BURNUP=41,000 MWD/MTIHM
IRF     1312       -0.2   2   3   4  0   BURNUP=44,000 MWD/MTIHM
IRF     1387       -0.2   3   4   4  0   BURNUP=47,000 MWD/MTIHM
IRF     1462       -0.2   4  -2   4  0   BURNUP=50,000 MWD/MTIHM
RDA
RDA     -2 = IRRADIATED PLENUM ZONE MATERIAL
RDA
RDA      IRRADIATION OF BOTTOM NOZZLE MATERIAL AT 20% FLUX
RDA
IRF      75.0      -0.2  -4   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRF     150        -0.2   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRF     225        -0.2   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRF     300        -0.2   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRF     375        -0.2   4   5   4  0   BURNUP=15,000 MWD/MTIHM
IRF     437.5      -0.2   5   5   4  0   BURNUP=17,500 MWD/MTIHM
DEC     543.5             5   6   4  0   DECAY FOR 106.0 DAYS
IRF     618.5      -0.2   6   7   4  0   BURNUP=20,500 MWD/MTIHM
IRF     693.5      -0.2   7   8   4  0   BURNUP=23,500 MWD/MTIHM
IRF     768.5      -0.2   8   9   4  0   BURNUP=26,500 MWD/MTIHM
IRF     843.5      -0.2   9  10   4  0   BURNUP=29,500 MWD/MTIHM
IRF     918.5      -0.2  10  11   4  0   BURNUP=32,500 MWD/MTIHM
IRF     981        -0.2  11  11   4  0   BURNUP=35,000 MWD/MTIHM
DEC     1087             11  12   4  0   DECAY FOR 106.0 DAYS
IRF     1162       -0.2  12   1   4  0   BURNUP=38,000 MWD/MTIHM
IRF     1237       -0.2   1   2   4  0   BURNUP=41,000 MWD/MTIHM
IRF     1312       -0.2   2   3   4  0   BURNUP=44,000 MWD/MTIHM
IRF     1387       -0.2   3   4   4  0   BURNUP=47,000 MWD/MTIHM
IRF     1462       -0.2   4  -4   4  0   BURNUP=50,000 MWD/MTIHM
RDA     -4 = IRRADIATED BOTTOM NOZZLE MATERIAL
RDA
RDA      ADD VECTORS 1-5 TO CREATE A WHOLE FUEL ASSEMBLY
MOV            -1        -6        0       1.0
ADD            -2        -6        0       1.0
ADD            -3        -6        0       1.0
ADD            -4        -6        0       1.0
ADD            -5        -6        0       1.0
MOV            -6        -7        0       1.0
RDA
RDA       1 = IRRADIATED WHOLE ASSEMBLY AT DISCHARGE
TIT      SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
DEC             1        -7        1        1        2
DEC             1         1        2        5        0
DEC             2         2        3        5        0
DEC             3         3        4        5        0
DEC             4         4        5        5        0
DEC             5         5        6        5        0
BAS      ONE W 15X15 ANF PWR FUEL ASSEMBLY
OPTL     8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
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OPTA      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT       7  0.0001   9  0.01   25  0.01   25  0.01  27  0.01   -1
OUT       6   1   -1   0
STP       4
2   922340   89.      922350 47500.    922360     46.   922380 953365.   FUEL 4.65%
4   030000  1.0       050000 1.0       060000   89.4    070000 25.0      FUEL IMPU
4   080000 134454.    090000 10.7      110000   15.0    120000  2.0      FUEL IMPU
4   130000  16.7      140000 12.1      150000   35.0    170000  5.3      FUEL IMPU
4   200000  2.0       220000 1.0       230000   3.0     240000  4.0      FUEL IMPU
4   250000  1.7       260000 18.0      270000   1.0     280000 24.0      FUEL IMPU
4   290000  1.0       300000 40.3      420000   10.0    470000 0.1       FUEL IMPU
4   480000  25.0      490000 2.0       500000   4.0     640000 2.5       FUEL IMPU
4   740000  2.0       820000 1.0       830000   0.4     0      0.0       FUEL IMPU
0
4   400000  979.069   500000 16.0      260000   2.25    240000 1.25      ZIRD-4
4   280000  0.02      130000 0.024     050000 0.00033   480000 0.00025   ZIRD-4
4   060000  0.120     270000 0.010     290000   0.020   720000 0.078     ZIRD-4
4   010000  0.013     250000 0.020     070000   0.080   080000 0.950     ZIRD-4
4   160000  0.035     220000 0.020     740000   0.020   230000 0.020     ZIRD-4
5   920000  0.0002    410000 0.12        0       0.0       0    0.0      ZIRD-4
0
4   260000  687.15    240000 190.0     280000   89.2    250000 20.0      SS-304
4   060000  0.8       150000 0.45      160000   0.3     140000 10.0      SS-304
4   070000  1.3       270000 0.8       410000   0.12      0     0.0      SS-304
0
4   260000  67.846    240000 149.660   280000 721.859   130000 7.982     IND-750
4   060000  0.399     270000 6.485     290000   0.499   250000 6.984     IND-750
4   420000  0.0000    070000 1.3       410000   8.980   160000 0.07      IND-750
4   140000  2.993     220000 24.943         0   0.0       0     0.0      IND-750
0
4   260000 179.766    240000 189.753   280000 519.623   130000 5.992     IND-718
4   060000  0.4       270000 4.694     290000   0.999   250000 1.997     IND-718
4   420000  29.961    070000 1.3       410000  55.458   160000 0.07      IND-718
4   140000  1.997     220000 7.99           0   0.0       0     0.0      IND-718
0
END
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
  H  3       3.460E+02 3.271E+02 3.093E+02 2.924E+02 2.764E+02 2.613E+02
 KR 85       6.061E+03 5.682E+03 5.326E+03 4.993E+03 4.680E+03 4.387E+03
 SR 89       4.025E+05 2.676E+03 1.779E+01 1.183E-01 7.861E-04 5.226E-06
 SR 90       4.848E+04 4.734E+04 4.622E+04 4.514E+04 4.408E+04 4.304E+04
  Y 90       5.110E+04 4.735E+04 4.624E+04 4.515E+04 4.409E+04 4.305E+04
  Y 91       5.267E+05 7.002E+03 9.245E+01 1.221E+00 1.612E-02 2.128E-04
1                                                                          OUTPUT UNIT =  6
PAGE   30
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 ZR 95       7.555E+05 1.445E+04 2.763E+02 5.282E+00 1.010E-01 1.931E-03
 NB 95       7.512E+05 3.250E+04 6.350E+02 1.215E+01 2.324E-01 4.443E-03
 RU103       7.703E+05 1.225E+03 1.948E+00 3.095E-03 4.916E-06 7.828E-09
 RH103M      6.939E+05 1.104E+03 1.756E+00 2.790E-03 4.432E-06 7.057E-09
1                                                                          OUTPUT UNIT =  6
PAGE   31
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 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 RU106      2.835E+05 1.425E+05 7.165E+04 3.602E+04 1.811E+04 9.105E+03
 RH106      3.173E+05 1.425E+05 7.165E+04 3.602E+04 1.811E+04 9.105E+03
 AG109M     1.894E+05 6.060E-04 3.512E-04 2.035E-04 1.179E-04 6.834E-05
 AG110      1.063E+05 1.388E+01 5.040E+00 1.830E+00 6.643E-01 2.412E-01
 AG110M     2.874E+03 1.044E+03 3.789E+02 1.376E+02 4.995E+01 1.813E+01
 CD113M     3.775E+01 3.601E+01 3.434E+01 3.274E+01 3.122E+01 2.977E+01
1                                                                          OUTPUT UNIT =  6
PAGE   32
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 IN115M     1.008E+04 2.276E-04 7.794E-07 2.669E-09 9.138E-12 3.128E-14
 SN123      1.794E+03 2.526E+02 3.558E+01 5.012E+00 7.059E-01 9.943E-02
 SB125      8.052E+03 6.322E+03 4.922E+03 3.832E+03 2.984E+03 2.323E+03
 TE125M     1.718E+03 1.539E+03 1.201E+03 9.351E+02 7.280E+02 5.669E+02
 TE127      5.428E+04 6.947E+02 6.809E+01 6.675E+00 6.542E-01 6.413E-02
 TE127M     6.951E+03 7.092E+02 6.952E+01 6.814E+00 6.679E-01 6.547E-02
 TE129      1.566E+05 8.167E+00 4.362E-03 2.330E-06 1.244E-09 6.645E-13
 TE129M     2.338E+04 1.255E+01 6.701E-03 3.579E-06 1.911E-09 1.021E-12
1                                                                          OUTPUT UNIT =  6
PAGE   33
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CS134      1.324E+05 9.460E+04 6.759E+04 4.829E+04 3.451E+04 2.465E+04
 CS136      4.003E+04 1.623E-04 6.581E-13 2.668E-21 1.082E-29 4.191E-38
 CS137      6.759E+04 6.605E+04 6.454E+04 6.307E+04 6.163E+04 6.022E+04
 BA137M     6.406E+04 6.248E+04 6.106E+04 5.966E+04 5.830E+04 5.697E+04
 BA140      8.077E+05 2.042E-03 5.165E-12 1.306E-20 3.303E-29 8.588E-38
 LA140      8.481E+05 2.351E-03 5.944E-12 1.503E-20 3.801E-29 1.092E-37
 CE141      7.696E+05 3.211E+02 1.333E-01 5.532E-05 2.296E-08 9.529E-12
 PR143      6.824E+05 5.970E-03 4.681E-11 3.671E-19 2.878E-27 2.256E-35
1                                                                          OUTPUT UNIT =  6
PAGE   34
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CE144      5.625E+05 2.309E+05 9.475E+04 3.888E+04 1.596E+04 6.549E+03
 PR144      5.679E+05 2.309E+05 9.475E+04 3.888E+04 1.596E+04 6.549E+03
 PR144M     6.758E+03 2.770E+03 1.137E+03 4.666E+02 1.915E+02 7.859E+01
 PM147      5.778E+04 4.714E+04 3.620E+04 2.779E+04 2.134E+04 1.638E+04
 PM148      1.402E+05 1.816E+00 3.960E-03 8.616E-06 1.873E-08 4.075E-11
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 PM148M      1.480E+04 3.224E+01 7.033E-02 1.529E-04 3.324E-07 7.235E-10
 SM151       2.421E+02 2.438E+02 2.420E+02 2.401E+02 2.383E+02 2.365E+02
 EU154       7.436E+03 6.860E+03 6.329E+03 5.839E+03 5.387E+03 4.970E+03
 EU155       4.955E+03 4.308E+03 3.746E+03 3.258E+03 2.833E+03 2.463E+03
1                                                                    OUTPUT UNIT =  6
PAGE   35
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 EU156       1.400E+05 8.062E-03 4.632E-10 2.661E-17 1.529E-24 8.783E-32
 SUMTOT      7.835E+07 1.202E+06 6.795E+05 4.590E+05 3.495E+05 2.910E+05
0TOTAL       7.881E+07 1.202E+06 6.795E+05 4.590E+05 3.495E+05 2.910E+05
1                                                                    OUTPUT UNIT =  6
PAGE   36
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11

     * SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
  H          3.460E+02 3.271E+02 3.093E+02 2.924E+02 2.764E+02 2.613E+02
 GE          5.014E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AS          1.470E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE          4.440E+05 2.704E-01 2.704E-01 2.703E-01 2.703E-01 2.703E-01
 BR          9.391E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR          1.738E+06 5.682E+03 5.326E+03 4.993E+03 4.680E+03 4.387E+03
 RB          2.405E+06 2.067E-03 1.442E-05 1.442E-05 1.442E-05 1.442E-05
 SR          3.694E+06 5.001E+04 4.624E+04 4.514E+04 4.408E+04 4.304E+04
  Y          4.791E+06 5.435E+04 4.633E+04 4.515E+04 4.409E+04 4.305E+04
 ZR          4.274E+06 1.445E+04 2.775E+02 6.485E+00 1.303E+00 1.204E+00
 NB          6.629E+06 3.261E+04 6.373E+02 1.245E+01 5.401E-01 3.529E-01
 MO          4.581E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC          5.410E+06 8.309E+00 8.309E+00 8.309E+00 8.309E+00 8.309E+00
 RU          2.394E+06 1.437E+05 7.165E+04 3.602E+04 1.811E+04 9.105E+03
 RH          3.247E+06 1.436E+05 7.165E+04 3.602E+04 1.811E+04 9.105E+03
 PD          3.779E+05 6.933E-02 6.933E-02 6.933E-02 6.933E-02 6.933E-02
 AG          4.694E+05 1.058E+03 3.840E+02 1.394E+02 5.061E+01 1.838E+01
 CD          7.929E+04 3.925E+01 3.435E+01 3.274E+01 3.122E+01 2.977E+01
 IN          1.513E+05 3.512E-02 2.108E-04 1.266E-06 7.619E-09 5.253E-11
 SN          6.883E+05 2.983E+02 5.224E+01 1.134E+01 3.351E+00 1.435E+00
 SB          1.729E+06 6.338E+03 4.923E+03 3.833E+03 2.985E+03 2.324E+03
 TE          3.695E+06 2.966E+03 1.339E+03 9.486E+02 7.294E+02 5.670E+02
  I          5.511E+06 2.005E-02 2.005E-02 2.005E-02 2.005E-02 2.005E-02
 XE          4.038E+06 6.003E-05 4.823E-08 4.610E-11 4.406E-14 4.211E-17
 CS          3.599E+06 1.606E+05 1.321E+05 1.114E+05 9.613E+04 8.487E+04
 BA          4.507E+06 6.248E+04 6.106E+04 5.966E+04 5.830E+04 5.697E+04
 LA          4.516E+06 2.351E-03 7.462E-11 6.868E-11 6.868E-11 6.868E-11
 CE          3.507E+06 2.312E+05 9.475E+04 3.888E+04 1.596E+04 6.549E+03
 PR          3.117E+06 2.336E+05 9.589E+04 3.935E+04 1.615E+04 6.628E+03
 ND          7.353E+05 3.545E-05 1.039E-09 1.060E-09 1.069E-09 1.072E-09
 PM          8.056E+05 4.718E+04 3.620E+04 2.779E+04 2.134E+04 1.639E+04
 SM          3.483E+05 2.438E+02 2.420E+02 2.401E+02 2.383E+02 2.365E+02
 EU          1.781E+05 1.117E+04 1.008E+04 9.100E+03 8.223E+03 7.436E+03
 SUMTOT      7.880E+07 1.202E+06 6.795E+05 4.590E+05 3.495E+05 2.910E+05
0TOTAL       7.881E+07 1.202E+06 6.795E+05 4.590E+05 3.495E+05 2.910E+05
0                                       CUMULATIVE TABLE TOTALS

 AP+FP       7.908E+07 1.209E+06 6.829E+05 4.615E+05 3.515E+05 2.926E+05
 ACT+FP      1.018E+08 1.278E+06 7.478E+05 5.235E+05 4.110E+05 3.498E+05
 AP+ACT+FP   1.021E+08 1.285E+06 7.512E+05 5.260E+05 4.130E+05 3.515E+05
```

OUTPUT UNIT = 6

1
PAGE 37
ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:48:11

* SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 9 SUMMARY TABLE: THERMAL POWER, WATTS
ONE W 15X15 ANF PWR FUEL ASSEMBLY

	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
SR 90	5.627E+01	5.494E+01	5.365E+01	5.239E+01	5.116E+01	4.995E+01
Y 90	2.832E+02	2.624E+02	2.563E+02	2.502E+02	2.443E+02	2.386E+02
RB 91	1.120E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 93	9.709E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	1.119E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 95	1.080E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 95	9.672E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	3.827E+03	7.318E+01	1.399E+00	2.676E-02	5.116E-04	9.783E-06
NB 95	3.603E+03	1.559E+02	3.046E+00	5.829E-02	1.115E-03	2.131E-05
Y 96	1.590E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	9.743E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100	9.973E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB101	9.458E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	9.191E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB102	1.383E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO103	1.022E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	1.425E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.043E+03	1.367E+03	6.872E+02	3.455E+02	1.737E+02	8.733E+01
I132	1.122E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	1.989E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	1.347E+03	9.628E+02	6.879E+02	4.915E+02	3.512E+02	2.509E+02
I135	1.017E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	1.049E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	9.567E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	7.477E+01	7.306E+01	7.139E+01	6.976E+01	6.817E+01	6.661E+01
BA137M	2.515E+02	2.453E+02	2.397E+02	2.343E+02	2.289E+02	2.237E+02
CS138	1.794E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	9.226E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	9.526E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS140	1.734E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	1.422E+04	3.940E-05	9.964E-14	2.520E-22	6.372E-31	1.831E-39
CS141	9.928E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	1.545E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA143	9.356E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA144	1.231E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	3.731E+02	1.531E+02	6.284E+01	2.579E+01	1.058E+01	4.344E+00
PR144	4.175E+03	1.697E+03	6.964E+02	2.858E+02	1.173E+02	4.814E+01
EU154	6.651E+01	6.136E+01	5.661E+01	5.223E+01	4.818E+01	4.445E+01
SUMTOT	3.389E+05	5.106E+03	2.816E+03	1.808E+03	1.294E+03	1.014E+03
0TOTAL	8.974E+05	5.225E+03	2.868E+03	1.845E+03	1.322E+03	1.037E+03

OUTPUT UNIT = 6

1
PAGE 38
ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:48:11

* SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 9 SUMMARY TABLE: THERMAL POWER, WATTS
ONE W 15X15 ANF PWR FUEL ASSEMBLY

	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
BR	1.881E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR	2.629E+04	8.512E+00	7.979E+00	7.479E+00	7.011E+00	6.572E+00
RB	5.219E+04	9.288E-06	1.206E-08	1.205E-08	1.205E-08	1.205E-08
SR	4.462E+04	6.419E+01	5.371E+01	5.239E+01	5.116E+01	4.995E+01
Y	6.380E+04	2.876E+02	2.566E+02	2.502E+02	2.443E+02	2.386E+02
ZR	3.821E+04	7.318E+01	1.399E+00	2.690E-02	6.513E-04	1.495E-04
NB	8.477E+04	1.561E+02	3.049E+00	5.839E-02	1.171E-03	8.392E-05

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 MO          3.987E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC          5.799E+04 4.167E-03 4.167E-03 4.167E-03 4.167E-03 4.167E-03
 RU          1.319E+04 1.257E+01 4.266E+00 2.142E+00 1.077E+00 5.413E-01
 RH          1.672E+04 1.367E+03 6.872E+02 3.455E+02 1.737E+02 8.733E+01
 SB          3.317E+04 1.998E+01 1.540E+01 1.199E+01 9.336E+00 7.271E+00
 TE          3.444E+04 2.667E+00 1.139E+00 7.987E-01 6.132E-01 4.766E-01
  I          7.995E+04 9.276E-06 9.276E-06 9.276E-06 9.276E-06 9.276E-06
 XE          3.667E+04 1.017E-07 8.837E-11 8.447E-14 8.073E-17 7.716E-20
 CS          6.647E+04 1.036E+03 7.593E+02 5.613E+02 4.194E+02 3.175E+02
 BA          4.011E+04 2.453E+02 2.397E+02 2.343E+02 2.289E+02 2.237E+02
 LA          7.126E+04 3.940E-05 6.032E-13 5.036E-13 5.036E-13 5.036E-13
 CE          1.608E+04 1.536E+02 6.285E+01 2.579E+01 1.058E+01 4.344E+00
 PR          2.572E+04 1.698E+03 6.968E+02 2.860E+02 1.174E+02 4.816E+01
 EU          1.700E+03 6.453E+01 5.937E+01 5.463E+01 5.027E+01 4.627E+01
 SUMTOT      8.620E+05 5.189E+03 2.849E+03 1.833E+03 1.314E+03 1.031E+03
0TOTAL       8.974E+05 5.225E+03 2.868E+03 1.845E+03 1.322E+03 1.037E+03
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       8.989E+05 5.261E+03 2.890E+03 1.863E+03 1.338E+03 1.051E+03
 ACT+FP      9.574E+05 5.652E+03 3.123E+03 2.063E+03 1.531E+03 1.244E+03
 AP+ACT+FP   9.588E+05 5.688E+03 3.145E+03 2.081E+03 1.547E+03 1.257E+03
1                                                                          OUTPUT UNIT =  6
PAGE   39
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11
                                SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
                              (ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC
 BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PU238       2.655E+06 2.764E+06 2.765E+06 2.748E+06 2.727E+06 2.706E+06
 PU239       1.332E+05 1.353E+05 1.353E+05 1.353E+05 1.353E+05 1.353E+05
 PU240       2.341E+05 2.343E+05 2.344E+05 2.346E+05 2.348E+05 2.349E+05
 AM241       7.812E+04 1.786E+05 2.743E+05 3.652E+05 4.518E+05 5.340E+05
 CM242       3.727E+07 7.951E+06 1.695E+06 3.685E+05 8.734E+04 2.771E+04
 CM244       2.958E+06 2.848E+06 2.741E+06 2.638E+06 2.539E+06 2.443E+06
0-------------------------------------------------------------------------------------------------------------
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 TOTALS
 TABLE       4.336E+07 1.415E+07 7.881E+06 6.525E+06 6.210E+06 6.116E+06
 ACTUAL      4.336E+07 1.415E+07 7.881E+06 6.525E+06 6.210E+06 6.116E+06
1                                                                          OUTPUT UNIT =  6
PAGE   40
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11
                                SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
                            SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
                          BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PU238       4.329E+05 4.508E+05 4.509E+05 4.481E+05 4.448E+05 4.413E+05
 PU240       1.234E+06 1.235E+06 1.236E+06 1.237E+06 1.238E+06 1.238E+06
 PU242       4.503E+05 4.503E+05 4.503E+05 4.503E+05 4.503E+05 4.503E+05
 CM242       1.808E+08 3.858E+07 8.223E+06 1.788E+06 4.238E+05 1.345E+05
 CM244       3.561E+08 3.428E+08 3.300E+08 3.176E+08 3.057E+08 2.942E+08
 CM246       1.981E+06 1.980E+06 1.980E+06 1.980E+06 1.980E+06 1.979E+06
0-------------------------------------------------------------------------------------------------------------
-----------------------------------
 TOTALS
 TABLE       5.415E+08 3.859E+08 3.426E+08 3.237E+08 3.104E+08 2.986E+08
 ACTUAL      5.415E+08 3.859E+08 3.426E+08 3.237E+08 3.104E+08 2.986E+08
0-------------------------------------------------------------------------------------------------------------
-----------------------------------
 OVERALL
 TOTALS
 TABLE       5.849E+08 4.000E+08 3.505E+08 3.302E+08 3.166E+08 3.047E+08
 ACTUAL      5.849E+08 4.000E+08 3.505E+08 3.302E+08 3.166E+08 3.047E+08
1                                                                          OUTPUT UNIT =  6
PAGE   41
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11
                 PHOTON SPECTRUM FOR ACTIVATION PRODUCTS
0                               SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
```

POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00

N/CM**2-SEC

0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY

EMEAN	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
1.000E-02	1.900E+15	1.183E+13	5.701E+12	4.185E+12	3.312E+12	2.706E+12
2.500E-02	6.038E+14	4.979E+13	2.748E+13	1.780E+13	1.263E+13	9.421E+12
3.750E-02	2.478E+14	6.743E+12	5.052E+12	3.947E+12	3.092E+12	2.425E+12
5.750E-02	3.532E+14	1.007E+12	4.611E+11	3.604E+11	2.994E+11	2.521E+11
8.500E-02	2.051E+14	3.698E+11	1.843E+11	1.471E+11	1.226E+11	1.031E+11
1.250E-01	1.413E+14	3.352E+11	1.853E+11	1.433E+11	1.144E+11	9.207E+10
2.250E-01	3.357E+14	2.382E+12	1.705E+12	1.318E+12	1.026E+12	7.995E+11
3.750E-01	1.946E+14	1.280E+13	9.950E+12	7.747E+12	6.032E+12	4.697E+12
5.750E-01	2.571E+15	1.677E+13	1.280E+13	9.957E+12	7.751E+12	6.034E+12
8.500E-01	4.220E+15	7.298E+13	2.253E+12	4.145E+11	1.759E+11	8.093E+10
1.250E+00	2.829E+14	1.026E+14	8.971E+13	7.858E+13	6.887E+13	6.038E+13
1.750E+00	1.108E+14	1.153E+10	6.300E+08	1.608E+08	6.365E+07	2.956E+07
2.250E+00	3.437E+13	1.150E+09	4.839E+08	4.164E+08	3.650E+08	3.200E+08
2.750E+00	9.978E+12	2.120E+06	1.476E+06	1.288E+06	1.129E+06	9.901E+05
3.500E+00	4.412E+11	2.052E-02	3.295E-03	5.292E-04	8.510E-05	1.378E-05
5.000E+00	1.638E+10	6.108E-03	9.809E-04	1.575E-04	2.531E-05	4.080E-06
7.000E+00	2.581E+12	3.963E-04	6.365E-05	1.022E-05	1.642E-06	2.648E-07
9.500E+00	2.667E+09	2.506E-05	4.025E-06	6.464E-07	1.039E-07	1.674E-08
0 TOTAL	1.121E+16	2.777E+14	1.555E+14	1.246E+14	1.034E+14	8.699E+13
0MEV/SEC	5.984E+15	2.071E+14	1.265E+14	1.082E+14	9.370E+13	8.134E+13

0 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY

EMEAN	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
1.000E-02	1.900E+07	1.183E+05	5.701E+04	4.185E+04	3.312E+04	2.706E+04
2.500E-02	1.509E+07	1.245E+06	6.870E+05	4.450E+05	3.158E+05	2.355E+05
3.750E-02	9.294E+06	2.529E+05	1.895E+05	1.480E+05	1.160E+05	9.094E+04
5.750E-02	2.031E+07	5.792E+04	2.652E+04	2.072E+04	1.722E+04	1.450E+04
8.500E-02	1.743E+07	3.143E+04	1.567E+04	1.250E+04	1.042E+04	8.766E+03
1.250E-01	1.766E+07	4.190E+04	2.316E+04	1.791E+04	1.431E+04	1.151E+04
2.250E-01	7.554E+07	5.359E+05	3.837E+05	2.965E+05	2.308E+05	1.799E+05
3.750E-01	7.296E+07	4.800E+06	3.731E+06	2.905E+06	2.262E+06	1.761E+06
5.750E-01	1.478E+09	9.641E+06	7.361E+06	5.725E+06	4.457E+06	3.470E+06
8.500E-01	3.587E+09	6.203E+07	1.915E+06	3.523E+05	1.495E+05	6.879E+04
1.250E+00	3.537E+08	1.283E+08	1.121E+08	9.823E+07	8.609E+07	7.547E+07
1.750E+00	1.939E+08	2.017E+04	1.102E+03	2.813E+02	1.114E+02	5.174E+01
2.250E+00	7.734E+07	2.587E+03	1.089E+03	9.369E+02	8.211E+02	7.199E+02
2.750E+00	2.744E+07	5.831E+00	4.058E+00	3.542E+00	3.106E+00	2.723E+00
3.500E+00	1.544E+06	7.181E-08	1.153E-08	1.852E-09	2.978E-10	4.822E-11
5.000E+00	8.188E+04	3.054E-08	4.905E-09	7.877E-10	1.266E-10	2.040E-11
7.000E+00	1.806E+07	2.774E-09	4.455E-10	7.155E-11	1.150E-11	1.853E-12
9.500E+00	2.533E+04	2.381E-10	3.824E-11	6.141E-12	9.867E-13	1.591E-13
0 TOTAL	5.984E+09	2.071E+08	1.265E+08	1.082E+08	9.370E+07	8.134E+07
0 GAM POW	9.593E+02	3.320E+01	2.028E+01	1.734E+01	1.502E+01	1.304E+01

1 OUTPUT UNIT = 6

PAGE 48

ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:48:11

PHOTON SPECTRUM FOR ACTINIDES + DAUGHTERS

0 SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL

POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00

N/CM**2-SEC

0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY

EMEAN	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
1.000E-02	5.827E+17	7.265E+13	4.479E+13	3.895E+13	3.776E+13	3.755E+13
2.500E-02	2.569E+16	1.903E+11	2.835E+11	3.722E+11	4.565E+11	5.367E+11
3.750E-02	3.679E+16	2.188E+11	1.595E+11	1.515E+11	1.541E+11	1.587E+11
5.750E-02	3.765E+16	2.612E+12	3.983E+12	5.287E+12	6.527E+12	7.706E+12
8.500E-02	2.569E+17	5.538E+11	5.515E+11	5.493E+11	5.471E+11	5.449E+11
1.250E-01	2.043E+17	5.052E+11	4.970E+11	4.917E+11	4.871E+11	4.828E+11
2.250E-01	1.449E+17	3.996E+11	3.923E+11	3.866E+11	3.813E+11	3.763E+11
3.750E-01	1.573E+16	2.330E+10	2.330E+10	2.331E+10	2.331E+10	2.331E+10

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 5.750E-01  2.822E+15 8.570E+08 4.749E+08 4.493E+08 4.958E+08 5.528E+08
 8.500E-01  8.637E+15 1.441E+09 1.351E+09 1.337E+09 1.339E+09 1.342E+09
 1.250E+00  3.079E+15 7.282E+08 6.902E+08 6.749E+08 6.646E+08 6.555E+08
 1.750E+00  1.185E+12 1.419E+08 1.302E+08 1.276E+08 1.269E+08 1.262E+08
 2.250E+00  1.094E+08 7.658E+07 6.759E+07 6.378E+07 6.114E+07 5.882E+07
 2.750E+00  8.244E+07 9.361E+07 1.268E+08 1.646E+08 2.011E+08 2.339E+08
 3.500E+00  5.698E+07 3.993E+07 3.526E+07 3.328E+07 3.190E+07 3.069E+07
 5.000E+00  2.437E+07 1.708E+07 1.508E+07 1.423E+07 1.364E+07 1.313E+07
 7.000E+00  2.807E+06 1.969E+06 1.739E+06 1.641E+06 1.573E+06 1.514E+06
 9.500E+00  3.230E+05 2.263E+05 1.998E+05 1.886E+05 1.807E+05 1.739E+05
0  TOTAL    1.319E+18 7.715E+13 5.068E+13 4.621E+13 4.634E+13 4.738E+13
0MEV/SEC    1.087E+17 1.102E+12 8.992E+11 9.156E+11 9.754E+11 1.041E+12
0                                18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                 BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  5.827E+09 7.265E+05 4.479E+05 3.895E+05 3.776E+05 3.755E+05
 2.500E-02  6.423E+08 4.758E+03 7.088E+03 9.304E+03 1.141E+04 1.342E+04
 3.750E-02  1.379E+09 8.205E+03 5.982E+03 5.681E+03 5.778E+03 5.950E+03
 5.750E-02  2.165E+09 1.502E+05 2.290E+05 3.040E+05 3.753E+05 4.431E+05
 8.500E-02  2.183E+10 4.707E+04 4.688E+04 4.669E+04 4.650E+04 4.632E+04
 1.250E-01  2.553E+10 6.315E+04 6.213E+04 6.146E+04 6.089E+04 6.034E+04
 2.250E-01  3.260E+10 8.991E+04 8.828E+04 8.699E+04 8.580E+04 8.466E+04
 3.750E-01  5.900E+09 8.738E+03 8.739E+03 8.740E+03 8.742E+03 8.743E+03
 5.750E-01  1.623E+09 4.928E+02 2.730E+02 2.584E+02 2.851E+02 3.179E+02
 8.500E-01  7.341E+09 1.225E+03 1.148E+03 1.137E+03 1.138E+03 1.141E+03
 1.250E+00  3.848E+09 9.102E+02 8.627E+02 8.436E+02 8.307E+02 8.194E+02
 1.750E+00  2.074E+06 2.484E+02 2.279E+02 2.234E+02 2.220E+02 2.209E+02
 2.250E+00  2.462E+02 1.723E+02 1.521E+02 1.435E+02 1.376E+02 1.323E+02
 2.750E+00  2.267E+02 2.574E+02 3.486E+02 4.525E+02 5.529E+02 6.433E+02
 3.500E+00  1.994E+02 1.398E+02 1.234E+02 1.165E+02 1.116E+02 1.074E+02
 5.000E+00  1.219E+02 8.540E+01 7.541E+01 7.117E+01 6.822E+01 6.563E+01
 7.000E+00  1.965E+01 1.378E+01 1.217E+01 1.149E+01 1.101E+01 1.059E+01
 9.500E+00  3.068E+00 2.150E+00 1.898E+00 1.791E+00 1.717E+00 1.652E+00
0  TOTAL    1.087E+11 1.102E+06 8.992E+05 9.156E+05 9.754E+05 1.041E+06
0 GAM POW   1.742E+04 1.767E-01 1.441E-01 1.468E-01 1.564E-01 1.670E-01
1                                                                          OUTPUT UNIT =  6
PAGE   49
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:48:11
                PHOTON SPECTRUM FOR FISSION PRODUCTS
0                                SOURCE FOR 4.65%, 50 GWD/MTU PWR FUEL
                                    POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                 BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  1.010E+18 1.314E+16 6.706E+15 3.883E+15 2.578E+15 1.952E+15
 2.500E-02  2.650E+17 2.953E+15 1.537E+15 9.061E+14 6.068E+14 4.576E+14
 3.750E-02  2.174E+17 3.065E+15 1.586E+15 9.411E+14 6.467E+14 5.054E+14
 5.750E-02  2.173E+17 2.738E+15 1.387E+15 7.914E+14 5.164E+14 3.853E+14
 8.500E-02  1.597E+17 1.936E+15 9.706E+14 5.452E+14 3.498E+14 2.567E+14
 1.250E-01  1.728E+17 2.262E+15 1.090E+15 5.885E+14 3.652E+14 2.618E+14
 2.250E-01  3.662E+17 1.676E+15 8.377E+14 4.654E+14 2.938E+14 2.122E+14
 3.750E-01  2.747E+17 9.081E+14 4.678E+14 2.658E+14 1.688E+14 1.199E+14
 5.750E-01  4.562E+17 9.251E+15 6.710E+15 5.179E+15 4.196E+15 3.539E+15
 8.500E-01  4.708E+17 5.024E+15 2.468E+15 1.738E+15 1.252E+15 9.107E+14
 1.250E+00  2.627E+17 5.614E+14 3.740E+14 2.688E+14 2.050E+14 1.637E+14
 1.750E+00  9.878E+16 4.280E+13 2.174E+13 1.203E+13 7.370E+12 5.046E+12
 2.250E+00  4.949E+16 7.277E+13 3.057E+13 1.290E+13 5.477E+12 2.339E+12
 2.750E+00  2.105E+16 1.192E+12 5.937E+11 2.963E+11 1.481E+11 7.406E+10
 3.500E+00  1.052E+16 1.481E+11 7.447E+10 3.744E+10 1.882E+10 9.464E+09
 5.000E+00  4.550E+15 3.726E-05 3.778E-05 3.817E-05 3.848E-05 3.872E-05
 7.000E+00  3.706E+13 2.417E-06 2.451E-06 2.477E-06 2.497E-06 2.512E-06
 9.500E+00  6.932E+09 1.529E-07 1.550E-07 1.566E-07 1.579E-07 1.589E-07
0  TOTAL    4.057E+18 4.363E+16 2.419E+16 1.560E+16 1.119E+16 8.772E+15
0MEV/SEC    1.651E+18 1.218E+16 7.360E+15 5.309E+15 4.058E+15 3.247E+15
0                                18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                 BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
```

EMEAN	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
1.000E-02	1.010E+10	1.314E+08	6.706E+07	3.883E+07	2.578E+07	1.952E+07
2.500E-02	6.625E+09	7.383E+07	3.842E+07	2.265E+07	1.517E+07	1.144E+07
3.750E-02	8.153E+09	1.150E+08	5.946E+07	3.529E+07	2.425E+07	1.895E+07
5.750E-02	1.250E+10	1.574E+08	7.977E+07	4.550E+07	2.970E+07	2.216E+07
8.500E-02	1.357E+10	1.646E+08	8.250E+07	4.635E+07	2.974E+07	2.182E+07
1.250E-01	2.160E+10	2.827E+08	1.363E+08	7.357E+07	4.565E+07	3.273E+07
2.250E-01	8.239E+10	3.771E+08	1.885E+08	1.047E+08	6.610E+07	4.775E+07
3.750E-01	1.030E+11	3.406E+08	1.754E+08	9.969E+07	6.330E+07	4.498E+07
5.750E-01	2.623E+11	5.320E+09	3.858E+09	2.978E+09	2.413E+09	2.035E+09
8.500E-01	4.001E+11	4.270E+09	2.098E+09	1.477E+09	1.064E+09	7.741E+08
1.250E+00	3.284E+11	7.018E+08	4.676E+08	3.360E+08	2.563E+08	2.047E+08
1.750E+00	1.729E+11	7.491E+07	3.804E+07	2.105E+07	1.290E+07	8.831E+06
2.250E+00	1.114E+11	1.637E+08	6.878E+07	2.903E+07	1.232E+07	5.262E+06
2.750E+00	5.788E+10	3.277E+06	1.633E+06	8.148E+05	4.071E+05	2.037E+05
3.500E+00	3.684E+10	5.184E+05	2.606E+05	1.310E+05	6.588E+04	3.312E+04
5.000E+00	2.275E+10	1.863E-10	1.889E-10	1.909E-10	1.924E-10	1.936E-10
7.000E+00	2.594E+08	1.692E-11	1.716E-11	1.734E-11	1.748E-11	1.759E-11
9.500E+00	6.585E+04	1.452E-12	1.472E-12	1.488E-12	1.500E-12	1.509E-12
0 TOTAL	1.651E+12	1.218E+10	7.360E+09	5.309E+09	4.058E+09	3.247E+09
GAM POW	2.646E+05	1.952E+03	1.180E+03	8.510E+02	6.505E+02	5.206e+02

ORIGEN2 File: SPC PWR Fuel- 3.45 wt% ^{235}U for 50 GWD/MTU - Minimum Enrichment

```
-1

-1

-1

RDA      ##########################################################
RDA      ##   IF300 HIGH BURNUP/ENRICHMENT PWR FUEL              ##
RDA      ##   Input Filename: PWR345UE         ORIGEN2 VER2.1    ##
RDA      ##   Creation Date:        1/05/99                      ##
RDA      ##   Fuel Type:          3.45% W 15X15 ANF PWR          ##
RDA      ##   Burnup:50000 MWd/MTIHM, SP.POWER = 40MW/MTU        ##
RDA      ##   Cycle Burnup: 17.5, 17.5, 15K, PWRUE  xsect lib    ##
RDA      ##   CPL-WEIGHT,IRR HISTORY,FLX FACT=DOE/RW 0184,RV1    ##
RDA      ##   Low End Enrichment for Shielding Source Term       ##
RDA      ##########################################################
LIP      0  0  0
LIB      0 1 2 3      604      605      606   9  0  0  1  39
PHO      101  102  103  10
RDA     READ UNIT AMOUNTS OF FUEL AND FUEL ASSEMBLY MATERIALS
RDA     -1 = FRESH PWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA     -2 = FRESH ZIRCALOY COMPOSITION (1 KG)
RDA     -3 = FRESH SS 304 COMPOSITION (1 KG)
RDA     -4 = FRESH INCONEL-X750 COMPOSITION (1 KG)
RDA     -5 = FRESH INCONEL-718 COMPOSITION (1 KG)
TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL MAT'LS
RDA     READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP     -1   1  -1  -1  1  1
RDA     READ ZIRCALOY COMPOSITION (1.0 KG)
INP     -2   1  -1  -1  1  1
RDA     READ SS304 COMPOSITION (1.0 KG)
INP     -3   1  -1  -1  1  1
RDA     READ INCONEL X750 COMPOSITION (1.0 KG)
INP     -4   1  -1  -1  1  1
RDA     READ INCONEL 718 COMPOSITION (1.0 KG)
INP     -5   1  -1  -1  1  1
RDA      MIX TOP, PLENUM, IN-CORE, AND BOTTOM MIXTURES
RDA      MIX TOP ZONE
MOV            -3        1        0    6.381  SS304
ADD            -4        1        0    0.024  INCONEL-X750
ADD            -5        1        0    0.672  INCONEL-718
RDA      MIX PLENUM ZONE
MOV            -4        2        0    3.019  INCONEL-X750
ADD            -2        2        0    7.551  ZIRCALOY-4
RDA      MIX IN-CORE ZONE WITHOUT UO2
MOV            -5        3        0    0.112  INCONEL-718
ADD            -2        3        0   133.927 ZIRCALOY-4
RDA      MIX BOTTOM ZONE
MOV            -3        4        0    4.459  SS304
RDA      MOVE MIXTURES INTO SCRATCH VECTORS
MOV            -1       -5        0      1.0  IN CORE U ONLY
MOV             1       -1        0      1.0  TOP ZONE
MOV             2       -2        0      1.0  PLENUM ZONE
MOV             3       -3        0      1.0  INCORE W/O UO2
MOV             4       -4        0      1.0  BOTTOM NOZZLE
RDA     IRRADIATION OF ONE METRIC TON OF PWRU FUEL AT 100% POWER
BUP
IRP    75        40.0  -5   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRP   150        40.0   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRP   225        40.0   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
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IRP    300       40.0   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRP    375       40.0   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRP    437.5     40.0   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRP    618.5     40.0   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRP    693.5     40.0   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRP    768.5     40.0   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRP    843.5     40.0   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRP    918.5     40.0  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRP    981       40.0  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRP    1162      40.0  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRP    1237      40.0   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRP    1312      40.0   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRP    1387      40.0   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRP    1462      40.0   4   5   4   0   BURNUP=50,000 MWD/MTIHM
BUP
RDA    -5  = IRRADIATED UO2 FUEL AT DISCHARGE [redacted] MTU/FA
MOV       5   -5      0      [redacted]
RDA
RDA     IRRADIATION OF INCORE MATERIAL WITHOUT UO2 AT 100% FLUX
IRF    75.0      -1.0  -3   1   4   2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -1.0   1   2   4   0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -1.0   2   3   4   0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -1.0   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRF    375       -1.0   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -1.0   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRF    618.5     -1.0   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -1.0   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -1.0   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -1.0   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -1.0  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRF    981       -1.0  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRF    1162      -1.0  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -1.0   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -1.0   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -1.0   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRF    1462      -1.0   4  -3   4   0   BURNUP=50,000 MWD/MTIHM
RDA
RDA    -3 = IRRADIATED INCORE MATERIAL WITHOUT UO2
RDA
RDA     IRRADIATION OF TOP NOZZLE MATERIAL AT 10% FLUX
RDA
IRF     75.0     -0.1  -1   1   4   2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -0.1   1   2   4   0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -0.1   2   3   4   0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -0.1   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRF    375       -0.1   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -0.1   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRF    618.5     -0.1   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -0.1   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -0.1   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -0.1   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -0.1  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRF    981       -0.1  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4   0   DECAY FOR 106.0 DAYS
IRF    1162      -0.1  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -0.1   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -0.1   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -0.1   3   4   4   0   BURNUP=47,000 MWD/MTIHM
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The highlighted data is proprietary information to Siemens Power Corporation.

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IRF    1462      -0.1   4  -1   4  0   BURNUP=50,000 MWD/MTIHM
RDA
RDA    -1 = IRRADIATED TOP NOZZLE MATERIAL
RDA
RDA     IRRADIATION OF PLENUM ZONE MATERIAL AT 20% FLUX
RDA
IRF     75.0     -0.2  -2   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -0.2   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -0.2   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -0.2   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRF    375       -0.2   4   5   4  0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -0.2   5   5   4  0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4  0   DECAY FOR 106.0 DAYS
IRF    618.5     -0.2   6   7   4  0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -0.2   7   8   4  0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -0.2   8   9   4  0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -0.2   9  10   4  0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -0.2  10  11   4  0   BURNUP=32,500 MWD/MTIHM
IRF    981       -0.2  11  11   4  0   BURNUP=35,000 MWD/MTIHM
DEC    1087             11  12   4  0   DECAY FOR 106.0 DAYS
IRF    1162      -0.2  12   1   4  0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -0.2   1   2   4  0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -0.2   2   3   4  0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -0.2   3   4   4  0   BURNUP=47,000 MWD/MTIHM
IRF    1462      -0.2   4  -2   4  0   BURNUP=50,000 MWD/MTIHM
RDA
RDA    -2 = IRRADIATED PLENUM ZONE MATERIAL
RDA
RDA     IRRADIATION OF BOTTOM NOZZLE MATERIAL AT 20% FLUX
RDA
IRF     75.0     -0.2  -4   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRF    150       -0.2   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRF    225       -0.2   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRF    300       -0.2   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRF    375       -0.2   4   5   4  0   BURNUP=15,000 MWD/MTIHM
IRF    437.5     -0.2   5   5   4  0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4  0   DECAY FOR 106.0 DAYS
IRF    618.5     -0.2   6   7   4  0   BURNUP=20,500 MWD/MTIHM
IRF    693.5     -0.2   7   8   4  0   BURNUP=23,500 MWD/MTIHM
IRF    768.5     -0.2   8   9   4  0   BURNUP=26,500 MWD/MTIHM
IRF    843.5     -0.2   9  10   4  0   BURNUP=29,500 MWD/MTIHM
IRF    918.5     -0.2  10  11   4  0   BURNUP=32,500 MWD/MTIHM
IRF    981       -0.2  11  11   4  0   BURNUP=35,000 MWD/MTIHM
DEC    1087             11  12   4  0   DECAY FOR 106.0 DAYS
IRF    1162      -0.2  12   1   4  0   BURNUP=38,000 MWD/MTIHM
IRF    1237      -0.2   1   2   4  0   BURNUP=41,000 MWD/MTIHM
IRF    1312      -0.2   2   3   4  0   BURNUP=44,000 MWD/MTIHM
IRF    1387      -0.2   3   4   4  0   BURNUP=47,000 MWD/MTIHM
IRF    1462      -0.2   4  -4   4  0   BURNUP=50,000 MWD/MTIHM
RDA    -4 = IRRADIATED BOTTOM NOZZLE MATERIAL
RDA
RDA     ADD VECTORS 1-5 TO CREATE A WHOLE FUEL ASSEMBLY
MOV          -1        -6        0       1.0
ADD          -2        -6        0       1.0
ADD          -3        -6        0       1.0
ADD          -4        -6        0       1.0
ADD          -5        -6        0       1.0
MOV          -6        -7        0       1.0
RDA
RDA      1 = IRRADIATED WHOLE ASSEMBLY AT DISCHARGE
TIT     SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
DEC          1        -7        1        1        2
DEC          1         1        2        5        0
DEC          2         2        3        5        0
DEC          3         3        4        5        0
DEC          4         4        5        5        0
DEC          5         5        6        5        0
BAS     ONE W 15X15 ANF PWR FUEL ASSEMBLY
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OPTL      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT       7  0.01   9  0.01   25  0.01   25  0.01  27  0.01   -1
OUT       6   1   -1   0
STP       4
2   922340  89.0      922350 34500.0   922360   46.0     922380 965365.0  FUEL 3.45%
4   030000  1.0       050000 1.0       060000   89.4     070000 25.0      FUEL IMPU
4   080000 134454.    090000 10.7      110000   15.0     120000  2.0      FUEL IMPU
4   130000  16.7      140000 12.1      150000   35.0     170000  5.3      FUEL IMPU
4   200000  2.0       220000 1.0       230000   3.0      240000  4.0      FUEL IMPU
4   250000  1.7       260000 18.0      270000   1.0      280000 24.0      FUEL IMPU
4   290000  1.0       300000 40.3      420000   10.0     470000 0.1       FUEL IMPU
4   480000  25.0      490000 2.0       500000   4.0      640000 2.5       FUEL IMPU
4   740000  2.0       820000 1.0       830000   0.4      0      0.0       FUEL IMPU
0
4   400000  979.069   500000 16.0      260000   2.25     240000 1.25      ZIRD-4
4   280000  0.02      130000 0.024     050000 0.00033    480000 0.00025   ZIRD-4
4   060000  0.120     270000 0.010     290000   0.020    720000 0.078     ZIRD-4
4   010000  0.013     250000 0.020     070000   0.080    080000 0.950     ZIRD-4
4   160000  0.035     220000 0.020     740000   0.020    230000 0.020     ZIRD-4
5   920000  0.0002    410000 0.12        0       0.0       0    0.0       ZIRD-4
0
4   260000  687.15    240000 190.0     280000   89.2     250000 20.0      SS-304
4   060000  0.8       150000 0.45      160000   0.3      140000 10.0      SS-304
4   070000  1.3       270000 0.8       410000   0.12       0     0.0      SS-304
0
4   260000  67.846    240000 149.660   280000 721.859    130000 7.982     IND-750
4   060000  0.399     270000 6.485     290000   0.499    250000 6.984     IND-750
4   420000  0.0000    070000 1.3       410000   8.980    160000 0.07      IND-750
4   140000  2.993     220000 24.943         0   0.0       0     0.0      IND-750
0
4   260000 179.766    240000 189.753   280000 519.623    130000 5.992     IND-718
4   060000  0.4       270000 4.694     290000   0.999    250000 1.997     IND-718
4   420000  29.961    070000 1.3       410000  55.458    160000 0.07      IND-718
4   140000  1.997     220000 7.99           0   0.0       0     0.0      IND-718
0
END
```

OUTPUT UNIT = 6

PAGE 28
ORIGEN2 V2.1 (8-1-91), Run on 02/24/99 at 11:26:16

* SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL

\+
FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
ONE W 15X15 ANF PWR FUEL ASSEMBLY

	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
KR 85	5.484E+03	5.142E+03	4.820E+03	4.518E+03	4.235E+03	3.970E+03
SR 90	4.286E+04	4.185E+04	4.087E+04	3.991E+04	3.897E+04	3.805E+04
Y 90	4.555E+04	4.186E+04	4.088E+04	3.992E+04	3.898E+04	3.806E+04
ZR 95	7.154E+05	1.368E+04	2.616E+02	5.002E+00	9.563E-02	1.829E-03
NB 95	7.100E+05	3.078E+04	6.013E+02	1.151E+01	2.200E-01	4.207E-03
NB 99	7.986E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 99	9.010E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	8.240E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC101	8.244E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO102	8.099E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	8.111E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO103	8.167E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC103	8.347E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU103	8.375E+05	1.328E+03	2.116E+00	3.365E-03	5.354E-06	8.501E-09
RU106	3.535E+05	1.777E+05	8.934E+04	4.492E+04	2.258E+04	1.135E+04
RH106	3.982E+05	1.777E+05	8.934E+04	4.492E+04	2.258E+04	1.135E+04
I133	9.470E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	9.494E+05	1.275E-15	1.396E-36	0.000E+00	0.000E+00	0.000E+00
I134	1.029E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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 CS134      1.493E+05 1.067E+05 7.621E+04 5.445E+04 3.891E+04 2.780E+04
  I135      8.889E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE137      8.208E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS137      6.768E+04 6.614E+04 6.463E+04 6.315E+04 6.171E+04 6.030E+04
 BA137M     6.415E+04 6.257E+04 6.114E+04 5.974E+04 5.838E+04 5.704E+04
 CS138      8.333E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BA139      8.209E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BA140      7.918E+05 2.002E-03 5.063E-12 1.280E-20 3.238E-29 8.588E-38
 LA140      8.371E+05 2.304E-03 5.827E-12 1.473E-20 3.726E-29 1.092E-37
 CE144      5.318E+05 2.183E+05 8.957E+04 3.676E+04 1.509E+04 6.191E+03
 PR144      5.378E+05 2.183E+05 8.958E+04 3.676E+04 1.509E+04 6.192E+03
 PM147      4.936E+04 4.065E+04 3.121E+04 2.396E+04 1.840E+04 1.413E+04
 EU154      8.673E+03 8.001E+03 7.382E+03 6.810E+03 6.283E+03 5.796E+03
 EU155      5.896E+03 5.127E+03 4.458E+03 3.877E+03 3.371E+03 2.931E+03
 SUMTOT     1.906E+07 1.216E+06 6.903E+05 4.597E+05 3.446E+05 2.832E+05
0TOTAL      7.894E+07 1.242E+06 7.000E+05 4.665E+05 3.497E+05 2.872E+05
1                                                                          OUTPUT UNIT =  6
PAGE   29
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16

     * SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 KR         1.464E+06 5.142E+03 4.820E+03 4.518E+03 4.235E+03 3.970E+03
 RB         2.065E+06 2.165E-03 1.284E-05 1.284E-05 1.284E-05 1.284E-05
 SR         3.332E+06 4.409E+04 4.088E+04 3.991E+04 3.897E+04 3.805E+04
  Y         4.431E+06 4.789E+04 4.096E+04 3.992E+04 3.898E+04 3.806E+04
 ZR         4.213E+06 1.368E+04 2.627E+02 6.118E+00 1.212E+00 1.118E+00
 NB         6.646E+06 3.088E+04 6.034E+02 1.179E+01 5.074E-01 3.293E-01
 MO         4.917E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC         5.904E+06 8.043E+00 8.043E+00 8.043E+00 8.043E+00 8.043E+00
 RU         2.785E+06 1.790E+05 8.935E+04 4.492E+04 2.258E+04 1.135E+04
 RH         3.776E+06 1.789E+05 8.935E+04 4.492E+04 2.258E+04 1.135E+04
 SB         1.770E+06 7.334E+03 5.694E+03 4.433E+03 3.452E+03 2.688E+03
 TE         3.681E+06 3.376E+03 1.543E+03 1.097E+03 8.436E+02 6.558E+02
  I         5.540E+06 2.135E-02 2.135E-02 2.135E-02 2.135E-02 2.135E-02
 XE         3.956E+06 9.030E-05 7.690E-08 7.350E-11 7.025E-14 6.715E-17
 CS         3.548E+06 1.728E+05 1.408E+05 1.176E+05 1.006E+05 8.810E+04
 BA         4.388E+06 6.257E+04 6.114E+04 5.974E+04 5.838E+04 5.704E+04
 LA         4.395E+06 2.304E-03 5.877E-11 5.294E-11 5.294E-11 5.294E-11
 CE         3.412E+06 2.186E+05 8.957E+04 3.676E+04 1.509E+04 6.191E+03
 PR         3.064E+06 2.209E+05 9.065E+04 3.720E+04 1.527E+04 6.266E+03
 PM         8.318E+05 4.068E+04 3.121E+04 2.397E+04 1.840E+04 1.413E+04
 EU         2.383E+05 1.313E+04 1.184E+04 1.069E+04 9.657E+03 8.731E+03
 SUMTOT     7.436E+07 1.239E+06 6.987E+05 4.657E+05 3.491E+05 2.866E+05
0TOTAL      7.894E+07 1.242E+06 7.000E+05 4.665E+05 3.497E+05 2.872E+05
0                                         CUMULATIVE TABLE TOTALS

 AP+FP      7.925E+07 1.250E+06 7.040E+05 4.695E+05 3.521E+05 2.892E+05
 ACT+FP     1.057E+08 1.333E+06 7.816E+05 5.434E+05 4.230E+05 3.573E+05
 AP+ACT+FP  1.060E+08 1.342E+06 7.856E+05 5.464E+05 4.254E+05 3.593E+05
1                                                                          OUTPUT UNIT =  6
PAGE   30
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16

     * SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 SR 90      4.975E+01 4.858E+01 4.743E+01 4.632E+01 4.523E+01 4.417E+01
  Y 90      2.524E+02 2.320E+02 2.266E+02 2.212E+02 2.160E+02 2.110E+02
 RB 91      9.580E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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SR 93	8.897E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	1.046E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 95	1.003E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 95	9.202E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	3.623E+03	6.929E+01	1.325E+00	2.533E-02	4.844E-04	9.262E-06
NB 95	3.406E+03	1.476E+02	2.884E+00	5.519E-02	1.055E-03	2.018E-05
Y 96	1.520E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	9.677E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100	9.995E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB101	9.594E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	9.412E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB102	1.432E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO103	1.111E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	1.607E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO105	9.229E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC106	1.049E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.819E+03	1.704E+03	8.569E+02	4.308E+02	2.166E+02	1.089E+02
I132	1.148E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	1.981E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	1.519E+03	1.086E+03	7.757E+02	5.542E+02	3.960E+02	2.829E+02
I135	1.020E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	1.050E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	9.551E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	7.486E+01	7.315E+01	7.148E+01	6.985E+01	6.825E+01	6.670E+01
BA137M	2.519E+02	2.457E+02	2.401E+02	2.346E+02	2.292E+02	2.240E+02
CS138	1.757E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	8.886E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	9.330E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS140	1.696E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	1.403E+04	3.863E-05	9.768E-14	2.470E-22	6.246E-31	1.831E-39
CS141	9.620E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	1.504E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA143	8.980E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA144	1.171E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	3.528E+02	1.448E+02	5.941E+01	2.438E+01	1.001E+01	4.107E+00
PR144	3.953E+03	1.604E+03	6.584E+02	2.702E+02	1.109E+02	4.551E+01
EU154	7.758E+01	7.157E+01	6.603E+01	6.092E+01	5.620E+01	5.185E+01
SUMTOT	3.543E+05	5.427E+03	3.006E+03	1.913E+03	1.348E+03	1.039E+03
0TOTAL	8.885E+05	5.553E+03	3.063E+03	1.952E+03	1.378E+03	1.062E+03

OUTPUT UNIT = 6

1
PAGE 31
ORIGEN2 V2.1 (8-1-91), Run on 02/24/99 at 11:26:16

* SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL

+
FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 9 SUMMARY TABLE: THERMAL POWER, WATTS
ONE W 15X15 ANF PWR FUEL ASSEMBLY

	1.0S	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
BR	1.553E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR	2.205E+04	7.702E+00	7.220E+00	6.768E+00	6.344E+00	5.947E+00
RB	4.485E+04	9.734E-06	1.074E-08	1.073E-08	1.073E-08	1.073E-08
SR	4.079E+04	5.631E+01	4.749E+01	4.632E+01	4.523E+01	4.417E+01
Y	6.007E+04	2.537E+02	2.269E+02	2.212E+02	2.160E+02	2.110E+02
ZR	3.793E+04	6.929E+01	1.325E+00	2.546E-02	6.141E-04	1.389E-04
NB	8.626E+04	1.478E+02	2.887E+00	5.529E-02	1.108E-03	7.885E-05
MO	4.364E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC	6.547E+04	4.033E-03	4.033E-03	4.033E-03	4.033E-03	4.033E-03
RU	1.543E+04	1.501E+01	5.319E+00	2.671E+00	1.343E+00	6.750E-01
RH	2.008E+04	1.705E+03	8.569E+02	4.308E+02	2.166E+02	1.089E+02
SB	3.377E+04	2.315E+01	1.781E+01	1.387E+01	1.080E+01	8.409E+00
TE	3.386E+04	3.032E+00	1.313E+00	9.233E-01	7.092E-01	5.512E-01
I	7.987E+04	9.877E-06	9.877E-06	9.877E-06	9.877E-06	9.877E-06
XE	3.567E+04	1.569E-07	1.409E-10	1.347E-13	1.287E-16	1.230E-19
CS	6.508E+04	1.159E+03	8.471E+02	6.241E+02	4.642E+02	3.496E+02
BA	3.893E+04	2.457E+02	2.401E+02	2.346E+02	2.292E+02	2.240E+02
LA	6.932E+04	3.863E-05	4.859E-13	3.882E-13	3.882E-13	3.882E-13
CE	1.581E+04	1.452E+02	5.942E+01	2.438E+01	1.001E+01	4.107E+00

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 PR          2.567E+04 1.605E+03 6.588E+02 2.704E+02 1.110E+02 4.554E+01
 EU          2.280E+03 7.533E+01 6.930E+01 6.376E+01 5.867E+01 5.400E+01
 SUMTOT      8.524E+05 5.511E+03 3.042E+03 1.940E+03 1.370E+03 1.057E+03
0TOTAL       8.885E+05 5.553E+03 3.063E+03 1.952E+03 1.378E+03 1.062E+03
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       8.902E+05 5.597E+03 3.089E+03 1.974E+03 1.397E+03 1.079E+03
 ACT+FP      9.584E+05 6.177E+03 3.454E+03 2.291E+03 1.702E+03 1.380E+03
 AP+ACT+FP   9.601E+05 6.221E+03 3.481E+03 2.313E+03 1.722E+03 1.397E+03
1                                                                          OUTPUT UNIT =  6
PAGE   32
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16
                                SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
                              (ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC
 BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PU238       3.004E+06 3.147E+06 3.152E+06 3.134E+06 3.111E+06 3.087E+06
 PU239       1.361E+05 1.385E+05 1.385E+05 1.385E+05 1.385E+05 1.385E+05
 PU240       2.565E+05 2.569E+05 2.573E+05 2.577E+05 2.581E+05 2.585E+05
 AM241       8.428E+04 2.003E+05 3.106E+05 4.155E+05 5.153E+05 6.103E+05
 CM242       4.975E+07 1.061E+07 2.259E+06 4.890E+05 1.138E+05 3.422E+04
 CM244       6.635E+06 6.387E+06 6.147E+06 5.916E+06 5.694E+06 5.480E+06
0-------------------------------------------------------------------------------------------
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 TOTALS
 TABLE       5.992E+07 2.080E+07 1.232E+07 1.041E+07 9.888E+06 9.665E+06
 ACTUAL      5.992E+07 2.080E+07 1.232E+07 1.041E+07 9.888E+06 9.665E+06
1                                                                          OUTPUT UNIT =  6
PAGE   33
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16
                                SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
                            SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
                          BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PU240       1.352E+06 1.354E+06 1.357E+06 1.359E+06 1.361E+06 1.363E+06
 CM242       2.414E+08 5.148E+07 1.096E+07 2.373E+06 5.522E+05 1.661E+05
 CM244       7.988E+08 7.690E+08 7.401E+08 7.123E+08 6.856E+08 6.598E+08
 CM246       6.582E+06 6.581E+06 6.580E+06 6.579E+06 6.578E+06 6.577E+06
 CF252       3.676E+06 2.827E+06 2.173E+06 1.671E+06 1.285E+06 9.881E+05
0-------------------------------------------------------------------------------------------
----------------------------------
 TOTALS
 TABLE       1.053E+09 8.325E+08 7.625E+08 7.256E+08 6.966E+08 6.702E+08
 ACTUAL      1.053E+09 8.325E+08 7.625E+08 7.256E+08 6.966E+08 6.702E+08
0-------------------------------------------------------------------------------------------
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 OVERALL
 TOTALS
 TABLE       1.113E+09 8.533E+08 7.748E+08 7.360E+08 7.065E+08 6.798E+08
 ACTUAL      1.113E+09 8.533E+08 7.748E+08 7.360E+08 7.065E+08 6.798E+08
1                                                                          OUTPUT UNIT =  6
PAGE   34
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16
                 PHOTON SPECTRUM FOR ACTIVATION PRODUCTS
0                               SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
                                    POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02   2.203E+15 1.413E+13 6.891E+12 5.068E+12 4.014E+12 3.281E+12
 2.500E-02   7.037E+14 5.984E+13 3.317E+13 2.154E+13 1.531E+13 1.143E+13
 3.750E-02   2.877E+14 8.174E+12 6.133E+12 4.792E+12 3.754E+12 2.944E+12
 5.750E-02   4.095E+14 1.214E+12 5.591E+11 4.370E+11 3.631E+11 3.057E+11
 8.500E-02   2.375E+14 4.431E+11 2.232E+11 1.783E+11 1.487E+11 1.251E+11
 1.250E-01   1.643E+14 4.059E+11 2.248E+11 1.739E+11 1.389E+11 1.117E+11
 2.250E-01   3.890E+14 2.895E+12 2.071E+12 1.600E+12 1.246E+12 9.708E+11
 3.750E-01   2.266E+14 1.554E+13 1.208E+13 9.407E+12 7.325E+12 5.703E+12
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 5.750E-01  2.980E+15 2.034E+13 1.554E+13 1.209E+13 9.412E+12 7.327E+12
 8.500E-01  4.916E+15 8.531E+13 2.656E+12 4.950E+11 2.105E+11 9.690E+10
 1.250E+00  3.341E+14 1.244E+14 1.087E+14 9.524E+13 8.347E+13 7.318E+13
 1.750E+00  1.283E+14 1.446E+10 6.542E+08 1.519E+08 6.088E+07 2.931E+07
 2.250E+00  3.972E+13 1.532E+09 5.885E+08 5.047E+08 4.423E+08 3.878E+08
 2.750E+00  1.155E+13 2.671E+06 1.790E+06 1.561E+06 1.369E+06 1.200E+06
 3.500E+00  5.104E+11 2.422E-02 3.889E-03 6.247E-04 1.005E-04 1.630E-05
 5.000E+00  1.898E+10 7.210E-03 1.158E-03 1.859E-04 2.988E-05 4.817E-06
 7.000E+00  2.990E+12 4.678E-04 7.512E-05 1.207E-05 1.939E-06 3.126E-07
 9.500E+00  3.090E+09 2.958E-05 4.751E-06 7.629E-07 1.226E-07 1.976E-08
0  TOTAL    1.304E+16 3.327E+14 1.883E+14 1.510E+14 1.254E+14 1.055E+14
0MEV/SEC    6.966E+15 2.483E+14 1.533E+14 1.311E+14 1.136E+14 9.859E+13
0                                 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  2.203E+07 1.413E+05 6.891E+04 5.068E+04 4.014E+04 3.281E+04
 2.500E-02  1.759E+07 1.496E+06 8.293E+05 5.386E+05 3.828E+05 2.858E+05
 3.750E-02  1.079E+07 3.065E+05 2.300E+05 1.797E+05 1.408E+05 1.104E+05
 5.750E-02  2.355E+07 6.982E+04 3.215E+04 2.513E+04 2.088E+04 1.758E+04
 8.500E-02  2.019E+07 3.766E+04 1.897E+04 1.516E+04 1.264E+04 1.063E+04
 1.250E-01  2.053E+07 5.074E+04 2.810E+04 2.173E+04 1.736E+04 1.396E+04
 2.250E-01  8.752E+07 6.513E+05 4.661E+05 3.600E+05 2.803E+05 2.184E+05
 3.750E-01  8.499E+07 5.828E+06 4.531E+06 3.528E+06 2.747E+06 2.139E+06
 5.750E-01  1.714E+09 1.169E+07 8.938E+06 6.952E+06 5.412E+06 4.213E+06
 8.500E-01  4.179E+09 7.251E+07 2.257E+06 4.208E+05 1.789E+05 8.236E+04
 1.250E+00  4.176E+08 1.555E+08 1.359E+08 1.190E+08 1.043E+08 9.147E+07
 1.750E+00  2.245E+08 2.531E+04 1.145E+03 2.658E+02 1.065E+02 5.129E+01
 2.250E+00  8.936E+07 3.448E+03 1.324E+03 1.136E+03 9.952E+02 8.725E+02
 2.750E+00  3.176E+07 7.346E+00 4.923E+00 4.293E+00 3.764E+00 3.300E+00
 3.500E+00  1.786E+06 8.476E-08 1.361E-08 2.186E-09 3.517E-10 5.705E-11
 5.000E+00  9.488E+04 3.605E-08 5.789E-09 9.297E-10 1.494E-10 2.409E-11
 7.000E+00  2.093E+07 3.275E-09 5.259E-10 8.446E-11 1.357E-11 2.188E-12
 9.500E+00  2.936E+04 2.810E-10 4.513E-11 7.248E-12 1.165E-12 1.878E-13
0  TOTAL    6.966E+09 2.483E+08 1.533E+08 1.311E+08 1.136E+08 9.859E+07
0 GAM POW   1.117E+03 3.981E+01 2.458E+01 2.102E+01 1.821E+01 1.580E+01
1                                                                          OUTPUT UNIT =  6
PAGE   41
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16
                 PHOTON SPECTRUM FOR ACTINIDES + DAUGHTERS
0                                 SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
                                      POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  6.729E+17 1.055E+14 6.770E+13 5.934E+13 5.721E+13 5.642E+13
 2.500E-02  2.990E+16 2.168E+11 3.243E+11 4.266E+11 5.239E+11 6.164E+11
 3.750E-02  4.297E+16 3.187E+11 2.373E+11 2.245E+11 2.259E+11 2.301E+11
 5.750E-02  4.093E+16 2.937E+12 4.518E+12 6.022E+12 7.453E+12 8.814E+12
 8.500E-02  2.986E+17 9.125E+11 9.089E+11 9.052E+11 9.016E+11 8.980E+11
 1.250E-01  2.353E+17 8.137E+11 8.017E+11 7.936E+11 7.864E+11 7.796E+11
 2.250E-01  1.668E+17 6.506E+11 6.397E+11 6.310E+11 6.228E+11 6.150E+11
 3.750E-01  1.828E+16 3.560E+10 3.560E+10 3.560E+10 3.560E+10 3.560E+10
 5.750E-01  3.359E+15 1.122E+09 5.970E+08 5.478E+08 5.953E+08 6.581E+08
 8.500E-01  9.598E+15 2.205E+09 2.061E+09 2.020E+09 2.000E+09 1.984E+09
 1.250E+00  3.258E+15 1.082E+09 1.023E+09 9.951E+08 9.738E+08 9.545E+08
 1.750E+00  1.598E+12 2.941E+08 2.735E+08 2.651E+08 2.594E+08 2.542E+08
 2.250E+00  2.108E+08 1.644E+08 1.500E+08 1.427E+08 1.370E+08 1.318E+08
 2.750E+00  1.435E+08 1.501E+08 1.841E+08 2.238E+08 2.623E+08 2.969E+08
 3.500E+00  1.098E+08 8.575E+07 7.827E+07 7.444E+07 7.146E+07 6.876E+07
 5.000E+00  4.698E+07 3.668E+07 3.348E+07 3.184E+07 3.057E+07 2.941E+07
 7.000E+00  5.412E+06 4.229E+06 3.861E+06 3.672E+06 3.526E+06 3.392E+06
 9.500E+00  6.225E+05 4.860E+05 4.436E+05 4.219E+05 4.050E+05 3.897E+05
0  TOTAL    1.522E+18 1.114E+14 7.517E+13 6.838E+13 6.777E+13 6.841E+13
0MEV/SEC    1.248E+17 1.586E+12 1.294E+12 1.295E+12 1.356E+12 1.426E+12
0                                 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
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 EMEAN
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 1.000E-02  6.729E+09 1.055E+06 6.770E+05 5.934E+05 5.721E+05 5.642E+05
 2.500E-02  7.475E+08 5.420E+03 8.108E+03 1.066E+04 1.310E+04 1.541E+04
 3.750E-02  1.612E+09 1.195E+04 8.899E+03 8.417E+03 8.470E+03 8.627E+03
 5.750E-02  2.353E+09 1.689E+05 2.598E+05 3.463E+05 4.286E+05 5.068E+05
 8.500E-02  2.538E+10 7.756E+04 7.725E+04 7.694E+04 7.663E+04 7.633E+04
 1.250E-01  2.941E+10 1.017E+05 1.002E+05 9.920E+04 9.830E+04 9.745E+04
 2.250E-01  3.753E+10 1.464E+05 1.439E+05 1.420E+05 1.401E+05 1.384E+05
 3.750E-01  6.855E+09 1.335E+04 1.335E+04 1.335E+04 1.335E+04 1.335E+04
 5.750E-01  1.931E+09 6.450E+02 3.432E+02 3.150E+02 3.423E+02 3.784E+02
 8.500E-01  8.158E+09 1.874E+03 1.752E+03 1.717E+03 1.700E+03 1.686E+03
 1.250E+00  4.072E+09 1.353E+03 1.279E+03 1.244E+03 1.217E+03 1.193E+03
 1.750E+00  2.797E+06 5.146E+02 4.786E+02 4.640E+02 4.540E+02 4.449E+02
 2.250E+00  4.742E+02 3.699E+02 3.375E+02 3.210E+02 3.081E+02 2.965E+02
 2.750E+00  3.946E+02 4.127E+02 5.062E+02 6.155E+02 7.214E+02 8.166E+02
 3.500E+00  3.844E+02 3.001E+02 2.740E+02 2.605E+02 2.501E+02 2.407E+02
 5.000E+00  2.349E+02 1.834E+02 1.674E+02 1.592E+02 1.529E+02 1.471E+02
 7.000E+00  3.789E+01 2.960E+01 2.703E+01 2.571E+01 2.468E+01 2.374E+01
 9.500E+00  5.914E+00 4.617E+00 4.215E+00 4.008E+00 3.848E+00 3.702E+00
0  TOTAL    1.248E+11 1.586E+06 1.294E+06 1.295E+06 1.356E+06 1.426E+06
0 GAM POW   2.000E+04 2.542E-01 2.074E-01 2.076E-01 2.173E-01 2.285E-01
1                                                                          OUTPUT UNIT =  6
PAGE   47
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:26:16
                PHOTON SPECTRUM FOR FISSION PRODUCTS
0                               SOURCE FOR 3.45%, 50 GWD/MTU PWR FUEL
                                    POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 1.000E-02  9.960E+17 1.376E+16 7.005E+15 3.992E+15 2.582E+15 1.900E+15
 2.500E-02  2.641E+17 3.117E+15 1.622E+15 9.451E+14 6.195E+14 4.556E+14
 3.750E-02  2.151E+17 3.134E+15 1.631E+15 9.676E+14 6.603E+14 5.108E+14
 5.750E-02  2.142E+17 2.881E+15 1.458E+15 8.195E+14 5.213E+14 3.778E+14
 8.500E-02  1.573E+17 2.026E+15 1.019E+15 5.676E+14 3.575E+14 2.563E+14
 1.250E-01  1.711E+17 2.294E+15 1.120E+15 6.100E+14 3.802E+14 2.721E+14
 2.250E-01  3.596E+17 1.779E+15 8.897E+14 4.885E+14 3.012E+14 2.113E+14
 3.750E-01  2.794E+17 9.771E+14 5.056E+14 2.857E+14 1.786E+14 1.241E+14
 5.750E-01  4.601E+17 1.028E+16 7.352E+15 5.592E+15 4.469E+15 3.723E+15
 8.500E-01  4.654E+17 5.406E+15 2.788E+15 1.965E+15 1.415E+15 1.029E+15
 1.250E+00  2.560E+17 6.449E+14 4.302E+14 3.092E+14 2.359E+14 1.884E+14
 1.750E+00  9.719E+16 5.165E+13 2.612E+13 1.438E+13 8.738E+12 5.929E+12
 2.250E+00  4.758E+16 7.115E+13 3.007E+13 1.279E+13 5.475E+12 2.360E+12
 2.750E+00  2.016E+16 1.468E+12 7.331E+11 3.665E+11 1.834E+11 9.186E+10
 3.500E+00  9.536E+15 1.847E+11 9.286E+10 4.669E+10 2.347E+10 1.180E+10
 5.000E+00  3.793E+15 3.584E-05 3.629E-05 3.663E-05 3.690E-05 3.710E-05
 7.000E+00  3.236E+13 2.326E-06 2.355E-06 2.377E-06 2.394E-06 2.407E-06
 9.500E+00  6.260E+09 1.471E-07 1.489E-07 1.503E-07 1.514E-07 1.522E-07
0  TOTAL    4.017E+18 4.643E+16 2.588E+16 1.657E+16 1.173E+16 9.057E+15
0MEV/SEC    1.623E+18 1.329E+16 8.122E+15 5.815E+15 4.404E+15 3.488E+15
0                                 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                  BASIS= ONE W 15X15 ANF PWR FUEL ASSEMBLY
  EMEAN
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 1.000E-02  9.960E+09 1.376E+08 7.005E+07 3.992E+07 2.582E+07 1.900E+07
 2.500E-02  6.603E+09 7.793E+07 4.056E+07 2.363E+07 1.549E+07 1.139E+07
 3.750E-02  8.065E+09 1.175E+08 6.118E+07 3.629E+07 2.476E+07 1.916E+07
 5.750E-02  1.232E+10 1.657E+08 8.384E+07 4.712E+07 2.998E+07 2.172E+07
 8.500E-02  1.337E+10 1.722E+08 8.660E+07 4.825E+07 3.039E+07 2.178E+07
 1.250E-01  2.139E+10 2.867E+08 1.400E+08 7.625E+07 4.752E+07 3.401E+07
 2.250E-01  8.091E+10 4.002E+08 2.002E+08 1.099E+08 6.777E+07 4.753E+07
 3.750E-01  1.048E+11 3.664E+08 1.896E+08 1.071E+08 6.699E+07 4.652E+07
 5.750E-01  2.645E+11 5.912E+09 4.227E+09 3.215E+09 2.569E+09 2.141E+09
 8.500E-01  3.956E+11 4.595E+09 2.370E+09 1.670E+09 1.203E+09 8.746E+08
 1.250E+00  3.200E+11 8.061E+08 5.377E+08 3.865E+08 2.949E+08 2.355E+08
 1.750E+00  1.701E+11 9.038E+07 4.571E+07 2.516E+07 1.529E+07 1.038E+07
```

2.250E+00	1.071E+11	1.601E+08	6.767E+07	2.878E+07	1.232E+07	5.311E+06
2.750E+00	5.543E+10	4.038E+06	2.016E+06	1.008E+06	5.044E+05	2.526E+05
3.500E+00	3.338E+10	6.465E+05	3.250E+05	1.634E+05	8.216E+04	4.130E+04
5.000E+00	1.897E+10	1.792E-10	1.814E-10	1.832E-10	1.845E-10	1.855E-10
7.000E+00	2.265E+08	1.628E-11	1.648E-11	1.664E-11	1.676E-11	1.685E-11
9.500E+00	5.947E+04	1.397E-12	1.415E-12	1.428E-12	1.438E-12	1.446E-12
0 TOTAL	1.623E+12	1.329E+10	8.122E+09	5.815E+09	4.404E+09	3.488E+09
0 GAM POW	2.601E+05	2.131E+03	1.302E+03	9.322E+02	7.059E+02	5.592E+02

ORIGEN2 File: Cobalt Activation for SPC PWR Fuel with 3.45 wt% ^{235}U and 50 GWD/MTU

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RDA      ##########################################################
RDA      ##   IF300 HIGH BURNUP PWR FUEL                         ##
RDA      ##   Input Filename: CO345UE          ORIGEN2 VER2.1    ##
RDA      ##   Creation Date:        2/05/99                      ##
RDA      ##   Fuel Type:           3.45% W 15X15 ANF PWR         ##
RDA      ##   Burnup:50000 MWd/MTIHM, SP.POWER = 40MW/MTU        ##
RDA      ##   Cycle Burnup: 17.5, 17.5, 15K,  PWRUE  xsect lib ##
RDA      ##   CPL-WEIGHT,IRR HISTORY,FLX FACT=DOE/RW 0184,RV1   ##
RDA      ##   CO-60 ACTIVATION ANALYSIS                          ##
RDA      ##########################################################
LIP      0  0  0
LIB      0 1 2 3      604      605      606   9  0  0  1  39
PHO      101  102  103  10
RDA     READ UNIT AMOUNTS OF FUEL AND FUEL ASSEMBLY MATERIALS
RDA     -1 = FRESH PWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA     -2 = 1 KG COBALT
TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL MAT'LS
RDA     READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP     -1   1  -1  -1  1  1
RDA     READ 1.0 KG OF COBALT
INP     -2   1  -1  -1  1  1
RDA
RDA      MOVE MIXTURES INTO SCRATCH VECTORS
MOV            -1        -1        0       1.0  IN CORE U ONLY
MOV            -2        -2        0       1.0  1 KG COBALT
RDA
RDA     IRRADIATION OF ONE METRIC TON OF PWRU FUEL AT 100% POWER
BUP
IRP    75        40.0  -1   1   4  2   BURNUP= 3,000 MWD/MTIHM
IRP    150       40.0   1   2   4  0   BURNUP= 6,000 MWD/MTIHM
IRP    225       40.0   2   3   4  0   BURNUP= 9,000 MWD/MTIHM
IRP    300       40.0   3   4   4  0   BURNUP=12,000 MWD/MTIHM
IRP    375       40.0   4   5   4  0   BURNUP=15,000 MWD/MTIHM
IRP    437.5     40.0   5   5   4  0   BURNUP=17,500 MWD/MTIHM
DEC    543.5            5   6   4  0   DECAY FOR 106.0 DAYS
IRP    618.5     40.0   6   7   4  0   BURNUP=20,500 MWD/MTIHM
IRP    693.5     40.0   7   8   4  0   BURNUP=23,500 MWD/MTIHM
IRP    768.5     40.0   8   9   4  0   BURNUP=26,500 MWD/MTIHM
IRP    843.5     40.0   9  10   4  0   BURNUP=29,500 MWD/MTIHM
IRP    918.5     40.0  10  11   4  0   BURNUP=32,500 MWD/MTIHM
IRP    981       40.0  11  11   4  0   BURNUP=35,000 MWD/MTIHM
DEC    1087            11  12   4  0   DECAY FOR 106.0 DAYS
IRP    1162      40.0  12   1   4  0   BURNUP=38,000 MWD/MTIHM
IRP    1237      40.0   1   2   4  0   BURNUP=41,000 MWD/MTIHM
IRP    1312      40.0   2   3   4  0   BURNUP=44,000 MWD/MTIHM
IRP    1387      40.0   3   4   4  0   BURNUP=47,000 MWD/MTIHM
IRP    1462      40.0   4   5   4  0   BURNUP=50,000 MWD/MTIHM
BUP
RDA    -5  = IRRADIATED UO2 FUEL AT DISCHARGE [redacted] MTU/FA
MOV       5   -5      0      [redacted]
RDA
RDA     IRRADIATION OF 1 KG OF COBALT
RDA
IRF     75.0      -0.1  -2   1   4  2   BURNUP= 3,000 MWD/MTIHM
```

The highlighted data is proprietary information to Siemens Power Corporation.

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IRF     150       -0.1   1   2   4   0   BURNUP= 6,000 MWD/MTIHM
IRF     225       -0.1   2   3   4   0   BURNUP= 9,000 MWD/MTIHM
IRF     300       -0.1   3   4   4   0   BURNUP=12,000 MWD/MTIHM
IRF     375       -0.1   4   5   4   0   BURNUP=15,000 MWD/MTIHM
IRF     437.5     -0.1   5   5   4   0   BURNUP=17,500 MWD/MTIHM
DEC     543.5            5   6   4   0   DECAY FOR 106.0 DAYS
IRF     618.5     -0.1   6   7   4   0   BURNUP=20,500 MWD/MTIHM
IRF     693.5     -0.1   7   8   4   0   BURNUP=23,500 MWD/MTIHM
IRF     768.5     -0.1   8   9   4   0   BURNUP=26,500 MWD/MTIHM
IRF     843.5     -0.1   9  10   4   0   BURNUP=29,500 MWD/MTIHM
IRF     918.5     -0.1  10  11   4   0   BURNUP=32,500 MWD/MTIHM
IRF     981       -0.1  11  11   4   0   BURNUP=35,000 MWD/MTIHM
DEC     1087             11  12   4   0   DECAY FOR 106.0 DAYS
IRF     1162      -0.1  12   1   4   0   BURNUP=38,000 MWD/MTIHM
IRF     1237      -0.1   1   2   4   0   BURNUP=41,000 MWD/MTIHM
IRF     1312      -0.1   2   3   4   0   BURNUP=44,000 MWD/MTIHM
IRF     1387      -0.1   3   4   4   0   BURNUP=47,000 MWD/MTIHM
IRF     1462      -0.1   4  -1   4   0   BURNUP=50,000 MWD/MTIHM
RDA
RDA     -1 = IRRADIATED TOP NOZZLE MATERIAL
RDA
TIT       ACTIVATION OF 1 KG OF COBALT
DEC             1       -1        1        1        2
DEC             1        1        2        5        0
DEC             2        2        3        5        0
DEC             3        3        4        5        0
DEC             4        4        5        5        0
DEC             5        5        6        5        0
BAS       ONE W 15X15 ANF PWR FUEL ASSEMBLY
OPTL      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT       7  0.0001   9  0.01   25  0.01   25  0.01  27  0.01   -1
OUT       6   1   -1   0
STP       4
2   922340   89.     922350 34500.    922360     46.   922380 965365.   FUEL 3.45%
4   030000  1.0      050000 1.0       060000   89.4    070000 25.0      FUEL IMPU
4   080000 134454.   090000 10.7      110000   15.0    120000  2.0      FUEL IMPU
4   130000  16.7     140000 12.1      150000   35.0    170000  5.3      FUEL IMPU
4   200000  2.0      220000 1.0       230000   3.0     240000  4.0      FUEL IMPU
4   250000  1.7      260000 18.0      270000   1.0     280000 24.0      FUEL IMPU
4   290000  1.0      300000 40.3      420000   10.0    470000 0.1       FUEL IMPU
4   480000  25.0     490000 2.0       500000   4.0     640000 2.5       FUEL IMPU
4   740000  2.0      820000 1.0       830000   0.4     0      0.0       FUEL IMPU
0
4   270000  1000.         0 0.0            0   0.0        0    0.0      1 KG COBALT
0
END
1                                                                        OUTPUT UNIT =  6
PAGE   17
 ORIGEN2 V2.1 (8-1-91), Run on 02/24/99    at 11:38:01

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S       1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 FE          6.363E+00 2.293E-02 8.263E-05 2.976E-07 1.072E-09 3.864E-12
 CO          5.496E+04 2.249E+04 1.972E+04 1.729E+04 1.516E+04 1.329E+04
 SUMTOT      5.496E+04 2.249E+04 1.972E+04 1.729E+04 1.516E+04 1.329E+04
0TOTAL       5.496E+04 2.249E+04 1.972E+04 1.729E+04 1.516E+04 1.329E+04
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       5.496E+04 2.249E+04 1.972E+04 1.729E+04 1.516E+04 1.329E+04
 ACT+FP      0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AP+ACT+FP   5.496E+04 2.249E+04 1.972E+04 1.729E+04 1.516E+04 1.329E+04
```

ORIGEN2 File: Cobalt Activation for SPC PWR Fuel with 2.65 wt% ^{235}U and 35 GWD/MTU

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-1

-1

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RDA      ##########################################################
RDA      ##   IF300 HIGH BURNUP PWR FUEL                         ##
RDA      ##   Input Filename: CO265US          ORIGEN2 VER2.1    ##
RDA      ##   Creation Date:        2/05/99                      ##
RDA      ##   Fuel Type:          2.65% W 15X15 ANF PWR          ##
RDA      ##   Burnup:35000 MWd/MTIHM, SP.POWER = 40MW/MTU        ##
RDA      ##   Cycle Burnup: 12, 12, 11K,  PWRUS  xsect lib       ##
RDA      ##   CPL-WEIGHT,IRR HISTORY,FLX FACT=DOE/RW 0184,RV1    ##
RDA      ##   CO-60 ACTIVATION ANALYSIS                          ##
RDA      ##########################################################
LIP      0  0  0
LIB      0 1 2 3      601      602      603   9  0  0  1  38
PHO      101  102  103  10
RDA     READ UNIT AMOUNTS OF FUEL AND FUEL ASSEMBLY MATERIALS
RDA     -1 = FRESH PWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA     -2 = 1 KG COBALT
TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL MAT'LS
RDA     READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP     -1   1  -1  -1  1  1
RDA     READ 1.0 KG OF COBALT
INP     -2   1  -1  -1  1  1
RDA
RDA      MOVE MIXTURES INTO SCRATCH VECTORS
MOV            -1       -1        0      1.0  IN CORE U ONLY
MOV            -2       -2        0      1.0  1 KG COBALT
RDA
RDA     IRRADIATION OF ONE METRIC TON OF PWRU FUEL AT 100% POWER
BUP
IRP    75.00      40.0  -1   1   4  2   BURNUP=3,000  MWD/MTIHM
IRP    150.00     40.0   1   2   4  0   BURNUP=6,000  MWD/MTIHM
IRP    225.00     40.0   2   3   4  0   BURNUP=9,000  MWD/MTIHM
IRP    300.00     40.0   3   4   4  0   BURNUP=12,000 MWD/MTIHM
DEC    406.00            4   5   4  0   DECAY FOR 106.0 DAYS
IRP    481.00     40.0   5   6   4  0   BURNUP=15,000 MWD/MTIHM
IRP    556.00     40.0   6   7   4  0   BURNUP=18,000 MWD/MTIHM
IRP    631.00     40.0   7   8   4  0   BURNUP=21,000 MWD/MTIHM
IRP    706.00     40.0   8   9   4  0   BURNUP=24,000 MWD/MTIHM
DEC    812.00            9  10   4  0   DECAY FOR 106.0 DAYS
IRP    887.00     40.0  10   1   4  0   BURNUP=27,000 MWD/MTIHM
IRP    962.00     40.0   1   2   4  0   BURNUP=30,000 MWD/MTIHM
IRP    1037.00    40.0   2   3   4  0   BURNUP=33,000 MWD/MTIHM
IRP    1087.00    40.0   3   4   4  0   BURNUP=35,000 MWD/MTIHM
BUP
RDA    -4  = IRRADIATED UO2 FUEL AT DISCHARGE [redacted] MTU/FA
MOV       4   -4      0      [redacted]
RDA
RDA     IRRADIATION OF 1 KG OF COBALT
RDA
IRF    75.00      -0.1  -2   1   4  2   BURNUP=3,000  MWD/MTIHM
IRF    150.00     -0.1   1   2   4  0   BURNUP=6,000  MWD/MTIHM
IRF    225.00     -0.1   2   3   4  0   BURNUP=9,000  MWD/MTIHM
IRF    300.00     -0.1   3   4   4  0   BURNUP=12,000 MWD/MTIHM
DEC    406.00            4   5   4  0   DECAY FOR 106.0 DAYS
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```
IRF     481.00     -0.1   5   6   4   0   BURNUP=15,000 MWD/MTIHM
IRF     556.00     -0.1   6   7   4   0   BURNUP=18,000 MWD/MTIHM
IRF     631.00     -0.1   7   8   4   0   BURNUP=21,000 MWD/MTIHM
IRF     706.00     -0.1   8   9   4   0   BURNUP=24,000 MWD/MTIHM
DEC     812.00            9  10   4   0   DECAY FOR 106.0 DAYS
IRF     887.00     -0.1  10   1   4   0   BURNUP=27,000 MWD/MTIHM
IRF     962.00     -0.1   1   2   4   0   BURNUP=30,000 MWD/MTIHM
IRF     1037.00    -0.1   2   3   4   0   BURNUP=33,000 MWD/MTIHM
IRF     1087.00    -0.1   3  -1   4   0   BURNUP=35,000 MWD/MTIHM
RDA
RDA     -1 = IRRADIATED TOP NOZZLE MATERIAL
RDA
TIT       ACTIVATION OF 1 KG OF COBALT
DEC             1       -1        1        1        2
DEC             1        1        2        5        0
DEC             2        2        3        5        0
DEC             3        3        4        5        0
DEC             4        4        5        5        0
DEC             5        5        6        5        0
BAS       ONE W 15X15 ANF PWR FUEL ASSEMBLY
OPTL      8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT       7  0.0001   9  0.01   25  0.01   25  0.01  27  0.01   -1
CUT       6   1   -1   0
STP       4
2   922340   89.      922350 26500.    922360     46.   922380 973365.   FUEL 2.65%
4   030000  1.0       050000 1.0       060000   89.4    070000 25.0      FUEL IMPU
4   080000 134454.    090000 10.7      110000   15.0    120000  2.0      FUEL IMPU
4   130000  16.7      140000 12.1      150000   35.0    170000  5.3      FUEL IMPU
4   200000  2.0       220000 1.0       230000   3.0     240000  4.0      FUEL IMPU
4   250000  1.7       260000 18.0      270000   1.0     280000 24.0      FUEL IMPU
4   290000  1.0       300000 40.3      420000   10.0    470000 0.1       FUEL IMPU
4   480000  25.0      490000 2.0       500000   4.0     640000 2.5       FUEL IMPU
4   740000  2.0       820000 1.0       830000   0.4     0      0.0       FUEL IMPU
0
4   270000  1000.          0 0.0            0   0.0       0    0.0       1 KG COBALT
0
END

 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 11:03:23

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 FE 59       5.516E+00 1.987E-02 7.161E-05 2.580E-07 9.299E-10 3.352E-12
 CO 60       2.101E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
 CO 60M      3.190E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 61       6.083E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SUMTOT      5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
0TOTAL       5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
1                                                                          OUTPUT UNIT =  6
PAGE   16
 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 11:03:23

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 FE          5.516E+00 1.987E-02 7.161E-05 2.580E-07 9.299E-10 3.352E-12
 CO          5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
```

```
 SUMTOT      5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
0TOTAL       5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
 ACT+FP      0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AP+ACT+FP   5.297E+04 1.842E+04 1.615E+04 1.416E+04 1.241E+04 1.088E+04
1                                                                                    OUTPUT UNIT =  6
PAGE   18
 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 11:03:23

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO 60       3.239E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
 CO 60M      1.192E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SUMTOT      3.358E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
0TOTAL       3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
1                                                                                    OUTPUT UNIT =  6
PAGE   18
 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 11:03:23

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO          3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
 SUMTOT      3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
0TOTAL       3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
 ACT+FP      0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AP+ACT+FP   3.360E+02 2.839E+02 2.489E+02 2.183E+02 1.914E+02 1.678E+02
```

D-9.2 - APPENDIX B - ORIGEN2 FILES FOR BWR FUEL

ORIGEN2 File: GE BWR Fuel with 4.25 wt% ^{235}U and 45 GWD/MTU - Maximum Enrichment

```
-1

-1

-1

RDA     ######################################################
RDA     ##                                                  ##
RDA     ##   IF-300 45K BURNUP/ 4.25% ENRICHMENT AMENDMENT  ##
RDA     ##   Input Filename:       BWR425UE                 ##
RDA     ##   Creation Date:        12/28/98                 ##
RDA     ##   Fuel Type:            4.25% OCRWM DATABASE     ##
RDA     ##   Burnup:               45000 MWd/MTIHM          ##
RDA     ##   BWRUE    BWR XSECT Library                    ##
RDA     ##  .186 MTIHM/ASSEM - GE-7 Uranium Loading         ##
RDA     ######################################################
RDA
LIP     0  0  0
LIB     0 1 2 3      657      658      659   9  3  0  1  42
PHO     101  102  103  10
RDA    READ UNIT AMOUNTS OF FUEL AND FUEL ASSEM MAT WITH CHANNELS
INP           -1  1  -1  -1  1  1  ONE MTIHM UO2
INP           -2  1  -1  -1  1  1  ONE KG ZIRCALOY-4
INP           -3  1  -1  -1  1  1  ONE KG ZIRCALOY-2
INP           -4  1  -1  -1  1  1  ONE KG INCONEL-X750
INP           -5  1  -1  -1  1  1  ONE KG SS 302
INP           -6  1  -1  -1  1  1  ONE KG SS 304
RDA     MIX TOP, PLENUM, IN-CORE, AND BOTTOM MIXTURES
RDA     MIX TOP ZONE
MOV           -2       -7        0    0.000 ZIRCALOY-4
ADD           -3       -7        0    0.000 ZIRCALOY-2
ADD           -4       -7        0    0.000 INCONEL-X750
ADD           -5       -7        0    0.000 SS302
ADD           -6       -7        0    [redacted] SS304 - Max from Kunita
RDA     MIX PLENUM ZONE
MOV           -2       -8        0    [redacted] ZIRCALOY-4 - channel
ADD           -3       -8        0    [redacted] ZIRCALOY-2- Max from Kunita
ADD           -4       -8        0    [redacted] INCONEL-X750- Max from Kunita
ADD           -5       -8        0    [redacted] SS302
ADD           -6       -8        0    [redacted] SS304 - Max from Kunita
RDA     MIX IN-CORE ZONE - SANS UO2
MOV           -2       -9        0    [redacted] ZIRD-4 - channel,etc
ADD           -3       -9        0    [redacted] ZIRD-2 - Clad, etD-Max from Kunita
ADD           -4       -9        0    [redacted] INCONEL-X750
ADD           -5       -9        0    0.000 SS302
ADD           -6       -9        0    0.000 SS304
RDA     MIX BOTTOM ZONE
MOV           -2      -10        0    0.000 ZIRCALOY-4
ADD           -3      -10        0    [redacted] ZIRCALOY-2
ADD           -4      -10        0    [redacted] INCONEL-X750 Max from Kunita
ADD           -5      -10        0    0.000 SS302
ADD           -6      -10        0    [redacted] SS304 - Max from Kunita
RDA     IRRADIATE ONE MTIHM OF UO2 AT 100% POWER
BUP
IRP     106.18       25.9       -1        1   4   2  BURNUP =   2,750  MWD/MTIHM
IRP     212.36       25.9        1        1   4   0  BURNUP =   5,500  MWD/MTIHM
IRP     318.53       25.9        1        1   4   0  BURNUP =   8,250  MWD/MTIHM
IRP     463.32       25.9        1        1   4   0  BURNUP =  12,000  MWD/MTIHM
DEC     569.32                   1        1   4   0  106 DAY OUTAGE
```

The highlighted information is proprietary information to General Electric.

```
IRP     675.50     25.9      1      1   4   0  BURNUP =  14,750  MWD/MTIHM
IRP     781.68     25.9      1      1   4   0  BURNUP =  17,500  MWD/MTIHM
IRP     887.85     25.9      1      1   4   0  BURNUP =  20,250  MWD/MTIHM
IRP     994.03     25.9      1      1   4   0  BURNUP =  23,000  MWD/MTIHM
DEC    1100.03               1      1   4   0  106 DAY OUTAGE
IRP    1206.21     25.9      1      1   4   0  BURNUP =  25,750  MWD/MTIHM
IRP    1312.39     25.9      1      1   4   0  BURNUP =  28,500  MWD/MTIHM
IRP    1418.56     25.9      1      1   4   0  BURNUP =  31,250  MWD/MTIHM
IRP    1524.74     25.9      1      1   4   0  BURNUP =  34,000  MWD/MTIHM
DEC    1630.74               1      1   4   0  106 DAY OUTAGE
IRP    1736.92     25.9      1      1   4   0  BURNUP =  36,750  MWD/MTIHM
IRP    1843.10     25.9      1      1   4   0  BURNUP =  39,500  MWD/MTIHM
IRP    1949.27     25.9      1      1   4   0  BURNUP =  42,250  MWD/MTIHM
IRP    2055.45     25.9      1      1   4   0  BURNUP =  45,000  MWD/MTIHM
BUP
RDA
RDA    IRRADIATE TOP ZONE MATERIAL AT 10% FLUX
IRF    106.18     -0.1     -7      7   4   2
IRF    212.36     -0.1      7      7   4   0
IRF    318.53     -0.1      7      7   4   0
IRF    463.32     -0.1      7      7   4   0
DEC    569.32               7      7   4   0
IRF    675.50     -0.1      7      7   4   0
IRF    781.68     -0.1      7      7   4   0
IRF    887.85     -0.1      7      7   4   0
IRF    994.03     -0.1      7      7   4   0
DEC    1100.03              7      7   4   0
IRF    1206.21    -0.1      7      7   4   0
IRF    1312.39    -0.1      7      7   4   0
IRF    1418.56    -0.1      7      7   4   0
IRF    1524.74    -0.1      7      7   4   0
DEC    1630.74              7      7   4   0
IRF    1736.92    -0.1      7      7   4   0
IRF    1843.10    -0.1      7      7   4   0
IRF    1949.27    -0.1      7      7   4   0
IRF    2055.45    -0.1      7      7   4   0
RDA
RDA    IRRADIATE PLENUM ZONE MATERIAL AT 20% FLUX
IRF    106.18     -0.2     -8      8   4   2
IRF    212.36     -0.2      8      8   4   0
IRF    318.53     -0.2      8      8   4   0
IRF    463.32     -0.2      8      8   4   0
DEC    569.32               8      8   4   0
IRF    675.50     -0.2      8      8   4   0
IRF    781.68     -0.2      8      8   4   0
IRF    887.85     -0.2      8      8   4   0
IRF    994.03     -0.2      8      8   4   0
DEC    1100.03              8      8   4   0
IRF    1206.21    -0.2      8      8   4   0
IRF    1312.39    -0.2      8      8   4   0
IRF    1418.56    -0.2      8      8   4   0
IRF    1524.74    -0.2      8      8   4   0
DEC    1630.74              8      8   4   0
IRF    1736.92    -0.2      8      8   4   0
IRF    1843.10    -0.2      8      8   4   0
IRF    1949.27    -0.2      8      8   4   0
IRF    2055.45    -0.2      8      8   4   0
RDA
RDA    IRRADIATE CORE ZONE (SANS UO2) AT 100% FLUX
IRF    106.18     -1.0     -9      9   4   2
IRF    212.36     -1.0      9      9   4   0
IRF    318.53     -1.0      9      9   4   0
IRF    463.32     -1.0      9      9   4   0
DEC    569.32               9      9   4   0
IRF    675.50     -1.0      9      9   4   0
IRF    781.68     -1.0      9      9   4   0
IRF    887.85     -1.0      9      9   4   0
IRF    994.03     -1.0      9      9   4   0
```

```
DEC     1100.03                 9        9   4   0
IRF     1206.21       -1.0      9        9   4   0
IRF     1312.39       -1.0      9        9   4   0
IRF     1418.56       -1.0      9        9   4   0
IRF     1524.74       -1.0      9        9   4   0
DEC     1630.74                 9        9   4   0
IRF     1736.92       -1.0      9        9   4   0
IRF     1843.10       -1.0      9        9   4   0
IRF     1949.27       -1.0      9        9   4   0
IRF     2055.45       -1.0      9        9   4   0
RDA
RDA     IRRADIATE BOTTOM ZONE MATERIAL AT 15% FLUX
IRF     106.18       -0.15     -10       10  4   2
IRF     212.36       -0.15      10       10  4   0
IRF     318.53       -0.15      10       10  4   0
IRF     463.32       -0.15      10       10  4   0
DEC     569.32                  10       10  4   0
IRF     675.50       -0.15      10       10  4   0
IRF     781.68       -0.15      10       10  4   0
IRF     887.85       -0.15      10       10  4   0
IRF     994.03       -0.15      10       10  4   0
DEC     1100.03                 10       10  4   0
IRF     1206.21      -0.15      10       10  4   0
IRF     1312.39      -0.15      10       10  4   0
IRF     1418.56      -0.15      10       10  4   0
IRF     1524.74      -0.15      10       10  4   0
DEC     1630.74                 10       10  4   0
IRF     1736.92      -0.15      10       10  4   0
IRF     1843.10      -0.15      10       10  4   0
IRF     1949.27      -0.15      10       10  4   0
IRF     2055.45      -0.15      10       10  4   0
RDA
RDA     MIX A COMBINED IN-CORE ZONE
MOV            9       11        0      1.0
ADD            1       11        0      [redacted]
RDA     MIX A WHOLE ASSEMBLY OUT OF THE PARTS
MOV            7       12        0      1.0 TOP ZONE
ADD            8       12        0      1.0 PLENUM ZONE
ADD           10       12        0      1.0 BOTTOM ZONE
ADD           11       12        0      1.0 (COMBINED) IN-CORE ZONE
RDA     MOVE ASSEMBLY PARTS TO SCRATCH VECTORS
MOV            7       -1        0      1.0 TOP ZONE
MOV            8       -2        0      1.0 PLENUM ZONE
MOV           11       -3        0      1.0 (COMBINED) IN-CORE ZONE
MOV           10       -4        0      1.0 BOTTOM ZONE
MOV           12       -5        0      1.0 WHOLE ASSEMBLY
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AT DISCHARGE
BAS     ONE GE8X8 FUEL ASSEMBLY
OPTL    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT     7 0.0001 9 .01  25 .01  26 .01  27 .01     -1
RDA     MOVE VECTORS -1 THRU -5 TO POSITIVE VECTORS FOR OUTPUT
MOV           -1        1        0      1.0
MOV           -2        2        0      1.0
MOV           -3        3        0      1.0
MOV           -4        4        0      1.0
MOV           -5        5        0      1.0
HED            1 TOP
HED            2 PLENUM
HED            3 IN-CORE
HED            4 BOTTOM
HED            5 WHOLE
```

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```
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 0.3 YRS
DEC             0.3       -1        1        5        4
DEC             0.3       -2        2        5        4
DEC             0.3       -3        3        5        4
DEC             0.3       -4        4        5        4
DEC             0.3       -5        5        5        4
HED             1 TOP
HED             2 PLENUM
HED             3 IN-CORE
HED             4 BOTTOM
HED             5 WHOLE
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 1 YRS
DEC             1        -1        1        5        4
DEC             1        -2        2        5        4
DEC             1        -3        3        5        4
DEC             1        -4        4        5        4
DEC             1        -5        5        5        4
HED             1 TOP
HED             2 PLENUM
HED             3 IN-CORE
HED             4 BOTTOM
HED             5 WHOLE
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 2 YRS
DEC             2        -1        1        5        4
DEC             2        -2        2        5        4
DEC             2        -3        3        5        4
DEC             2        -4        4        5        4
DEC             2        -5        5        5        4
HED             1 TOP
HED             2 PLENUM
HED             3 IN-CORE
HED             4 BOTTOM
HED             5 WHOLE
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 3 YRS
DEC             3        -1        1        5        4
DEC             3        -2        2        5        4
DEC             3        -3        3        5        4
DEC             3        -4        4        5        4
DEC             3        -5        5        5        4
HED             1 TOP
HED             2 PLENUM
HED             3 IN-CORE
HED             4 BOTTOM
HED             5 WHOLE
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
DEC             4        -1        1        5        4
DEC             4        -2        2        5        4
DEC             4        -3        3        5        4
DEC             4        -4        4        5        4
DEC             4        -5        5        5        4
HED             1 TOP
HED             2 PLENUM
HED             3 IN-CORE
HED             4 BOTTOM
HED             5 WHOLE
OUT     5   1   -1   0
TIT     SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 5 YRS
DEC             5        -1        1        5        4
DEC             5        -2        2        5        4
DEC             5        -3        3        5        4
DEC             5        -4        4        5        4
DEC             5        -5        5        5        4
HED             1 TOP
```

```
HED              2 PLENUM
HED              3 IN-CORE
HED              4 BOTTOM
HED              5 WHOLE
OUT       5   1   -1   0
END
2   922340      89.0   922350  42500.0   922360    46.0    922380 957365.0 1 MTIHM FUEL
4    30000 1.00E+00    50000 1.00E+00    60000 8.94E+01    80000 1.19E+05 1 MTIHM FUEL IMPUR
4    90000 1.07E+01   110000 1.50E+01   130000 1.67E+01   140000 1.21E+01 1 MTIHM FUEL IMPUR
4   150000 3.50E+01   200000 2.00E+00   220000 1.00E+00   240000 3.00E+00 1 MTIHM FUEL IMPUR
4   250000 1.70E+00   260000 1.80E+01   270000 1.00E+00   290000 1.00E+00 1 MTIHM FUEL IMPUR
4   300000 4.03E+01   420000 1.00E+01   480000 2.50E+01   490000 2.00E+00 1 MTIHM FUEL IMPUR
4   500000 4.00E+00   740000 2.00E+00   820000 1.00E+00   830000 4.00E-01 1 MTIHM FUEL IMPUR
0
4    10000 1.30E-02    50000 3.30E-04    60000 1.20E-01    70000 8.00E-02 1 KG ZIRD-4
4    80000 9.50E-01   130000 2.40E-02   160000 3.50E-02   220000 2.00E-02 1 KG ZIRD-4
4   230000 2.00E-02   240000 1.25E+00   250000 2.00E-02   260000 2.25E+00 1 KG ZIRD-4
4   270000 1.00E-02   280000 2.00E-02   290000 2.00E-02   400000 9.80E+02 1 KG ZIRD-4
4   410000 1.20E-01   480000 2.50E-04   500000 1.60E+01   720000 7.80E-02 1 KG ZIRD-4
4   740000 2.00E-02   922340 2.00E-04        0 0.00E+00        0 0.00E+00 1 KG ZIRD-4
0
4    10000 1.30E-02    50000 3.30E-04    60000 1.20E-01    70000 8.00E-02 1 KG ZIRD-2
4    80000 9.50E-01   130000 2.40E-02   160000 3.50E-02   220000 2.00E-02 1 KG ZIRD-2
4   230000 2.00E-02   240000 1.00E+00   250000 2.00E-02   260000 1.50E+00 1 KG ZIRD-2
4   270000 1.00E-02   280000 5.00E-01   290000 2.00E-02   400000 9.80E+02 1 KG ZIRD-2
4   410000 1.20E-01   480000 2.50E-04   500000 1.60E+01   720000 7.80E-02 1 KG ZIRD-2
4   740000 2.00E-02        0 0.00E+00        0 0.00E+00        0 0.00E+00 1 KG ZIRD-2
0
4    60000 4.00E-01    70000 1.30E+00   130000 8.00E+00   140000 3.00E+00 1 KG IND-X750
4   160000 7.00E-02   220000 2.49E+01   240000 1.50E+02   250000 7.00E+01 1 KG IND-X750
4   260000 6.78E+01   270000 6.49E+00   280000 7.22E+02   290000 5.00E-01 1 KG IND-X750
4   410000 9.00E+00        0 0.00E+00        0 0.00E+00        0 0.00E+00 1 KG IND-X750
0
4    60000 1.50E+00    70000 1.30E+00   140000 1.00E+01   150000 4.50E-01 1 KG SS-302
4   160000 3.00E-01   240000 1.80E+02   250000 2.00E+01   260000 6.98E+02 1 KG SS-302
4   270000 8.00E-01   280000 8.92E+01   410000 1.00E-01        0 0.00E+00 1 KG SS-302
0
4    60000 8.00E-01    70000 1.30E+00   140000 1.00E+01   150000 4.50E-01 1 KG SS-304
4   160000 3.00E-01   240000 1.90E+02   250000 2.00E+01   260000 6.88E+02 1 KG SS-304
4   270000 8.00E-01   280000 8.92E+01   410000 1.00E-01        0 0.00E+00 1 KG SS-304
0

 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36

     * SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE GE8X8 FUEL ASSEMBLY
            TOP        PLENUM    IN-CORE   BOTTOM    WHOLE
  H  3      0.000E+00 0.000E+00 1.030E+02 0.000E+00 1.030E+02
 KR 85      0.000E+00 0.000E+00 1.669E+03 0.000E+00 1.669E+03
 SR 90      0.000E+00 0.000E+00 1.616E+04 0.000E+00 1.616E+04
  Y 90      0.000E+00 0.000E+00 1.616E+04 0.000E+00 1.616E+04
 RU106      0.000E+00 0.000E+00 5.723E+03 0.000E+00 5.723E+03
 RH106      0.000E+00 0.000E+00 5.723E+03 0.000E+00 5.723E+03
 AG110M     0.000E+00 0.000E+00 1.728E+01 0.000E+00 1.728E+01
 SB125      0.000E+00 0.000E+00 1.011E+03 0.000E+00 1.011E+03
 TE125M     0.000E+00 0.000E+00 2.466E+02 0.000E+00 2.466E+02
 CS134      0.000E+00 0.000E+00 1.207E+04 0.000E+00 1.207E+04
 CS137      0.000E+00 0.000E+00 2.319E+04 0.000E+00 2.319E+04
 BA137M     0.000E+00 0.000E+00 2.194E+04 0.000E+00 2.194E+04
 CE144      0.000E+00 0.000E+00 4.467E+03 0.000E+00 4.467E+03
 PR144      0.000E+00 0.000E+00 4.467E+03 0.000E+00 4.467E+03
 PR144M     0.000E+00 0.000E+00 5.360E+01 0.000E+00 5.360E+01
 PM147      0.000E+00 0.000E+00 7.582E+03 0.000E+00 7.582E+03
 SM151      0.000E+00 0.000E+00 1.005E+02 0.000E+00 1.005E+02
 EU154      0.000E+00 0.000E+00 2.061E+03 0.000E+00 2.061E+03
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 EU155       0.000E+00 0.000E+00 1.134E+03 0.000E+00 1.134E+03
 SUMTOT      0.000E+00 0.000E+00 1.239E+05 0.000E+00 1.239E+05
0TOTAL       0.000E+00 0.000E+00 1.239E+05 0.000E+00 1.239E+05
1                                                                    OUTPUT UNIT =  6
PAGE  201
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36

     * SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                              ONE GE8X8 FUEL ASSEMBLY
             TOP        PLENUM    IN-CORE   BOTTOM    WHOLE
  H          0.000E+00 0.000E+00 1.030E+02 0.000E+00 1.030E+02
 KR          0.000E+00 0.000E+00 1.669E+03 0.000E+00 1.669E+03
 SR          0.000E+00 0.000E+00 1.616E+04 0.000E+00 1.616E+04
  Y          0.000E+00 0.000E+00 1.616E+04 0.000E+00 1.616E+04
 RU          0.000E+00 0.000E+00 5.723E+03 0.000E+00 5.723E+03
 RH          0.000E+00 0.000E+00 5.723E+03 0.000E+00 5.723E+03
 AG          0.000E+00 0.000E+00 1.751E+01 0.000E+00 1.751E+01
 SB          0.000E+00 0.000E+00 1.011E+03 0.000E+00 1.011E+03
 TE          0.000E+00 0.000E+00 2.470E+02 0.000E+00 2.470E+02
 CS          0.000E+00 0.000E+00 3.526E+04 0.000E+00 3.526E+04
 BA          0.000E+00 0.000E+00 2.194E+04 0.000E+00 2.194E+04
 CE          0.000E+00 0.000E+00 4.467E+03 0.000E+00 4.467E+03
 PR          0.000E+00 0.000E+00 4.520E+03 0.000E+00 4.520E+03
 PM          0.000E+00 0.000E+00 7.582E+03 0.000E+00 7.582E+03
 SM          0.000E+00 0.000E+00 1.005E+02 0.000E+00 1.005E+02
 EU          0.000E+00 0.000E+00 3.196E+03 0.000E+00 3.196E+03
 SUMTOT      0.000E+00 0.000E+00 1.239E+05 0.000E+00 1.239E+05
0TOTAL       0.000E+00 0.000E+00 1.239E+05 0.000E+00 1.239E+05
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       4.168E+01 1.670E+02 1.247E+05 1.451E+02 1.250E+05
 ACT+FP      0.000E+00 0.000E+00 1.511E+05 0.000E+00 1.511E+05
 AP+ACT+FP   4.168E+01 1.670E+02 1.518E+05 1.451E+02 1.522E+05
1                                                                    OUTPUT UNIT =  6
PAGE  202
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36

     * SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE GE8X8 FUEL ASSEMBLY
             TOP        PLENUM    IN-CORE   BOTTOM    WHOLE
 SR 90       0.000E+00 0.000E+00 1.875E+01 0.000E+00 1.875E+01
  Y 90       0.000E+00 0.000E+00 8.958E+01 0.000E+00 8.958E+01
 RH106       0.000E+00 0.000E+00 5.489E+01 0.000E+00 5.489E+01
 CS134       0.000E+00 0.000E+00 1.229E+02 0.000E+00 1.229E+02
 CS137       0.000E+00 0.000E+00 2.565E+01 0.000E+00 2.565E+01
 BA137M      0.000E+00 0.000E+00 8.614E+01 0.000E+00 8.614E+01
 PR144       0.000E+00 0.000E+00 3.283E+01 0.000E+00 3.283E+01
 EU154       0.000E+00 0.000E+00 1.843E+01 0.000E+00 1.843E+01
 SUMTOT      0.000E+00 0.000E+00 4.491E+02 0.000E+00 4.491E+02
0TOTAL       0.000E+00 0.000E+00 4.622E+02 0.000E+00 4.622E+02
1                                                                    OUTPUT UNIT =  6
PAGE  203
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36

     * SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                     9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE GE8X8 FUEL ASSEMBLY
             TOP        PLENUM    IN-CORE   BOTTOM    WHOLE
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```
 SR          0.000E+00 0.000E+00 1.875E+01 0.000E+00 1.875E+01
  Y          0.000E+00 0.000E+00 8.958E+01 0.000E+00 8.958E+01
 RH          0.000E+00 0.000E+00 5.489E+01 0.000E+00 5.489E+01
 CS          0.000E+00 0.000E+00 1.485E+02 0.000E+00 1.485E+02
 BA          0.000E+00 0.000E+00 8.614E+01 0.000E+00 8.614E+01
 PR          0.000E+00 0.000E+00 3.285E+01 0.000E+00 3.285E+01
 EU          0.000E+00 0.000E+00 1.927E+01 0.000E+00 1.927E+01
 SUMTOT      0.000E+00 0.000E+00 4.500E+02 0.000E+00 4.500E+02
0TOTAL       0.000E+00 0.000E+00 4.622E+02 0.000E+00 4.622E+02
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       2.913E-01 1.619E+00 4.682E+02 1.050E+00 4.711E+02
 ACT+FP      0.000E+00 0.000E+00 5.568E+02 0.000E+00 5.568E+02
 AP+ACT+FP   2.913E-01 1.619E+00 5.628E+02 1.050E+00 5.657E+02
1                                                                    OUTPUT UNIT =  6
PAGE  204
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36
                                SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
                              (ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC
 BASIS= ONE GE8X8 FUEL ASSEMBLY
             TOP        PLENUM     IN-CORE    BOTTOM     WHOLE
 PU238       0.000E+00 0.000E+00 1.175E+06 0.000E+00 1.175E+06
 PU239       0.000E+00 0.000E+00 5.227E+04 0.000E+00 5.227E+04
 PU240       0.000E+00 0.000E+00 8.740E+04 0.000E+00 8.740E+04
 AM241       0.000E+00 0.000E+00 2.133E+05 0.000E+00 2.133E+05
 CM242       0.000E+00 0.000E+00 4.637E+04 0.000E+00 4.637E+04
 CM244       0.000E+00 0.000E+00 1.236E+06 0.000E+00 1.236E+06
0-----------------------------------------------------------------------------------------
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 TOTALS
 TABLE       0.000E+00 0.000E+00 2.828E+06 0.000E+00 2.828E+06
 ACTUAL      0.000E+00 0.000E+00 2.828E+06 0.000E+00 2.828E+06
1                                                                    OUTPUT UNIT =  6
PAGE  205
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36
                                SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
                            SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
                          BASIS= ONE GE8X8 FUEL ASSEMBLY
             TOP        PLENUM     IN-CORE    BOTTOM     WHOLE
 CM244       0.000E+00 0.000E+00 1.488E+08 0.000E+00 1.488E+08
0-----------------------------------------------------------------------------------------
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 TOTALS
 TABLE       0.000E+00 0.000E+00 1.509E+08 0.000E+00 1.509E+08
 ACTUAL      0.000E+00 0.000E+00 1.509E+08 0.000E+00 1.509E+08
0-----------------------------------------------------------------------------------------
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 OVERALL
 TOTALS
 TABLE       0.000E+00 0.000E+00 1.537E+08 0.000E+00 1.537E+08
 ACTUAL      0.000E+00 0.000E+00 1.537E+08 0.000E+00 1.537E+08
1                                                                    OUTPUT UNIT =  6
PAGE  206
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:36
                PHOTON SPECTRUM FOR ACTIVATION PRODUCTS
0                               SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS
                                    POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00

N/CM**2-SEC
0                                 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                  BASIS= ONE GE8X8 FUEL ASSEMBLY

  EMEAN
             TOP        PLENUM     IN-CORE    BOTTOM     WHOLE
 1.000E-02  3.888E+10 2.184E+11 1.441E+12 1.413E+11 1.840E+12
 2.500E-02  6.360E+09 1.075E+11 6.830E+12 3.878E+10 6.982E+12
 3.750E-02  3.625E+09 3.744E+10 1.673E+12 1.686E+10 1.731E+12
 5.750E-02  4.086E+09 2.327E+10 1.246E+11 1.483E+10 1.668E+11
 8.500E-02  1.606E+09 9.176E+09 5.161E+10 5.836E+09 6.822E+10
 1.250E-01  6.169E+08 3.923E+09 5.690E+10 2.329E+09 6.376E+10
 2.250E-01  2.029E+08 7.162E+09 5.651E+11 2.060E+09 5.746E+11
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3.750E-01	5.692E+07	3.614E+10	3.335E+12	8.097E+09	3.379E+12
5.750E-01	3.395E+06	4.607E+10	4.285E+12	1.016E+10	4.341E+12

BASIS= ONE GE8X8 FUEL ASSEMBLY

EMEAN	TOP	PLENUM	IN-CORE	BOTTOM	WHOLE
1.000E-02	0.000E+00	0.000E+00	1.723E+05	0.000E+00	1.723E+05
2.500E-02	0.000E+00	0.000E+00	5.414E+03	0.000E+00	5.414E+03
3.750E-02	0.000E+00	0.000E+00	2.687E+03	0.000E+00	2.687E+03
5.750E-02	0.000E+00	0.000E+00	1.772E+05	0.000E+00	1.772E+05
8.500E-02	0.000E+00	0.000E+00	2.240E+04	0.000E+00	2.240E+04
1.250E-01	0.000E+00	0.000E+00	3.051E+04	0.000E+00	3.051E+04
2.250E-01	0.000E+00	0.000E+00	4.259E+04	0.000E+00	4.259E+04
3.750E-01	0.000E+00	0.000E+00	3.911E+03	0.000E+00	3.911E+03
5.750E-01	0.000E+00	0.000E+00	1.305E+02	0.000E+00	1.305E+02
8.500E-01	0.000E+00	0.000E+00	6.608E+02	0.000E+00	6.608E+02
1.250E+00	0.000E+00	0.000E+00	5.079E+02	0.000E+00	5.079E+02
1.750E+00	0.000E+00	0.000E+00	1.063E+02	0.000E+00	1.063E+02
2.250E+00	0.000E+00	0.000E+00	6.684E+01	0.000E+00	6.684E+01
2.750E+00	0.000E+00	0.000E+00	2.514E+02	0.000E+00	2.514E+02
3.500E+00	0.000E+00	0.000E+00	5.425E+01	0.000E+00	5.425E+01
5.000E+00	0.000E+00	0.000E+00	3.315E+01	0.000E+00	3.315E+01
7.000E+00	0.000E+00	0.000E+00	5.351E+00	0.000E+00	5.351E+00
9.500E+00	0.000E+00	0.000E+00	8.343E-01	0.000E+00	8.343E-01
0 TOTAL	0.000E+00	0.000E+00	4.589E+05	0.000E+00	4.589E+05
0 GAM POW	0.000E+00	0.000E+00	7.355E-02	0.000E+00	7.355E-02

1 OUTPUT UNIT = 6

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ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:46:36

PHOTON SPECTRUM FOR FISSION PRODUCTS

0 SOURCE CHARACTERISTICS OF 4.25%, 45.0 GWD/MTIHM FUEL AFTER 4 YRS

POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00

N/CM**2-SEC

0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND

BASIS= ONE GE8X8 FUEL ASSEMBLY

EMEAN	TOP	PLENUM	IN-CORE	BOTTOM	WHOLE
1.000E-02	0.000E+00	0.000E+00	8.775E+14	0.000E+00	8.775E+14
2.500E-02	0.000E+00	0.000E+00	2.058E+14	0.000E+00	2.058E+14
3.750E-02	0.000E+00	0.000E+00	2.241E+14	0.000E+00	2.241E+14
5.750E-02	0.000E+00	0.000E+00	1.752E+14	0.000E+00	1.752E+14
8.500E-02	0.000E+00	0.000E+00	1.191E+14	0.000E+00	1.191E+14
1.250E-01	0.000E+00	0.000E+00	1.236E+14	0.000E+00	1.236E+14
2.250E-01	0.000E+00	0.000E+00	9.864E+13	0.000E+00	9.864E+13
3.750E-01	0.000E+00	0.000E+00	5.617E+13	0.000E+00	5.617E+13
5.750E-01	0.000E+00	0.000E+00	1.518E+15	0.000E+00	1.518E+15
8.500E-01	0.000E+00	0.000E+00	4.403E+14	0.000E+00	4.403E+14
1.250E+00	0.000E+00	0.000E+00	7.429E+13	0.000E+00	7.429E+13
1.750E+00	0.000E+00	0.000E+00	2.536E+12	0.000E+00	2.536E+12
2.250E+00	0.000E+00	0.000E+00	1.569E+12	0.000E+00	1.569E+12
2.750E+00	0.000E+00	0.000E+00	4.664E+10	0.000E+00	4.664E+10
3.500E+00	0.000E+00	0.000E+00	5.948E+09	0.000E+00	5.948E+09
5.000E+00	0.000E+00	0.000E+00	1.481E-05	0.000E+00	1.481E-05
7.000E+00	0.000E+00	0.000E+00	9.610E-07	0.000E+00	9.610E-07
9.500E+00	0.000E+00	0.000E+00	6.077E-08	0.000E+00	6.077E-08
0 TOTAL	0.000E+00	0.000E+00	3.917E+15	0.000E+00	3.917E+15
0MEV/SEC	0.000E+00	0.000E+00	1.449E+15	0.000E+00	1.449E+15

0 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC

BASIS= ONE GE8X8 FUEL ASSEMBLY

EMEAN	TOP	PLENUM	IN-CORE	BOTTOM	WHOLE
1.000E-02	0.000E+00	0.000E+00	8.775E+06	0.000E+00	8.775E+06
2.500E-02	0.000E+00	0.000E+00	5.146E+06	0.000E+00	5.146E+06
3.750E-02	0.000E+00	0.000E+00	8.403E+06	0.000E+00	8.403E+06
5.750E-02	0.000E+00	0.000E+00	1.008E+07	0.000E+00	1.008E+07
8.500E-02	0.000E+00	0.000E+00	1.012E+07	0.000E+00	1.012E+07
1.250E-01	0.000E+00	0.000E+00	1.546E+07	0.000E+00	1.546E+07
2.250E-01	0.000E+00	0.000E+00	2.219E+07	0.000E+00	2.219E+07
3.750E-01	0.000E+00	0.000E+00	2.106E+07	0.000E+00	2.106E+07
5.750E-01	0.000E+00	0.000E+00	8.726E+08	0.000E+00	8.726E+08
8.500E-01	0.000E+00	0.000E+00	3.743E+08	0.000E+00	3.743E+08
1.250E+00	0.000E+00	0.000E+00	9.287E+07	0.000E+00	9.287E+07

1.750E+00	0.000E+00	0.000E+00	4.437E+06	0.000E+00	4.437E+06
2.250E+00	0.000E+00	0.000E+00	3.529E+06	0.000E+00	3.529E+06
2.750E+00	0.000E+00	0.000E+00	1.283E+05	0.000E+00	1.283E+05
3.500E+00	0.000E+00	0.000E+00	2.082E+04	0.000E+00	2.082E+04
5.000E+00	0.000E+00	0.000E+00	7.405E-11	0.000E+00	7.405E-11
7.000E+00	0.000E+00	0.000E+00	6.727E-12	0.000E+00	6.727E-12
9.500E+00	0.000E+00	0.000E+00	5.773E-13	0.000E+00	5.773E-13
0 TOTAL	0.000E+00	0.000E+00	1.449E+09	0.000E+00	1.449E+09
0 GAM POW	0.000E+00	0.000E+00	2.323E+02	0.000E+00	2.323E+02

ORIGEN2 File: GE BWR Fuel with 3.19 wt% ^{235}U and 45 GWD/MTU - Minimum Enrichment

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-1

-1

-1

RDA     ##########################################################
RDA     ##                                                      ##
RDA     ##   IF-300 45K BURNUP/ 3.19% ENRICHMENT AMENDMENT      ##
RDA     ##   Input Filename:        BWR319UE                    ##
RDA     ##   Creation Date:         2/23/99                     ##
RDA     ##   Fuel Type:             3.19% OCRWM DATABASE        ##
RDA     ##   Burnup:                45000 MWd/MTIHM             ##
RDA     ##   BWRUE    BWR XSECT Library                         ##
RDA     ##   .186 MTIHM/ASSEM - GE-7 Uranium Loading            ##
RDA     ##   Low Enrichment End for Shielding Source Terms      ##
RDA     ##########################################################
RDA
LIP     0  0  0
LIB     0 1 2 3      657      658      659   9  3  0  1  42
PHO     101  102  103  10
RDA    READ UNIT AMOUNTS OF FUEL AND FUEL ASSEM MAT WITH CHANNELS
INP           -1  1  -1  -1  1  1  ONE MTIHM UO2
INP           -2  1  -1  -1  1  1  ONE KG ZIRCALOY-4
INP           -3  1  -1  -1  1  1  ONE KG ZIRCALOY-2
INP           -4  1  -1  -1  1  1  ONE KG INCONEL-X750
INP           -5  1  -1  -1  1  1  ONE KG SS 302
INP           -6  1  -1  -1  1  1  ONE KG SS 304
RDA     MIX TOP, PLENUM, IN-CORE, AND BOTTOM MIXTURES
RDA     MIX TOP ZONE
MOV           -2       -7        0    0.000 ZIRCALOY-4
ADD           -3       -7        0    0.000 ZIRCALOY-2
ADD           -4       -7        0    0.000 INCONEL-X750
ADD           -5       -7        0    0.000 SS302
ADD           -6       -7        0    [redacted] SS304 - Max from Kunita
RDA     MIX PLENUM ZONE
MOV           -2       -8        0    [redacted] ZIRCALOY-4 - channel
ADD           -3       -8        0    [redacted] ZIRCALOY-2- Max from Kunita
ADD           -4       -8        0    [redacted] INCONEL-X750- Max from Kunita
ADD           -5       -8        0    [redacted] SS302
ADD           -6       -8        0    [redacted] SS304 - Max from Kunita
RDA     MIX IN-CORE ZONE - SANS UO2
MOV           -2       -9        0    [redacted] ZIRD-4 - channel,etc
ADD           -3       -9        0    [redacted] ZIRD-2 - Clad, etD-Max from Kunita
ADD           -4       -9        0    [redacted] INCONEL-X750
ADD           -5       -9        0    0.000 SS302
ADD           -6       -9        0    0.000 SS304
RDA     MIX BOTTOM ZONE
MOV           -2      -10        0    0.000 ZIRCALOY-4
ADD           -3      -10        0    [redacted] ZIRCALOY-2
ADD           -4      -10        0    [redacted] INCONEL-X750 Max from Kunita
ADD           -5      -10        0    0.000 SS302
ADD           -6      -10        0    [redacted] SS304 - Max from Kunita
RDA     IRRADIATE ONE MTIHM OF UO2 AT 100% POWER
BUP
IRP     106.18       25.9       -1        1   4   2  BURNUP =   2,750  MWD/MTIHM
IRP     212.36       25.9        1        1   4   0  BURNUP =   5,500  MWD/MTIHM
IRP     318.53       25.9        1        1   4   0  BURNUP =   8,250  MWD/MTIHM
IRP     463.32       25.9        1        1   4   0  BURNUP =  12,000  MWD/MTIHM
DEC     569.32                   1        1   4   0  106 DAY OUTAGE
```

The highlighted information is proprietary information to General Electric.

```
IRP     675.50     25.9     1     1   4   0   BURNUP =  14,750   MWD/MTIHM
IRP     781.68     25.9     1     1   4   0   BURNUP =  17,500   MWD/MTIHM
IRP     887.85     25.9     1     1   4   0   BURNUP =  20,250   MWD/MTIHM
IRP     994.03     25.9     1     1   4   0   BURNUP =  23,000   MWD/MTIHM
DEC     1100.03             1     1   4   0   106 DAY OUTAGE
IRP     1206.21    25.9     1     1   4   0   BURNUP =  25,750   MWD/MTIHM
IRP     1312.39    25.9     1     1   4   0   BURNUP =  28,500   MWD/MTIHM
IRP     1418.56    25.9     1     1   4   0   BURNUP =  31,250   MWD/MTIHM
IRP     1524.74    25.9     1     1   4   0   BURNUP =  34,000   MWD/MTIHM
DEC     1630.74             1     1   4   0   106 DAY OUTAGE
IRP     1736.92    25.9     1     1   4   0   BURNUP =  36,750   MWD/MTIHM
IRP     1843.10    25.9     1     1   4   0   BURNUP =  39,500   MWD/MTIHM
IRP     1949.27    25.9     1     1   4   0   BURNUP =  42,250   MWD/MTIHM
IRP     2055.45    25.9     1     1   4   0   BURNUP =  45,000   MWD/MTIHM
BUP
RDA
RDA     IRRADIATE TOP ZONE MATERIAL AT 10% FLUX
IRF     106.18     -0.1    -7     7   4   2
IRF     212.36     -0.1     7     7   4   0
IRF     318.53     -0.1     7     7   4   0
IRF     463.32     -0.1     7     7   4   0
DEC     569.32              7     7   4   0
IRF     675.50     -0.1     7     7   4   0
IRF     781.68     -0.1     7     7   4   0
IRF     887.85     -0.1     7     7   4   0
IRF     994.03     -0.1     7     7   4   0
DEC     1100.03             7     7   4   0
IRF     1206.21    -0.1     7     7   4   0
IRF     1312.39    -0.1     7     7   4   0
IRF     1418.56    -0.1     7     7   4   0
IRF     1524.74    -0.1     7     7   4   0
DEC     1630.74             7     7   4   0
IRF     1736.92    -0.1     7     7   4   0
IRF     1843.10    -0.1     7     7   4   0
IRF     1949.27    -0.1     7     7   4   0
IRF     2055.45    -0.1     7     7   4   0
RDA
RDA     IRRADIATE PLENUM ZONE MATERIAL AT 20% FLUX
IRF     106.18     -0.2    -8     8   4   2
IRF     212.36     -0.2     8     8   4   0
IRF     318.53     -0.2     8     8   4   0
IRF     463.32     -0.2     8     8   4   0
DEC     569.32              8     8   4   0
IRF     675.50     -0.2     8     8   4   0
IRF     781.68     -0.2     8     8   4   0
IRF     887.85     -0.2     8     8   4   0
IRF     994.03     -0.2     8     8   4   0
DEC     1100.03             8     8   4   0
IRF     1206.21    -0.2     8     8   4   0
IRF     1312.39    -0.2     8     8   4   0
IRF     1418.56    -0.2     8     8   4   0
IRF     1524.74    -0.2     8     8   4   0
DEC     1630.74             8     8   4   0
IRF     1736.92    -0.2     8     8   4   0
IRF     1843.10    -0.2     8     8   4   0
IRF     1949.27    -0.2     8     8   4   0
IRF     2055.45    -0.2     8     8   4   0
RDA
RDA     IRRADIATE CORE ZONE (SANS UO2) AT 100% FLUX
IRF     106.18     -1.0    -9     9   4   2
IRF     212.36     -1.0     9     9   4   0
IRF     318.53     -1.0     9     9   4   0
IRF     463.32     -1.0     9     9   4   0
DEC     569.32              9     9   4   0
IRF     675.50     -1.0     9     9   4   0
IRF     781.68     -1.0     9     9   4   0
IRF     887.85     -1.0     9     9   4   0
IRF     994.03     -1.0     9     9   4   0
```

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DEC     1100.03                 9        9   4   0
IRF     1206.21       -1.0      9        9   4   0
IRF     1312.39       -1.0      9        9   4   0
IRF     1418.56       -1.0      9        9   4   0
IRF     1524.74       -1.0      9        9   4   0
DEC     1630.74                 9        9   4   0
IRF     1736.92       -1.0      9        9   4   0
IRF     1843.10       -1.0      9        9   4   0
IRF     1949.27       -1.0      9        9   4   0
IRF     2055.45       -1.0      9        9   4   0
RDA
RDA     IRRADIATE BOTTOM ZONE MATERIAL AT 15% FLUX
IRF     106.18       -0.15     -10       10  4   2
IRF     212.36       -0.15      10       10  4   0
IRF     318.53       -0.15      10       10  4   0
IRF     463.32       -0.15      10       10  4   0
DEC     569.32                  10       10  4   0
IRF     675.50       -0.15      10       10  4   0
IRF     781.68       -0.15      10       10  4   0
IRF     887.85       -0.15      10       10  4   0
IRF     994.03       -0.15      10       10  4   0
DEC     1100.03                 10       10  4   0
IRF     1206.21      -0.15      10       10  4   0
IRF     1312.39      -0.15      10       10  4   0
IRF     1418.56      -0.15      10       10  4   0
IRF     1524.74      -0.15      10       10  4   0
DEC     1630.74                 10       10  4   0
IRF     1736.92      -0.15      10       10  4   0
IRF     1843.10      -0.15      10       10  4   0
IRF     1949.27      -0.15      10       10  4   0
IRF     2055.45      -0.15      10       10  4   0
RDA
RDA     MIX A COMBINED IN-CORE ZONE
MOV            9       11        0      1.0
ADD            1       11        0      [redacted]
RDA     MIX A WHOLE ASSEMBLY OUT OF THE PARTS
MOV            7       12        0      1.0 TOP ZONE
ADD            8       12        0      1.0 PLENUM ZONE
ADD           10       12        0      1.0 BOTTOM ZONE
ADD           11       12        0      1.0 (COMBINED) IN-CORE ZONE
RDA     MOVE ASSEMBLY PARTS TO SCRATCH VECTORS
MOV            7       -1        0      1.0 TOP ZONE
MOV            8       -2        0      1.0 PLENUM ZONE
MOV           11       -3        0      1.0 (COMBINED) IN-CORE ZONE
MOV           10       -4        0      1.0 BOTTOM ZONE
MOV           12       -5        0      1.0 WHOLE ASSEMBLY
TIT     SOURCE CHARACTERISTICS OF 3.19%, 45.0 GWD/MTIHM FUEL AT DISCHARGE
BAS     ONE GE8X8 FUEL ASSEMBLY
OPTL    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF    8 8 8 8 8   8 7 8 7 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT     9 .01  25 .01  26 .01  27 .01     -1
TIT     SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
DEC            1          -5        1        1        2
DEC            0.3         1        2        5        0
DEC            1           2        3        5        0
DEC            2           3        4        5        0
DEC            3           4        5        5        0
DEC            4           5        6        5        0
DEC            5           6        7        5        0
```

The highlighted information is proprietary information to General Electric.

```
OUT       7   1   -1   0
END
       2   922340     53.12   922350  31900.0   922380 968046.9        0         0      1 MTIHM
FUEL ACTINIDES
       4    30000 1.00E+00    50000 1.00E+00    60000 8.94E+01    80000 1.19E+05      1 MTIHM
FUEL IMPUR
       4    90000 1.07E+01   110000 1.50E+01   130000 1.67E+01   140000 1.21E+01      1 MTIHM
FUEL IMPUR
       4   150000 3.50E+01   200000 2.00E+00   220000 1.00E+00   240000 3.00E+00      1 MTIHM
FUEL IMPUR
       4   250000 1.70E+00   260000 1.80E+01   270000 1.00E+00   290000 1.00E+00      1 MTIHM
FUEL IMPUR
       4   300000 4.03E+01   420000 1.00E+01   480000 2.50E+01   490000 2.00E+00      1 MTIHM
FUEL IMPUR
       4   500000 4.00E+00   740000 2.00E+00   820000 1.00E+00   830000 4.00E-01      1 MTIHM
FUEL IMPUR
       0
       4    10000 1.30E-02    50000 3.30E-04    60000 1.20E-01    70000 8.00E-02      1 KG ZIRD-4
       4    80000 9.50E-01   130000 2.40E-02   160000 3.50E-02   220000 2.00E-02      1 KG ZIRD-4
       4   230000 2.00E-02   240000 1.25E+00   250000 2.00E-02   260000 2.25E+00      1 KG ZIRD-4
       4   270000 1.00E-02   280000 2.00E-02   290000 2.00E-02   400000 9.80E+02      1 KG ZIRD-4
       4   410000 1.20E-01   480000 2.50E-04   500000 1.60E+01   720000 7.80E-02      1 KG ZIRD-4
       4   740000 2.00E-02   922340 2.00E-04        0 0.00E+00        0 0.00E+00      1 KG ZIRD-4
       0
       4    10000 1.30E-02    50000 3.30E-04    60000 1.20E-01    70000 8.00E-02      1 KG ZIRD-2
       4    80000 9.50E-01   130000 2.40E-02   160000 3.50E-02   220000 2.00E-02      1 KG ZIRD-2
       4   230000 2.00E-02   240000 1.00E+00   250000 2.00E-02   260000 1.50E+00      1 KG ZIRD-2
       4   270000 1.00E-02   280000 5.00E-01   290000 2.00E-02   400000 9.80E+02      1 KG ZIRD-2
       4   410000 1.20E-01   480000 2.50E-04   500000 1.60E+01   720000 7.80E-02      1 KG ZIRD-2
       4   740000 2.00E-02        0 0.00E+00        0 0.00E+00        0 0.00E+00      1 KG ZIRD-2
       0
       4    60000 4.00E-01    70000 1.30E+00   130000 8.00E+00   140000 3.00E+00      1 KG IND-
X750
       4   160000 7.00E-02   220000 2.49E+01   240000 1.50E+02   250000 7.00E+01      1 KG IND-
X750
       4   260000 6.78E+01   270000 6.49E+00   280000 7.22E+02   290000 5.00E-01      1 KG IND-
X750
       4   410000 9.00E+00        0 0.00E+00        0 0.00E+00        0 0.00E+00      1 KG IND-
X750
       0
       4    60000 1.50E+00    70000 1.30E+00   140000 1.00E+01   150000 4.50E-01      1 KG SS-302
       4   160000 3.00E-01   240000 1.80E+02   250000 2.00E+01   260000 6.98E+02      1 KG SS-302
       4   270000 8.00E-01   280000 8.92E+01   410000 1.00E-01        0 0.00E+00      1 KG SS-302
       0
       4    60000 8.00E-01    70000 1.30E+00   140000 1.00E+01   150000 4.50E-01      1 KG SS-304
       4   160000 3.00E-01   240000 1.90E+02   250000 2.00E+01   260000 6.88E+02      1 KG SS-304
       4   270000 8.00E-01   280000 8.92E+01   410000 1.00E-01        0 0.00E+00      1 KG SS-304
       0
1                                                                                  OUTPUT UNIT =  6
PAGE   28
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18

     * SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE GE8X8 FUEL ASSEMBLY
                 1.0S       0.3YR      1.0YR      2.0YR      3.0YR      4.0YR      5.0YR
 KR 85       1.979E+03 1.941E+03 1.855E+03 1.739E+03 1.630E+03 1.528E+03 1.432E+03
 SR 89       9.402E+04 2.090E+04 6.252E+02 4.155E+00 2.762E-02 1.836E-04 1.220E-06
 SR 90       1.595E+04 1.584E+04 1.557E+04 1.521E+04 1.485E+04 1.450E+04 1.416E+04
  Y 90       1.661E+04 1.584E+04 1.558E+04 1.521E+04 1.485E+04 1.450E+04 1.416E+04
  Y 91       1.263E+05 3.473E+04 1.680E+03 2.218E+01 2.928E-01 3.867E-03 5.106E-05
 ZR 95       1.983E+05 6.052E+04 3.793E+03 7.252E+01 1.387E+00 2.652E-02 5.070E-04
 NB 95       1.976E+05 1.064E+05 8.236E+03 1.665E+02 3.190E+00 6.101E-02 1.167E-03
1                                                                                  OUTPUT UNIT =  6
PAGE   29
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 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18

     * SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                    7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                            ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 RU103      2.294E+05 3.318E+04 3.644E+02 5.784E-01 9.206E-04 1.463E-06 2.319E-09
 RH103M     2.066E+05 2.991E+04 3.285E+02 5.219E-01 8.300E-04 1.319E-06 2.095E-09
 RU106      1.069E+05 8.701E+04 5.377E+04 2.703E+04 1.359E+04 6.833E+03 3.435E+03
 RH106      1.151E+05 8.701E+04 5.377E+04 2.703E+04 1.359E+04 6.833E+03 3.435E+03
 AG109M     6.614E+04 5.916E-04 4.038E-04 2.340E-04 1.356E-04 7.857E-05 4.553E-05
 AG110      4.111E+04 1.357E+01 6.675E+00 2.423E+00 8.799E-01 3.195E-01 1.160E-01
 AG110M     1.382E+03 1.020E+03 5.019E+02 1.822E+02 6.616E+01 2.402E+01 8.721E+00
 SB125      3.083E+03 2.879E+03 2.416E+03 1.881E+03 1.465E+03 1.141E+03 8.881E+02
 TE125M     6.782E+02 6.811E+02 5.886E+02 4.590E+02 3.574E+02 2.783E+02 2.167E+02
 TE127      1.636E+04 1.093E+03 2.150E+02 2.108E+01 2.066E+00 2.025E-01 1.985E-02
 TE127M     2.154E+03 1.116E+03 2.195E+02 2.152E+01 2.109E+00 2.067E-01 2.026E-02
1                                                                    OUTPUT UNIT =  6
PAGE   30
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18

     * SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                    7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                            ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 TE129      4.570E+04 4.640E+02 2.376E+00 1.269E-03 6.777E-07 3.620E-10 1.933E-13
 CS134      5.114E+04 4.623E+04 3.654E+04 2.611E+04 1.865E+04 1.333E+04 9.523E+03
 CS137      2.546E+04 2.529E+04 2.488E+04 2.431E+04 2.376E+04 2.322E+04 2.269E+04
 BA137M     2.412E+04 2.392E+04 2.354E+04 2.300E+04 2.248E+04 2.196E+04 2.146E+04
 BA140      2.188E+05 5.772E+02 5.539E-04 1.401E-12 3.542E-21 8.956E-30 2.863E-38
 CE141      2.075E+05 2.018E+04 8.661E+01 3.595E-02 1.492E-05 6.192E-09 2.570E-12
1                                                                    OUTPUT UNIT =  6
PAGE   31
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18

     * SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                    7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                            ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PR143      1.821E+05 7.524E+02 1.594E-03 1.250E-11 9.802E-20 7.686E-28 6.032E-36
 CE144      1.502E+05 1.150E+05 6.162E+04 2.529E+04 1.038E+04 4.259E+03 1.748E+03
 PR144      1.513E+05 1.150E+05 6.163E+04 2.529E+04 1.038E+04 4.260E+03 1.748E+03
 PR144M     1.804E+03 1.379E+03 7.395E+02 3.035E+02 1.246E+02 5.111E+01 2.098E+01
 PM147      1.851E+04 1.802E+04 1.497E+04 1.150E+04 8.828E+03 6.778E+03 5.204E+03
 PM148      3.647E+04 4.543E+01 6.213E-01 1.351E-03 2.942E-06 6.410E-09 1.395E-11
 EU154      3.246E+03 3.168E+03 2.994E+03 2.762E+03 2.549E+03 2.351E+03 2.169E+03
 EU155      2.307E+03 2.212E+03 2.006E+03 1.744E+03 1.517E+03 1.319E+03 1.147E+03
 EU156      4.765E+04 3.212E+02 2.744E-03 1.576E-10 9.057E-18 5.203E-25 2.989E-32
 SUMTOT     2.071E+07 8.733E+05 3.885E+05 2.294E+05 1.591E+05 1.232E+05 1.034E+05
0TOTAL      2.189E+07 8.762E+05 3.889E+05 2.296E+05 1.593E+05 1.234E+05 1.037E+05
1                                                                    OUTPUT UNIT =  6
PAGE   32
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18

     * SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                    7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                            ONE GE8X8 FUEL ASSEMBLY
```

	1.0S	0.3YR	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
SE	1.081E+05	1.006E-01	1.006E-01	1.006E-01	1.006E-01	1.006E-01	1.006E-01
KR	4.158E+05	1.941E+03	1.855E+03	1.739E+03	1.630E+03	1.528E+03	1.432E+03
RB	5.838E+05	7.952E+00	6.009E-04	4.878E-06	4.877E-06	4.877E-06	4.877E-06
SR	9.369E+05	3.673E+04	1.620E+04	1.521E+04	1.485E+04	1.450E+04	1.416E+04
Y	1.240E+06	5.057E+04	1.726E+04	1.523E+04	1.485E+04	1.450E+04	1.416E+04
ZR	1.166E+06	6.052E+04	3.793E+03	7.295E+01	1.813E+00	4.523E-01	4.263E-01
NB	1.835E+06	1.068E+05	8.265E+03	1.671E+02	3.307E+00	1.827E-01	1.367E-01
TC	1.609E+06	3.112E+00	3.112E+00	3.112E+00	3.112E+00	3.112E+00	3.112E+00
RU	7.678E+05	1.202E+05	5.413E+04	2.703E+04	1.359E+04	6.833E+03	3.435E+03
RH	1.038E+06	1.169E+05	5.410E+04	2.703E+04	1.359E+04	6.833E+03	3.435E+03
PD	1.268E+05	3.518E-02	3.518E-02	3.518E-02	3.518E-02	3.518E-02	3.518E-02
AG	1.630E+05	1.034E+03	5.085E+02	1.846E+02	6.704E+01	2.434E+01	8.837E+00
CD	2.418E+04	7.294E+01	1.888E+01	1.703E+01	1.624E+01	1.549E+01	1.477E+01
IN	4.590E+04	7.358E-01	2.049E-02	1.231E-04	7.402E-07	4.454E-09	2.934E-11
SN	1.974E+05	3.395E+02	9.357E+01	1.679E+01	3.799E+00	1.194E+00	5.503E-01
SB	4.881E+05	2.987E+03	2.422E+03	1.882E+03	1.465E+03	1.141E+03	8.883E+02
TE	1.019E+06	4.071E+03	1.030E+03	5.017E+02	3.616E+02	2.787E+02	2.167E+02
I	1.528E+06	1.095E+01	8.256E-03	8.256E-03	8.256E-03	8.256E-03	8.256E-03
XE	1.125E+06	7.650E+00	2.520E-05	2.158E-08	2.062E-11	1.971E-14	1.884E-17
CS	1.002E+06	7.157E+04	6.142E+04	5.042E+04	4.241E+04	3.654E+04	3.221E+04
BA	1.224E+06	2.451E+04	2.354E+04	2.300E+04	2.248E+04	2.196E+04	2.146E+04
LA	1.217E+06	6.642E+02	6.374E-04	2.240E-11	2.078E-11	2.078E-11	2.078E-11
CE	9.477E+05	1.351E+05	6.171E+04	2.529E+04	1.038E+04	4.259E+03	1.748E+03
PR	8.496E+05	1.171E+05	6.237E+04	2.559E+04	1.050E+04	4.311E+03	1.769E+03
ND	2.101E+05	8.837E+01	9.717E-06	3.872E-10	3.928E-10	3.950E-10	3.960E-10
PM	2.273E+05	1.887E+04	1.499E+04	1.150E+04	8.828E+03	6.779E+03	5.205E+03
SM	1.053E+05	1.020E+02	1.014E+02	1.007E+02	9.990E+01	9.913E+01	9.837E+01
EU	6.109E+04	5.704E+03	5.002E+03	4.509E+03	4.067E+03	3.672E+03	3.318E+03
SUMTOT	2.187E+07	8.759E+05	3.888E+05	2.295E+05	1.592E+05	1.233E+05	1.036E+05
0TOTAL	2.189E+07	8.762E+05	3.889E+05	2.296E+05	1.593E+05	1.234E+05	1.037E+05

0 CUMULATIVE TABLE TOTALS

AP+FP	2.203E+07	8.957E+05	3.931E+05	2.318E+05	1.609E+05	1.247E+05	1.047E+05
ACT+FP	2.921E+07	9.239E+05	4.282E+05	2.645E+05	1.921E+05	1.546E+05	1.336E+05
AP+ACT+FP	2.936E+07	9.434E+05	4.324E+05	2.666E+05	1.937E+05	1.559E+05	1.346E+05

1 OUTPUT UNIT = 6

PAGE 33

ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:47:18

* SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY

+

FISSION PRODUCTS

POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC

0 9 SUMMARY TABLE: THERMAL POWER, WATTS

ONE GE8X8 FUEL ASSEMBLY

	1.0S	0.3YR	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
SR 89	3.250E+02	7.225E+01	2.161E+00	1.436E-02	9.548E-05	6.347E-07	4.219E-09
SR 90	1.851E+01	1.838E+01	1.808E+01	1.765E+01	1.724E+01	1.683E+01	1.643E+01
Y 90	9.207E+01	8.779E+01	8.634E+01	8.431E+01	8.232E+01	8.039E+01	7.850E+01
Y 91	4.537E+02	1.247E+02	6.033E+00	7.965E-02	1.052E-03	1.389E-05	1.834E-07
ZR 95	1.005E+03	3.065E+02	1.921E+01	3.673E-01	7.024E-03	1.343E-04	2.568E-06
NB 95	9.480E+02	5.102E+02	3.951E+01	7.986E-01	1.530E-02	2.926E-04	5.595E-06
RU103	7.675E+02	1.110E+02	1.219E+00	1.935E-03	3.080E-06	4.893E-09	7.757E-12
RH106	1.104E+03	8.345E+02	5.157E+02	2.593E+02	1.303E+02	6.553E+01	3.295E+01
CS134	5.205E+02	4.706E+02	3.719E+02	2.657E+02	1.899E+02	1.357E+02	9.693E+01
CS137	2.817E+01	2.797E+01	2.752E+01	2.689E+01	2.628E+01	2.568E+01	2.509E+01
BA137M	9.472E+01	9.393E+01	9.242E+01	9.031E+01	8.825E+01	8.624E+01	8.427E+01
CE144	9.960E+01	7.625E+01	4.088E+01	1.678E+01	6.884E+00	2.825E+00	1.160E+00
PR144	1.112E+03	8.450E+02	4.530E+02	1.859E+02	7.629E+01	3.131E+01	1.285E+01
EU154	2.903E+01	2.834E+01	2.678E+01	2.471E+01	2.280E+01	2.103E+01	1.940E+01
SUMTOT	9.974E+04	3.618E+03	1.701E+03	9.728E+02	6.403E+02	4.655E+02	3.676E+02
0TOTAL	2.463E+05	3.725E+03	1.732E+03	9.920E+02	6.539E+02	4.759E+02	3.758E+02

1 OUTPUT UNIT = 6

PAGE 34

ORIGEN2 V2.1 (8-1-91), Run on 03/26/99 at 15:47:18

* SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY

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+
FISSION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                    9 SUMMARY TABLE:  THERMAL POWER,  WATTS
                              ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 BR          4.424E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR          6.263E+03 2.908E+00 2.779E+00 2.605E+00 2.442E+00 2.289E+00 2.146E+00
 RB          1.268E+04 3.593E-02 2.697E-06 4.080E-09 4.076E-09 4.076E-09 4.076E-09
 SR          1.142E+04 9.063E+01 2.024E+01 1.766E+01 1.724E+01 1.683E+01 1.643E+01
  Y          1.676E+04 2.125E+02 9.237E+01 8.439E+01 8.232E+01 8.039E+01 7.850E+01
 ZR          1.051E+04 3.065E+02 1.921E+01 3.674E-01 7.074E-03 1.838E-04 5.204E-05
 NB          2.379E+04 5.108E+02 3.955E+01 7.994E-01 1.534E-02 3.148E-04 3.003E-05
 MO          1.193E+04 8.076E-10 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC          1.779E+04 1.560E-03 1.560E-03 1.560E-03 1.560E-03 1.560E-03 1.560E-03
 RU          4.187E+03 1.162E+02 4.416E+00 1.609E+00 8.080E-01 4.062E-01 2.042E-01
 RH          5.487E+03 8.414E+02 5.157E+02 2.593E+02 1.303E+02 6.553E+01 3.295E+01
 SB          9.321E+03 1.044E+01 7.633E+00 5.886E+00 4.583E+00 3.569E+00 2.780E+00
 TE          9.406E+03 5.562E+00 9.194E-01 4.260E-01 3.044E-01 2.343E-01 1.822E-01
  I          2.207E+04 3.718E-02 3.819E-06 3.819E-06 3.819E-06 3.819E-06 3.819E-06
 XE          1.001E+04 7.380E-03 4.389E-08 3.954E-11 3.779E-14 3.612E-17 3.452E-20
 CS          1.820E+04 4.991E+02 3.994E+02 2.926E+02 2.161E+02 1.613E+02 1.220E+02
 BA          1.084E+04 9.563E+01 9.242E+01 9.031E+01 8.825E+01 8.624E+01 8.427E+01
 LA          1.920E+04 1.113E+01 1.068E-05 1.794E-13 1.524E-13 1.524E-13 1.524E-13
 CE          4.380E+03 1.058E+02 4.100E+01 1.678E+01 6.884E+00 2.825E+00 1.160E+00
 PR          7.104E+03 8.468E+02 4.532E+02 1.860E+02 7.633E+01 3.133E+01 1.286E+01
 EU          5.808E+02 3.328E+01 2.826E+01 2.599E+01 2.391E+01 2.200E+01 2.025E+01
 SUMTOT      2.364E+05 3.689E+03 1.717E+03 9.847E+02 6.496E+02 4.730E+02 3.737E+02
0TOTAL       2.463E+05 3.725E+03 1.732E+03 9.920E+02 6.539E+02 4.759E+02 3.758E+02
0                                          CUMULATIVE TABLE TOTALS

 AP+FP       2.471E+05 3.817E+03 1.753E+03 1.006E+03 6.659E+02 4.862E+02 3.847E+02
 ACT+FP      2.657E+05 4.272E+03 2.008E+03 1.159E+03 7.965E+02 6.118E+02 5.090E+02
 AP+ACT+FP   2.665E+05 4.363E+03 2.030E+03 1.173E+03 8.084E+02 6.221E+02 5.179E+02
1                                                                          OUTPUT UNIT =  6
PAGE   35
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18
                                 SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
                              (ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC
 BASIS= ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 PU238       1.252E+06 1.287E+06 1.316E+06 1.320E+06 1.312E+06 1.303E+06 1.293E+06
 PU239       5.262E+04 5.329E+04 5.329E+04 5.328E+04 5.328E+04 5.328E+04 5.328E+04
 PU240       9.307E+04 9.312E+04 9.325E+04 9.342E+04 9.359E+04 9.375E+04 9.391E+04
 AM241       5.151E+04 6.661E+04 1.010E+05 1.481E+05 1.929E+05 2.354E+05 2.760E+05
 CM242       2.349E+07 1.482E+07 5.010E+06 1.069E+06 2.335E+05 5.639E+04 1.882E+04
 CM244       2.777E+06 2.746E+06 2.673E+06 2.573E+06 2.476E+06 2.383E+06 2.294E+06
0-----------------------------------------------------------------------------------------
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 TOTALS
 TABLE       2.775E+07 1.910E+07 9.273E+06 5.283E+06 4.388E+06 4.150E+06 4.054E+06
 ACTUAL      2.775E+07 1.910E+07 9.273E+06 5.283E+06 4.388E+06 4.150E+06 4.054E+06
1                                                                          OUTPUT UNIT =  6
PAGE   36
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18
                                 SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
                              SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
                            BASIS= ONE GE8X8 FUEL ASSEMBLY
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CM242       1.140E+08 7.193E+07 2.431E+07 5.186E+06 1.133E+06 2.736E+05 9.131E+04
 CM244       3.343E+08 3.306E+08 3.218E+08 3.097E+08 2.981E+08 2.869E+08 2.761E+08
0-----------------------------------------------------------------------------------------
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 TOTALS
 TABLE       4.531E+08 4.072E+08 3.506E+08 3.192E+08 3.033E+08 2.912E+08 2.801E+08
 ACTUAL      4.531E+08 4.072E+08 3.506E+08 3.192E+08 3.033E+08 2.912E+08 2.801E+08
0-----------------------------------------------------------------------------------------
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 OVERALL
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 TOTALS
 TABLE      4.809E+08 4.263E+08 3.599E+08 3.245E+08 3.077E+08 2.953E+08 2.842E+08
 ACTUAL     4.809E+08 4.263E+08 3.599E+08 3.245E+08 3.077E+08 2.953E+08 2.842E+08
1                                                                          OUTPUT UNIT =  6
PAGE   37
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18
                PHOTON SPECTRUM FOR ACTIVATION PRODUCTS
0                              SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
                                   POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                 BASIS= ONE GE8X8 FUEL ASSEMBLY
  EMEAN
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  1.027E+15 3.148E+13 6.857E+12 3.593E+12 2.688E+12 2.144E+12 1.757E+12
 2.500E-02  3.261E+14 5.275E+13 2.967E+13 1.703E+13 1.132E+13 8.152E+12 6.126E+12
 3.750E-02  1.360E+14 6.963E+12 4.362E+12 3.303E+12 2.583E+12 2.024E+12 1.587E+12
 5.750E-02  1.925E+14 3.427E+12 6.086E+11 2.971E+11 2.336E+11 1.944E+11 1.637E+11
 8.500E-02  1.123E+14 1.108E+12 2.163E+11 1.178E+11 9.512E+10 7.949E+10 6.691E+10
 1.250E-01  7.714E+13 1.273E+12 2.069E+11 1.200E+11 9.316E+10 7.445E+10 5.988E+10
 2.250E-01  1.775E+14 2.978E+12 1.537E+12 1.116E+12 8.627E+11 6.717E+11 5.236E+11
 3.750E-01  1.042E+14 1.058E+13 8.379E+12 6.517E+12 5.074E+12 3.950E+12 3.076E+12
 5.750E-01  1.295E+15 1.533E+13 1.091E+13 8.378E+12 6.520E+12 5.076E+12 3.952E+12
 8.500E-01  2.286E+15 4.839E+14 3.626E+13 1.316E+12 2.913E+11 1.263E+11 5.847E+10
 1.250E+00  1.565E+14 7.328E+13 6.641E+13 5.809E+13 5.090E+13 4.462E+13 3.912E+13
 1.750E+00  9.962E+13 8.971E+10 5.545E+09 1.170E+08 4.243E+06 6.976E+05 2.388E+05
 2.250E+00  3.845E+13 7.754E+09 7.249E+08 3.132E+08 2.698E+08 2.365E+08 2.073E+08
 2.750E+00  6.950E+12 6.383E+06 1.359E+06 9.559E+05 8.346E+05 7.317E+05 6.415E+05
 3.500E+00  4.671E+11 2.610E-02 7.256E-03 1.165E-03 1.872E-04 3.011E-05 4.885E-06
 5.000E+00  5.059E+09 7.771E-03 2.160E-03 3.469E-04 5.571E-05 8.955E-06 1.446E-06
 7.000E+00  7.977E+11 5.042E-04 1.402E-04 2.251E-05 3.615E-06 5.810E-07 9.382E-08
 9.500E+00  8.243E+08 3.189E-05 8.863E-06 1.423E-06 2.286E-07 3.674E-08 5.933E-09
0  TOTAL    6.036E+15 6.831E+14 1.654E+14 9.988E+13 8.066E+13 6.711E+13 5.649E+13
0MEV/SEC    3.303E+15 5.189E+14 1.247E+14 8.187E+13 7.016E+13 6.076E+13 5.274E+13
0                                18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                 BASIS= ONE GE8X8 FUEL ASSEMBLY
  EMEAN
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  1.027E+07 3.148E+05 6.857E+04 3.593E+04 2.688E+04 2.144E+04 1.757E+04
 2.500E-02  8.152E+06 1.319E+06 7.418E+05 4.259E+05 2.830E+05 2.038E+05 1.531E+05
 3.750E-02  5.099E+06 2.611E+05 1.636E+05 1.239E+05 9.685E+04 7.588E+04 5.951E+04
 5.750E-02  1.107E+07 1.970E+05 3.499E+04 1.709E+04 1.343E+04 1.118E+04 9.415E+03
 8.500E-02  9.543E+06 9.422E+04 1.838E+04 1.002E+04 8.086E+03 6.757E+03 5.687E+03
 1.250E-01  9.642E+06 1.591E+05 2.586E+04 1.500E+04 1.165E+04 9.306E+03 7.485E+03
 2.250E-01  3.993E+07 6.700E+05 3.459E+05 2.510E+05 1.941E+05 1.511E+05 1.178E+05
 3.750E-01  3.907E+07 3.967E+06 3.142E+06 2.444E+06 1.903E+06 1.481E+06 1.154E+06
 5.750E-01  7.445E+08 8.816E+06 6.271E+06 4.818E+06 3.749E+06 2.919E+06 2.272E+06
 8.500E-01  1.943E+09 4.113E+08 3.082E+07 1.118E+06 2.476E+05 1.074E+05 4.970E+04
 1.250E+00  1.957E+08 9.160E+07 8.301E+07 7.261E+07 6.363E+07 5.577E+07 4.890E+07
 1.750E+00  1.743E+08 1.570E+05 9.704E+03 2.047E+02 7.425E+00 1.221E+00 4.179E-01
 2.250E+00  8.651E+07 1.745E+04 1.631E+03 7.047E+02 6.070E+02 5.320E+02 4.664E+02
 2.750E+00  1.911E+07 1.755E+01 3.737E+00 2.629E+00 2.295E+00 2.012E+00 1.764E+00
 3.500E+00  1.635E+06 9.136E-08 2.539E-08 4.078E-09 6.551E-10 1.054E-10 1.710E-11
 5.000E+00  2.529E+04 3.886E-08 1.080E-08 1.735E-09 2.786E-10 4.477E-11 7.230E-12
 7.000E+00  5.584E+06 3.530E-09 9.812E-10 1.576E-10 2.531E-11 4.067E-12 6.568E-13
 9.500E+00  7.831E+03 3.029E-10 8.420E-11 1.352E-11 2.172E-12 3.491E-13 5.636E-14
0  TOTAL    3.303E+09 5.189E+08 1.247E+08 8.187E+07 7.016E+07 6.076E+07 5.274E+07
0 GAM POW   5.295E+02 8.317E+01 1.998E+01 1.312E+01 1.125E+01 9.740E+00 8.455E+00
1                                                                          OUTPUT UNIT =  6
PAGE   44
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18
                PHOTON SPECTRUM FOR ACTINIDES + DAUGHTERS
0                              SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
                                   POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                 BASIS= ONE GE8X8 FUEL ASSEMBLY
  EMEAN
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
```

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 1.000E-02  1.834E+17 9.096E+13 4.690E+13 2.911E+13 2.519E+13 2.422E+13 2.387E+13
 2.500E-02  8.156E+15 7.829E+10 1.091E+11 1.550E+11 1.986E+11 2.401E+11 2.796E+11
 3.750E-02  1.172E+16 2.429E+11 1.418E+11 1.031E+11 9.680E+10 9.723E+10 9.900E+10
 5.750E-02  1.113E+16 1.018E+12 1.477E+12 2.152E+12 2.794E+12 3.405E+12 3.985E+12
 8.500E-02  8.140E+16 4.137E+11 3.968E+11 3.950E+11 3.932E+11 3.914E+11 3.896E+11
 1.250E-01  6.411E+16 4.032E+11 3.678E+11 3.621E+11 3.582E+11 3.547E+11 3.514E+11
 2.250E-01  4.542E+16 3.188E+11 2.925E+11 2.873E+11 2.831E+11 2.793E+11 2.755E+11
 3.750E-01  4.969E+15 1.597E+10 1.475E+10 1.475E+10 1.475E+10 1.475E+10 1.474E+10
 5.750E-01  8.741E+14 1.211E+09 5.232E+08 2.699E+08 2.405E+08 2.567E+08 2.806E+08
 8.500E-01  2.530E+15 1.282E+09 1.125E+09 1.056E+09 1.036E+09 1.026E+09 1.017E+09
 1.250E+00  8.570E+14 6.261E+08 5.749E+08 5.477E+08 5.348E+08 5.253E+08 5.166E+08
 1.750E+00  2.692E+11 1.439E+08 1.244E+08 1.149E+08 1.110E+08 1.084E+08 1.060E+08
 2.250E+00  9.084E+07 8.114E+07 6.929E+07 6.282E+07 5.965E+07 5.725E+07 5.508E+07
 2.750E+00  6.628E+07 6.433E+07 6.759E+07 8.014E+07 9.480E+07 1.088E+08 1.213E+08
 3.500E+00  4.733E+07 4.230E+07 3.614E+07 3.278E+07 3.112E+07 2.987E+07 2.874E+07
 5.000E+00  2.025E+07 1.809E+07 1.546E+07 1.402E+07 1.331E+07 1.278E+07 1.229E+07
 7.000E+00  2.332E+06 2.085E+06 1.782E+06 1.617E+06 1.535E+06 1.474E+06 1.418E+06
 9.500E+00  2.683E+05 2.398E+05 2.048E+05 1.858E+05 1.764E+05 1.693E+05 1.629E+05
0  TOTAL    4.146E+17 9.346E+13 4.971E+13 3.258E+13 2.933E+13 2.900E+13 2.927E+13
0MEV/SEC    3.386E+16 1.146E+12 7.158E+11 5.741E+11 5.711E+11 5.960E+11 6.256E+11
0                                 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                                  BASIS= ONE GE8X8 FUEL ASSEMBLY
  EMEAN
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  1.834E+09 9.096E+05 4.690E+05 2.911E+05 2.519E+05 2.422E+05 2.387E+05
 2.500E-02  2.039E+08 1.957E+03 2.728E+03 3.875E+03 4.966E+03 6.003E+03 6.990E+03
 3.750E-02  4.393E+08 9.110E+03 5.316E+03 3.867E+03 3.630E+03 3.646E+03 3.712E+03
 5.750E-02  6.401E+08 5.856E+04 8.495E+04 1.237E+05 1.607E+05 1.958E+05 2.291E+05
 8.500E-02  6.919E+09 3.516E+04 3.372E+04 3.357E+04 3.342E+04 3.327E+04 3.312E+04
 1.250E-01  8.013E+09 5.040E+04 4.598E+04 4.526E+04 4.477E+04 4.434E+04 4.392E+04
 2.250E-01  1.022E+10 7.173E+04 6.581E+04 6.465E+04 6.371E+04 6.283E+04 6.199E+04
 3.750E-01  1.863E+09 5.987E+03 5.531E+03 5.530E+03 5.530E+03 5.529E+03 5.529E+03
 5.750E-01  5.026E+08 6.962E+02 3.008E+02 1.552E+02 1.383E+02 1.476E+02 1.613E+02
 8.500E-01  2.150E+09 1.089E+03 9.562E+02 8.979E+02 8.806E+02 8.717E+02 8.644E+02
 1.250E+00  1.071E+09 7.826E+02 7.186E+02 6.846E+02 6.686E+02 6.566E+02 6.457E+02
 1.750E+00  4.712E+05 2.518E+02 2.177E+02 2.010E+02 1.943E+02 1.897E+02 1.856E+02
 2.250E+00  2.044E+02 1.826E+02 1.559E+02 1.413E+02 1.342E+02 1.288E+02 1.239E+02
 2.750E+00  1.823E+02 1.769E+02 1.859E+02 2.204E+02 2.607E+02 2.993E+02 3.335E+02
 3.500E+00  1.656E+02 1.480E+02 1.265E+02 1.147E+02 1.089E+02 1.046E+02 1.006E+02
 5.000E+00  1.012E+02 9.047E+01 7.730E+01 7.011E+01 6.657E+01 6.389E+01 6.147E+01
 7.000E+00  1.633E+01 1.460E+01 1.248E+01 1.132E+01 1.075E+01 1.032E+01 9.924E+00
 9.500E+00  2.549E+00 2.278E+00 1.946E+00 1.765E+00 1.676E+00 1.608E+00 1.547E+00
0  TOTAL    3.386E+10 1.146E+06 7.158E+05 5.741E+05 5.711E+05 5.960E+05 6.256E+05
0 GAM POW   5.427E+03 1.837E-01 1.147E-01 9.202E-02 9.154E-02 9.554E-02 1.003E-01
1                                                                          OUTPUT UNIT =  6
PAGE   45
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:47:18
                 PHOTON SPECTRUM FOR FISSION PRODUCTS
0                                 SOURCE FOR 3.19%, 45.0 GWD/MTIHM FUEL - WHOLE ASSEMBLY
                                      POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                                 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
                                  BASIS= ONE GE8X8 FUEL ASSEMBLY
  EMEAN
                 1.0S      0.3YR     1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 1.000E-02  2.762E+17 7.859E+15 4.149E+15 2.176E+15 1.289E+15 8.699E+14 6.645E+14
 2.500E-02  7.311E+16 1.824E+15 9.433E+14 5.054E+14 3.050E+14 2.075E+14 1.576E+14
 3.750E-02  5.957E+16 1.807E+15 9.489E+14 5.132E+14 3.187E+14 2.274E+14 1.820E+14
 5.750E-02  5.938E+16 1.604E+15 8.672E+14 4.514E+14 2.634E+14 1.749E+14 1.317E+14
 8.500E-02  4.363E+16 1.109E+15 6.097E+14 3.158E+14 1.830E+14 1.205E+14 8.986E+13
 1.250E-01  4.735E+16 1.627E+15 6.826E+14 3.439E+14 1.957E+14 1.280E+14 9.554E+13
 2.250E-01  1.007E+17 9.717E+14 5.331E+14 2.733E+14 1.553E+14 9.972E+13 7.275E+13
 3.750E-01  7.711E+16 5.263E+14 2.944E+14 1.557E+14 9.047E+13 5.837E+13 4.179E+13
 5.750E-01  1.277E+17 5.619E+15 3.487E+15 2.543E+15 1.966E+15 1.594E+15 1.343E+15
 8.500E-01  1.289E+17 7.262E+15 1.739E+15 9.520E+14 6.746E+14 4.873E+14 3.554E+14
 1.250E+00  7.101E+16 3.104E+14 2.147E+14 1.468E+14 1.078E+14 8.362E+13 6.766E+13
 1.750E+00  2.682E+16 5.058E+13 1.594E+13 8.211E+12 4.640E+12 2.916E+12 2.048E+12
 2.250E+00  1.320E+16 3.941E+13 2.028E+13 8.589E+12 3.661E+12 1.571E+12 6.789E+11
 2.750E+00  5.600E+15 1.537E+12 4.431E+11 2.214E+11 1.107E+11 5.541E+10 2.776E+10
```

3.500E+00	2.672E+15	9.714E+10	5.588E+10	2.810E+10	1.413E+10	7.102E+09	3.570E+09
5.000E+00	1.077E+15	1.374E-05	1.389E-05	1.405E-05	1.418E-05	1.428E-05	1.435E-05
7.000E+00	9.134E+12	8.916E-07	9.010E-07	9.117E-07	9.199E-07	9.263E-07	9.311E-07
9.500E+00	1.765E+09	5.638E-08	5.697E-08	5.765E-08	5.817E-08	5.857E-08	5.888E-08
0 TOTAL	1.114E+18	3.061E+16	1.451E+16	8.394E+15	5.558E+15	4.055E+15	3.205E+15
0MEV/SEC	4.501E+17	1.097E+16	4.344E+15	2.759E+15	2.012E+15	1.547E+15	1.241E+15

0 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS= ONE GE8X8 FUEL ASSEMBLY

EMEAN	1.0S	0.3YR	1.0YR	2.0YR	3.0YR	4.0YR	5.0YR
1.000E-02	2.762E+09	7.859E+07	4.149E+07	2.176E+07	1.289E+07	8.699E+06	6.645E+06
2.500E-02	1.828E+09	4.561E+07	2.358E+07	1.263E+07	7.624E+06	5.187E+06	3.941E+06
3.750E-02	2.234E+09	6.777E+07	3.558E+07	1.924E+07	1.195E+07	8.527E+06	6.825E+06
5.750E-02	3.414E+09	9.225E+07	4.986E+07	2.595E+07	1.515E+07	1.006E+07	7.573E+06
8.500E-02	3.709E+09	9.425E+07	5.183E+07	2.684E+07	1.556E+07	1.024E+07	7.638E+06
1.250E-01	5.918E+09	2.034E+08	8.532E+07	4.298E+07	2.446E+07	1.600E+07	1.194E+07
2.250E-01	2.266E+10	2.186E+08	1.199E+08	6.149E+07	3.493E+07	2.244E+07	1.637E+07
3.750E-01	2.891E+10	1.974E+08	1.104E+08	5.838E+07	3.393E+07	2.189E+07	1.567E+07
5.750E-01	7.346E+10	3.231E+09	2.005E+09	1.462E+09	1.131E+09	9.163E+08	7.723E+08
8.500E-01	1.096E+11	6.173E+09	1.478E+09	8.092E+08	5.734E+08	4.142E+08	3.021E+08
1.250E+00	8.877E+10	3.880E+08	2.684E+08	1.835E+08	1.347E+08	1.045E+08	8.458E+07
1.750E+00	4.694E+10	8.851E+07	2.790E+07	1.437E+07	8.120E+06	5.104E+06	3.584E+06
2.250E+00	2.970E+10	8.868E+07	4.564E+07	1.933E+07	8.237E+06	3.534E+06	1.527E+06
2.750E+00	1.540E+10	4.226E+06	1.219E+06	6.087E+05	3.044E+05	1.524E+05	7.634E+04
3.500E+00	9.352E+09	3.400E+05	1.956E+05	9.834E+04	4.944E+04	2.486E+04	1.250E+04
5.000E+00	5.386E+09	6.871E-11	6.943E-11	7.026E-11	7.089E-11	7.138E-11	7.175E-11
7.000E+00	6.394E+07	6.241E-12	6.307E-12	6.382E-12	6.440E-12	6.484E-12	6.518E-12
9.500E+00	1.677E+04	5.356E-13	5.413E-13	5.477E-13	5.526E-13	5.564E-13	5.594E-13
0 TOTAL	4.501E+11	1.097E+10	4.344E+09	2.759E+09	2.012E+09	1.547E+09	1.241E+09
0 GAM POW	7.215E+04	1.759E+03	6.964E+02	4.422E+02	3.225E+02	2.480E+02	1.989E+02

ORIGEN2 File: Cobalt Activation for GE BWR Fuel with 3.19 wt% ^{235}U and 45 GWD/MTU

```
-1
-1
-1
RDA     ######################################################
RDA     ##                                                  ##
RDA     ##   IF-300 REDESIGNED BWR BASKET 17 FUEL ASSEM     ##
RDA     ##   PNFS Project 420-0400                          ##
RDA     ##   Input Filename:       BWR319CO                 ##
RDA     ##   Creation Date:        2/23/99                  ##
RDA     ##   Fuel Type:            3.19%                    ##
RDA     ##   Burnup:               45000 MWd/MTIHM          ##
RDA     ##   ACTIVATION OF 1 KG COBALT                      ##
RDA     ######################################################
RDA
LIP     0  0  0
LIB     0 1 2 3      657      658      659   9  3  0  1  42
PHO     101  102  103  10
RDA    READ UNIT AMOUNTS OF FUEL AND FUEL ASSEM MAT WITH CHANNELS
INP          -1  1  -1  -1  1  1  ONE MTIHM UO2
INP          -2  1  -1  -1  1  1  ONE KG COBALT
RDA     IRRADIATE ONE MTIHM OF UO2 AT 100% POWER
BUP
IRP      106.18        25.9       -1        1   4   2  BURNUP =   2,750  MWD/MTIHM
IRP      212.36        25.9        1        1   4   0  BURNUP =   5,500  MWD/MTIHM
IRP      318.53        25.9        1        1   4   0  BURNUP =   8,250  MWD/MTIHM
IRP      463.32        25.9        1        1   4   0  BURNUP =  12,000  MWD/MTIHM
DEC      569.32                    1        1   4   0  106 DAY OUTAGE
IRP      675.50        25.9        1        1   4   0  BURNUP =  14,750  MWD/MTIHM
IRP      781.68        25.9        1        1   4   0  BURNUP =  17,500  MWD/MTIHM
IRP      887.85        25.9        1        1   4   0  BURNUP =  20,250  MWD/MTIHM
IRP      994.03        25.9        1        1   4   0  BURNUP =  23,000  MWD/MTIHM
DEC      1100.03                   1        1   4   0  106 DAY OUTAGE
IRP      1206.21       25.9        1        1   4   0  BURNUP =  25,750  MWD/MTIHM
IRP      1312.39       25.9        1        1   4   0  BURNUP =  28,500  MWD/MTIHM
IRP      1418.56       25.9        1        1   4   0  BURNUP =  31,250  MWD/MTIHM
IRP      1524.74       25.9        1        1   4   0  BURNUP =  34,000  MWD/MTIHM
DEC      1630.74                   1        1   4   0  106 DAY OUTAGE
IRP      1736.92       25.9        1        1   4   0  BURNUP =  36,750  MWD/MTIHM
IRP      1843.10       25.9        1        1   4   0  BURNUP =  39,500  MWD/MTIHM
IRP      1949.27       25.9        1        1   4   0  BURNUP =  42,250  MWD/MTIHM
IRP      2055.45       25.9        1        1   4   0  BURNUP =  45,000  MWD/MTIHM
BUP
RDA
RDA     IRRADIATE 1 KG COBALT AT 10% FLUX
IRF      106.18        -0.1       -2        7   4   2
IRF      212.36        -0.1        7        7   4   0
IRF      318.53        -0.1        7        7   4   0
IRF      463.32        -0.1        7        7   4   0
DEC      569.32                    7        7   4   0
IRF      675.50        -0.1        7        7   4   0
IRF      781.68        -0.1        7        7   4   0
IRF      887.85        -0.1        7        7   4   0
IRF      994.03        -0.1        7        7   4   0
DEC      1100.03                   7        7   4   0
IRF      1206.21       -0.1        7        7   4   0
IRF      1312.39       -0.1        7        7   4   0
IRF      1418.56       -0.1        7        7   4   0
IRF      1524.74       -0.1        7        7   4   0
DEC      1630.74                   7        7   4   0
IRF      1736.92       -0.1        7        7   4   0
IRF      1843.10       -0.1        7        7   4   0
IRF      1949.27       -0.1        7        7   4   0
IRF      2055.45       -0.1        7       -2   4   0
TIT     ACTIVATION OF 1 KG COBALT FOR 2.65%,35.0 GWD/MTIHM FUEL
BAS     ONE GE8X8 FUEL ASSEMBLY
RDA
```

```
RDA     -2 = IRRADIATED Cobalt
RDA
TIT       ACTIVATION OF 1 KG OF COBALT
DEC             1       -2        1        1        2
DEC             1        1        2        5        0
DEC             2        2        3        5        0
DEC             3        3        4        5        0
DEC             4        4        5        5        0
DEC             5        5        6        5        0
BAS       ONE W 15X15 ANF PWR FUEL ASSEMBLY
OPTL      8 8 8 8 8   8 7 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF      8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT       7  0.0001   9  0.01   25  0.01   25  0.01  27  0.01   -1
OUT       6   1   -1   0
END
       2   922340    53.12   922350  31900.0   922380 968046.9        0 0.00E+00      1 MTIHM
FUEL ACTINIDES
       4    30000 1.00E+00    50000 1.00E+00    60000 8.94E+01    80000 1.19E+05      1 MTIHM
FUEL IMPUR
       4    90000 1.07E+01   110000 1.50E+01   130000 1.67E+01   140000 1.21E+01      1 MTIHM
FUEL IMPUR
       4   150000 3.50E+01   200000 2.00E+00   220000 1.00E+00   240000 3.00E+00      1 MTIHM
FUEL IMPUR
       4   250000 1.70E+00   260000 1.80E+01   270000 1.00E+00   290000 1.00E+00      1 MTIHM
FUEL IMPUR
       4   300000 4.03E+01   420000 1.00E+01   480000 2.50E+01   490000 2.00E+00      1 MTIHM
FUEL IMPUR
       4   500000 4.00E+00   740000 2.00E+00   820000 1.00E+00   830000 4.00E-01      1 MTIHM
FUEL IMPUR
       0
       4   270000 1.00E+03        0    0             0    0             0   0          1 KG COBALT
       0
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:48

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO 60       2.183E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
 CO 60M      1.913E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 61       3.831E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SUMTOT      4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
0TOTAL       4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
1                                                                          OUTPUT UNIT =  6
PAGE   16
 ORIGEN2 V2.1 (8-1-91), Run on 03/26/99    at 15:46:48

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO          4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
 SUMTOT      4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
0TOTAL       4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
0                                       CUMULATIVE TABLE TOTALS

 AP+FP       4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
 ACT+FP      0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AP+ACT+FP   4.100E+04 1.914E+04 1.678E+04 1.471E+04 1.290E+04 1.131E+04
```

ORIGEN2 File: Cobalt Activation for GE BWR Fuel with 2.65 wt% ^{235}U and 35 GWD/MTU

```
-1
-1
-1
RDA     ##################################################
RDA     ##                                              ##
RDA     ##   IF-300 REDESIGNED BWR BASKET 17 FUEL ASSEM ##
RDA     ##   PNFS Project 420-0400                      ##
RDA     ##   Input Filename:       BWR265CO             ##
RDA     ##   Creation Date:        2/21/99              ##
RDA     ##   Fuel Type:            2.65% OCRWM DATABASE ##
RDA     ##   Burnup:               35000 MWd/MTIHM      ##
RDA     ##   ACTIVATION OF 1 KG COBALT                  ##
RDA     ##################################################
RDA
LIP     0  0  0
LIB     -1 1 2 3      651      652      653   9  3  0  1  40
PHO     101  102  103  10
RDA     READ UNIT AMOUNTS OF FUEL AND FUEL ASSEM MAT WITH CHANNELS
INP          -1  1  -1  -1  1  1  ONE MTIHM UO2
INP          -2  1  -1  -1  1  1  ONE KG COBALT
RDA     IRRADIATE ONE MTIHM OF UO2 AT 100% POWER
BUP
IRP       112.61     25.9       -1        1   4   2  BURNUP = 2917 MWD/MTIHM
IRP       225.22     25.9        1        1   4   0  BURNUP = 5833 MWD/MTIHM
IRP       337.83     25.9        1        1   4   0  BURNUP = 8750 MWD/MTIHM
DEC       443.83                 1        1   4   0  106 DAY OUTAGE
IRP       556.44     25.9        1        1   4   0  BURNUP = 11666 MWD/MTIHM
IRP       669.05     25.9        1        1   4   0  BURNUP = 14583 MWD/MTIHM
IRP       781.66     25.9        1        1   4   0  BURNUP = 17500 MWD/MTIHM
DEC       887.66                 1        1   4   0  106 DAY OUTAGE
IRP      1000.27     25.9        1        1   4   0  BURNUP = 20416 MWD/MTIHM
IRP      1112.88     25.9        1        1   4   0  BURNUP = 23333 MWD/MTIHM
IRP      1225.49     25.9        1        1   4   0  BURNUP = 26250 MWD/MTIHM
DEC      1331.49                 1        1   4   0  106 DAY OUTAGE
IRP      1444.10     25.9        1        1   4   0  BURNUP = 29166 MWD/MTIHM
IRP      1556.71     25.9        1        1   4   0  BURNUP = 32083 MWD/MTIHM
IRP      1669.34     25.9        1        1   4   0  BURNUP = 35000 MWD/MTIHM
BUP
RDA
RDA     IRRADIATE 1 KG COBALT AT 10% FLUX
IRF       112.61     -0.1       -2        7        4        2
IRF       225.22     -0.1        7        7        4        0
IRF       337.83     -0.1        7        7        4        0
DEC       443.83                 7        7        4        0
IRF       556.44     -0.1        7        7        4        0
IRF       669.05     -0.1        7        7        4        0
IRF       781.66     -0.1        7        7        4        0
DEC       887.66                 7        7        4        0
IRF      1000.27     -0.1        7        7        4        0
IRF      1112.88     -0.1        7        7        4        0
IRF      1225.49     -0.1        7        7        4        0
DEC      1331.49                 7        7        4        0
IRF      1444.10     -0.1        7        7        4        0
IRF      1556.71     -0.1        7        7        4        0
IRF      1669.34     -0.1        7       -2        4        0
TIT     ACTIVATION OF 1 KG COBALT FOR 2.65%,35.0 GWD/MTIHM FUEL
BAS     ONE GE8X8 FUEL ASSEMBLY
RDA
RDA    -2 = IRRADIATED Cobalt
RDA
TIT     ACTIVATION OF 1 KG OF COBALT
DEC            1        -2        1        1        2
DEC            1         1        2        5        0
DEC            2         2        3        5        0
DEC            3         3        4        5        0
DEC            4         4        5        5        0
```

```
DEC             5        5        6        5        0
BAS      ONE W 15X15 ANF PWR FUEL ASSEMBLY
OPTL     8 8 8 8 8   8 7 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTA     8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
OPTF     8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8 8   8 8 8 8
CUT      7  0.0001   9  0.01   25  0.01   25  0.01  27  0.01   -1
OUT      6   1   -1   0
END
       2   922340    53.12   922350  26500.0   922380 973446.9        0 0.00E+00      1 MTIHM
FUEL ACTINIDES
       4    30000 1.00E+00    50000 1.00E+00    60000 8.94E+01    80000 1.19E+05      1 MTIHM
FUEL IMPUR
       4    90000 1.07E+01   110000 1.50E+01   130000 1.67E+01   140000 1.21E+01      1 MTIHM
FUEL IMPUR
       4   150000 3.50E+01   200000 2.00E+00   220000 1.00E+00   240000 3.00E+00      1 MTIHM
FUEL IMPUR
       4   250000 1.70E+00   260000 1.80E+01   270000 1.00E+00   290000 1.00E+00      1 MTIHM
FUEL IMPUR
       4   300000 4.03E+01   420000 1.00E+01   480000 2.50E+01   490000 2.00E+00      1 MTIHM
FUEL IMPUR
       4   500000 4.00E+00   740000 2.00E+00   820000 1.00E+00   830000 4.00E-01      1 MTIHM
FUEL IMPUR
       0
       4   270000 1.00E+03        0    0             0    0             0   0          1 KG COBALT
       0


 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 10:50:02

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO 60       1.948E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
 CO 60M      2.053E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 61       3.641E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SUMTOT      4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
0TOTAL       4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
1                                                                          OUTPUT UNIT =  6
PAGE   16
 ORIGEN2 V2.1 (8-1-91), Run on 02/22/99    at 10:50:02

     * ACTIVATION OF 1 KG OF COBALT
+
ACTIVATION PRODUCTS
     POWER= 1.00000E+00 MW,  BURNUP= 1.00000E+00 MWD,  FLUX= 1.00E+00 N/CM**2-SEC
0                      7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                                ONE W 15X15 ANF PWR FUEL ASSEMBLY
                 1.0S      1.0YR     2.0YR     3.0YR     4.0YR     5.0YR
 CO          4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
 SUMTOT      4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
0TOTAL       4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
0                                        CUMULATIVE TABLE TOTALS

 AP+FP       4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04
 ACT+FP      0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AP+ACT+FP   4.005E+04 1.708E+04 1.497E+04 1.313E+04 1.151E+04 1.009E+04


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ATTACHMENT 4

DRAFT REVISED C OF C

NRC FORM 618
(3-96)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9001	32	USA/9001/B( )F	1	6

PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (*Name and Address*)

Chem-Nuclear Systems, Inc.
140 Stoneridge Drive
Columbia, SC 29210

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

VECTRA Technologies, Inc., application dated March 30, 1995, as supplemented

c. DOCKET NUMBER 71-9001

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: IF-300

(2) Description

A stainless steel encased, depleted uranium shielded cask. The cask is cylindrical in shape, 64 inches in diameter, and a maximum of 210-inches long with maximum cavity dimensions of 37-1/2 inches in diameter by 180-1/4-inches long. Shielding is provided by 4 inches of depleted uranium, 2-1/8 inches of stainless steel, and a minimum of 4-1/2 inches (550 gallons) of a water ethylene glycol mixture.

Two closure heads are provided for the shipment of BWR and PWR fuel assemblies. The heads are 304 stainless steel forgings and end plates which encase the 3-inch thick depleted uranium shielding. Either closure head may be used for packaging solid irradiated hardware.

The closure heads are secured to the cask body by means of 32, 1-3/4 inch studs and nuts. The cask is sealed with a metallic ring gasket.

The cavity is penetrated by a vent line at the top and a drain line at the bottom. These lines are sealed by bellows stainless steel globe valves and valved quick-disconnect couplings. Stainless steel pipe caps may be used in lieu of the quick-disconnect couplings. The vent line is also equipped with a 350-400 psig rated rupture disk. All valves are housed in protected boxes on the cask exterior.

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5.(a) Packaging (continued)

(2) Description (continued)

Neutron shielding is provided by a liquid-filled, thin-walled, corrugated containment on the cask exterior. This cylindrical structure is separated into two longitudinal compartments, each equipped with two expansion tanks, fill and relief valves. The fill line from each compartment is terminated by a stainless steel globe valve in a protected box (separate from cavity boxes) on the cask exterior. The stainless steel globe valves may be replaced by stainless steel blind flanges. The vent line from each compartment goes to an expansion tank which is provided with a pressure relief valve set at 200 psig.

The cask has three types of fuel baskets which can be interchanged to accommodate various fuels. The PWR basket holds seven assemblies, the unchanneled BWR basket holds eighteen assemblies, and the channeled BWR basket holds seventeen assemblies. The channeled and unchanneled BWR fuel baskets may be provided with supplementary shielding (depleted uranium) near the cask closure.

The cask is shipped horizontally with the bottom supported in a tipping cradle between two pedestals and the upper end resting in a semi-circular saddle; the upper end is pinned to the saddle. The cask supports are welded to the framing of a 37-1/2-foot long by 8-foot wide structural steel skid. The skid may also have installed on it an auxiliary cooling system, consisting of two diesel engines driving two blowers which discharge cooling air to the corrugated surface of the cask via common ducting. Neither installation nor operation of all or part of this auxiliary cooling system is a requirement of this package approval.

The entire cask and cooling system is covered by a retractable aluminum enclosure. Access to the enclosure is via locked panels in the side and a locked door in one end. Although the Model No. IF-300 cask can be transported for short distances on the highway, its principal mode of transportation is by railroad.

The gross weight of the cask is approximately 140,000 pounds. The skid and other external components weigh approximately 45,000 pounds.

(3) Drawings

The Model No. IF-300 shipping cask is described by the following General Electric Company Drawing Nos.: 159C5238 - Sheet 1, Rev. 9; Sheet 2, Rev. 3; Sheet 3, Rev. 9; Sheet 4, Rev. 8; Sheet 5, Rev. 5; Sheet 6, Rev. 8; Sheet 7, Rev. 4; Sheet 8, Rev. 5; Sheet 9, Rev. 8; Sheet 10, Rev. 5; and Sheet 11, Rev. 2, and Pacific Nuclear Systems, Inc. Drawing Nos.:
420-11-3000, Sheets 1 through 9, Rev. 1; 420-11-3001, Sheet 1, Rev. 1;
420-11-3002, Sheets 1 and 2, Rev. 1; 420-11-3003, Sheets 1 and 2, Rev. 1; 420-11-3004, Sheets 1 and 2, Rev. 1; 420-11-3005, Sheets 1 and 2, Rev. 1; and 420-11-3006, Sheet 1, Rev 1.

5.(a)(4) Basic Components

The basic components of the Model No. IF-300 shipping cask that are important to nuclear safety are listed in Section IX, Table IX-1.

(b) Contents

(1) Type and form of material

(i) Irradiated PWR and BWR uranium oxide fuel assemblies. PWR assemblies may be shipped with or without control rods. Partial fuel assemblies, that is, assemblies from which fuel pins are missing, must not be shipped unless dummy fuel pins are used to displace an amount of water equal to that displaced by the original pins. The specific power of each fuel assembly must not exceed 40 kW/kgU ~~and the burnup of each fuel assembly must not exceed 35,000 MWD/MTU. The minimum cooling time of each assembly must be no less than 120 days. Prior to irradiation,~~ The BWR and PWR fuel assemblies must have the following dimensions and specifications:

Group 1a fuel assemblies

	PWR	BWR
Fuel form	Clad UO_2 pellets	Clad UO_2 pellets
Cladding material	Zr or SS	Zr or SS
Maximum number of assemblies	7	18 unchanneled/17 channeled
Maximum initial U content/assembly, kg	465	198
Maximum initial U-235 enrichment, w/o	4.0	4.0
Maximum assembly average burnup	35,000	35,000
Maximum cooling time, days	120	120
Maximum bundle cross section, in	8.75	5.75
Fuel pin array	14x14/15x15	7x7
Fuel diameter, in	0.380-0.460	0.500-0.600
Fuel pin pitch range, in	0.502-0.582	0.647-0.809
Maximum active fuel length, in	145	146
Transportation Index for criticality control	0.4	0.4

INSERT GROUP 1b assemblies from next page →

(i) Group Ib fuel assemblies

	PWR
Fuel Form	Clad UO_2 pellets
Cladding Material	Zr or SS
Maximum number of Assemblies	7
Maximum initial U Content/assembly, kg	439
Maximum initial U-235 Enrichment, w/o	4.00
Maximum assembly average Burnup, MWd/MTU	45,000
Minimum cooling time, yrs	5
Maximum bundle cross Section, in	8.75
Fuel pin array	15x15
Fuel diameter, in	0.380 - 0.460
Fuel pin pitch range, in	0.502 - 0.582
Maximum active fuel Length, in	144
Transportation Index For Criticality Control	0.4

5.(b) Contents (continued)

Group II fuel assemblies

	PWR	BWR
Fuel form	Clad UO_2 pellets	Clad UO_2 pellets
Cladding material	Zr or SS	Zr or SS
Maximum Number of assemblies	7	18 unchanneled/17 channeled
Maximum initial U content/assembly, kg	475	198
Maximum initial U-235 enrichment, w/o	4.0	4.0
maximum assembly average burnup, MWd/MTU	35,000	35,000
minimum cooling time, days	120	120
Maximum bundle cross section, in	8.75	5.75
Fuel pin array	16x16/17x17	8x8
Fuel diameter, in	0.376-0.400	0.475-0.505
Fuel pin pitch range, in	0.496-0.507	0.630-0.645
Maximum active fuel length, in	150	150
Transportation Index for Criticality Control	0.4	0.4

INSERT GROUP III assemblies - see next page

(ii) Solid irradiated hardware, which may include fissile material, provided the quantity of fissile material does not exceed a Type A quantity and does not exceed the mass limits of 10 CFR §71.53. As needed, appropriate component spacers must be used when loading irradiated hardware into the cask cavity to limit movement of the contents during accident conditions of transport. Use of a steel liner is authorized provided: (1) its outside dimensions are approximately those of the cask cavity inside dimensions, (2) constructed of single thickness of steel plate with full penetration welds, (3) thickness of steel plate does not exceed one inch, and (4) the liner is provided with a drain and vent to insure water removal.

(2) Maximum quantity of material per package

(i) Maximum decay heat per package not to exceed 40,000 Btu/hr. Maximum 5,725 Btu/hr/PWR assembly. Maximum 2,225 Btu/hr/BWR assembly.

(ii) Seven PWR fuel assemblies, seventeen channeled BWR assemblies, or eighteen unchanneled BWR fuel assemblies.

(iii) Above fuel assemblies to be contained in their respective fuel baskets as shown in GE Drawing No. 159C5238 - Sheet 6, Rev. 8, or PNSI Drawing No. 420-111-3000, Sheets 1 through 9, Rev. 1.

(i) Group III fuel assemblies

	PWR	BWR
Fuel Form	Clad UO_2 pellets	Clad UO_2 pellets
Cladding Material	Zr	Zr
Maximum number of Assemblies	6[a]	17 channeled
Maximum initial U Content/assembly, kg	437	187
Maximum initial U-235 Enrichment, w/o	4.65	4.25
Maximum assembly average Burnup, MWd/MTU	50,000	45,000
Minimum cooling time, yrs	5	4
Maximum bundle cross Section, in	8.75	5.75
Fuel pin array	15x15	8x8/9x9[b]
Fuel diameter, in	0.424	0.440 - 0.483
Fuel pin pitch range, in	0.563	0.566 – 0.64
Maximum active fuel Length, in	144	150
Transportation Index For Criticality Control	0	0

[a] The center fuel assembly location in the PWR basket must be left empty, with the 6 PWR assemblies being placed in the 6 peripheral basket locations.
[b] This fuel is only authorized for shipment in IF-300 Cask model numbers IF-303 and IF-304.

5. (c) Unloaded package - contents and maximum quantity of material

Greater than a Type A quantity of residual radioactive material consisting of mixed-fission and activation products adhering to interior cavity and fuel basket surfaces.

~~(d) Transport Index for Criticality Control~~

~~Minimum transport index to be shown on label for nuclear criticality control:~~ 0.4

6. The end of life total calculated residual gas that could become available from the fuel pins must not exceed 0.50 lb moles for content 5.(b).

7. The maximum gross weight of the cavity contents must not exceed 21,000 pounds.

8. For the shipment of irradiated fuel assemblies, the cask cavity (containment vessel) must be promptly inerted following removal of the water from the cavity. The cask cavity must be purged at least three times with argon, nitrogen, or helium. Each purge volume must be equivalent to or greater than the cask cavity volume. After the final purge, the cavity must be promptly filled with argon, nitrogen, or helium at 1.0 atm pressure.

9. Known or suspected failed fuel assemblies (rods) and fuel with cladding defects greater than pin holes and hairline cracks are not authorized.

~~10. Group I fuel assemblies which are 15x15 type PWR fuel assemblies and have a maximum initial U content of 439 kilograms per assembly and a minimum cool time of 60 months may have a maximum assembly burnup of 45,000 MWD/MTU.~~

~~11.~~ 10 Prior to each shipment, the licensee must confirm that the cask contains no more than 1 cubic foot of water in the cavity and the licensee must prepare the cask for shipment, in accordance with Subsection 10.1 of the application.

~~12.~~ 11 The cask contents shall be so limited that under normal conditions prior to transport, 62 times the neutron dose rate plus 6.3 times the gamma dose rate will not exceed 560 mrem/hr at a distance of six feet from the side of the cask (ten feet from the cask center-line).

~~13.~~ 12 The neutron shielding tanks must be filled with approximately a 50/50 volume percent mixture of ethylene glycol and water during the months of October through May.

~~14.~~ 13 Replacement globe valves other than the valve specified on Drawing No. 159C5238-Sheet 4, Rev. 8, must be tested as stated in Subsection 6.6.3.2 of the application.

~~15.~~ 14 The packaging must be maintained in accordance with the requirements of Subsection 10.2 of the application. During inactive periods, the maintenance and testing frequency may be disregarded provided that the package is brought into full compliance with these requirements prior to the next use of the package.

~~16.~~ 15 The cask cavity must be equipped with a rupture disk device with a burst pressure within the range of 350-400 psig (443°F) including all tolerances.

~~17.~~ 16 The uranium shielding material must be separated from all steel surfaces with a minimum copper thickness of 4-mils, except that the stud bolts attaching the shield assemblies to top of the unchanneled BWR basket must be coated with a minimum of ½-mil of copper.

~~18.~~ 17 A shutoff valve must not be installed between each neutron shield tank and its respective thermal expansion tank.

~~19.~~ 18 The cask may be wrapped with reinforced plastic during shipment, provided that the decay heat of the contents does not exceed 1.5 KW. The reinforced plastic used to wrap the cask must not be greater than 0.015 inches thick or have a thermal conductivity less than 0.0242 Btu/hr-ft-°F. The reinforced plastic wrapping cannot be used as the cask surface for purposes of complying with 10 CFR §71.87.

~~20.~~ 19 The package authorized by the certificate is hereby approved for use under the general license provisions of 10 §CFR 71.12.

~~21.~~ 20 Expiration date: ~~September 30, 2000.~~

REFERENCES

VECTRA Technologies, Inc., application dated March 30, 1995.

VECTRA Technologies, Inc., supplements dated: April 27, and August 18, 1995; November 25, 1997; and Chem-Nuclear Systems supplement dated January 9, 1998.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles J. Haughney, Acting Director
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Date April 1, 1998

ATTACHMENT 5

PROPRIETARY DATA PAGES FOR APPENDIX D