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# Revised RTG Source Term and Dose Rate Shielding Evaluation

**H. J. Goldberg**

Westinghouse Hanford Company, Richland, WA 99352  
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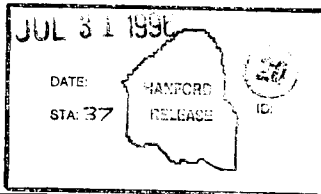
Key Words: RTG, <sup>238</sup>Pu, shielding, photon, neutron

Abstract: A source term was developed for the RTG and the adequacy with regards to shielding of the shipping container in which it will be transported was evaluated.

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## REVISED RTG SOURCE TERM AND DOSE RATE SHIELDING EVALUATION

### 1.0 SOURCE TERM

#### 1.1 Purpose

Radioisotope thermoelectric generators (RTGs) are used for the production of heat and its conversion to electricity aboard artificial satellites and space probes. The radioisotope  $^{238}\text{Pu}$  is the most widely used source of this heat. For these RTGs to be shipped from their place of fabrication to their place of utilization, they must be adequately shielded so as to meet Department of Transportation (DOT) limits on packaging of radioactive materials. The purpose of the present analysis is to develop the photon and neutron source terms which will be used in subsequent shielding analyses.

Since the present analysis represents a perturbation of similar analyses performed in the past (References 1, 2, 3, 4, 5, & 6), many of the previous techniques and data were retained for this analysis.

#### 1.2 Methodology

The photon source was calculated using a spreadsheet previously developed and run using the software Quattro Pro<sup>1</sup> on a personal computer. The spreadsheet has been reviewed for accuracy each time it has been used. The energies and abundances were taken from References 7 and 8, the fission spectrum from Reference 9, and the Bremsstrahlung spectrum from ISOSHLD (References 10, 11, & 12). These changes to the spreadsheet have been reported in Reference 5. In that memo the final photon spectrum was compared with results reported in References 13, 14, and 15 and found to agree.

In all of the previous calculations of the neutron spectra (References 1 through 6) the neutron spectrum was also calculated using a spreadsheet. However, for this analysis the computer Code SOURCES, which had been obtained from W. B. Wilson of the Los Alamos National Laboratory, was run on a SUN<sup>2</sup> workstation. The local version, modified to meet local needs, is called SOURCES/WSRCS. The code results had been reported in Reference 16 along with comparison with other calculations and measurements. Reference 17 is a further comparison of the older spreadsheet used previously and SOURCES which indicated agreement in the results. A document verifying and validating the code as used at Hanford is presently being prepared (Reference 18).

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<sup>1</sup>Quattro Pro is a registered trademark of Borland International, Inc.

<sup>2</sup>SUN is a registered trademark of Sun Microsystems, Inc.

### 1.3 Assumptions

The following assumptions were made:

- The light element and actinide impurities were at the maximum allowed by the acceptance specifications from Savannah River Laboratory (Reference 19) and the Los Alamos National Laboratory (Reference 20).
- The pellet of plutonia is isotropic and thus the  $\alpha$ -particle has a probability of interaction that is proportional to the bulk density of the target atom in the pellet.
- The buildup of fission products is negligible and thus the photonic emissions from the fission products are negligible.
- The powder is tamped to 85% of the  $\text{PuO}_2$ 's theoretical density in the manufacture of the pellet.

### 1.4 Input Data

In the latest iteration the pellet contains 151.7 g of  $\text{PuO}_2$ . The plutonium consists of 83%  $^{238}\text{Pu}$  and 0.5 ppm of  $^{236}\text{Pu}$ . Using past analyses from LANL and SRL, the following isotopic breakdown of the plutonium was assumed:

Table 1.1: Plutonium Composition		
Isotope	Percent of Pu	Fraction of $\text{PuO}_2$
$^{236}\text{Pu}$	$5 \times 10^{-5}$	$4.408 \times 10^{-7}$
$^{238}\text{Pu}$	83	$7.316 \times 10^{-1}$
$^{239}\text{Pu}$	14.3	$1.261 \times 10^{-1}$
$^{240}\text{Pu}$	2.1	$1.851 \times 10^{-2}$
$^{241}\text{Pu}$	.4	$3.526 \times 10^{-3}$
$^{242}\text{Pu}$	.1	$8.815 \times 10^{-4}$

The impurities were chosen to represent the worst case allowed by the acceptance specifications for SRL and LANL (References 19 & 20). These are given in Table 1.2.

Table 1.2: Impurity Concentrations	
Element/Isotope	Fraction of PuO <sub>2</sub>
<sup>241</sup> Am	2.5 x 10 <sup>-4</sup>
<sup>234</sup> U	6.0 x 10 <sup>-3</sup>
<sup>232</sup> Th	2.0 x 10 <sup>-4</sup>
<sup>237</sup> Np	2.0 x 10 <sup>-4</sup>
B	1.0 x 10 <sup>-6</sup>
Mg	5.0 x 10 <sup>-5</sup>
Na	2.5 x 10 <sup>-4</sup>
Si	2.0 x 10 <sup>-4</sup>

The powder was separated in 1994 and will be used in June 1997. Thus, the isotopic composition was aged for 3½ years using the subprogram DK which is a part of the Microshield<sup>3</sup> software package. The photon source was developed using the aged source because, from an exposure point of view, the photon source term becomes worse with time up to about 17.5 years. The neutron source was developed using newly separated powder because this is the worst case for the neutrons.

Much of the neutron source is due to the fact that some of the α-particles interact with a variety of light elements to produce neutrons via the (α,n) reaction. The largest contributor to this process is oxygen. In order to minimize this process, the powder is heated, usually in a tube furnace. While the powder is being heated, a flow of oxygen is maintained over the powder. This oxygen is very highly enriched in the isotope <sup>16</sup>O.

This isotope of oxygen is very stable and does not participate in the (α,n) reaction. The heating of the powder causes the oxygen atoms in the powder to exchange with those in the gas and vice versa. Thus the oxygen in the powder gets progressively more enriched in <sup>16</sup>O as the process continues, and the neutron production rate decreases as time goes on. When the neutron flux reaches a certain specified value, the process will be stopped and the pellet made with the enriched plutonia.

Two values of this limit were considered in this analysis: 7000 n/s per gram of <sup>238</sup>Pu and 7500 n/s per gram of <sup>239</sup>Pu. Once SOURCES/WSRCS computed the (α,n) and spontaneous fission neutron spectra and yields, the (α,n) contribution was decreased until the total yield equaled the limit.

<sup>3</sup>Microshield is a registered trademark of Grove Engineering, Inc.

### 1.5 Calculations and Results

The radioisotopes were decayed for 3.5 years using the DK subprogram of the Microshield® shielding program. These results were put into a spreadsheet which incorporates energies and yields taken from References 7 & 8. The results are presented in table 1.3.

Table 1.3: Photon Spectrum			
E-min (MeV)	E-av (MeV)	E-max (MeV)	Source (ph/sec)
0.15	0.20	0.25	7.10e+08
0.25	0.30	0.35	1.21e+07
0.35	0.40	0.45	4.29e+06
0.45	0.50	0.55	2.87e+06
0.55	0.60	0.65	1.49e+06
0.65	0.70	0.75	7.50e+06
0.75	0.80	0.85	5.68e+06
0.85	0.90	0.95	3.16e+06
0.95	1.00	1.05	1.31e+06
1.05	1.10	1.15	1.41e+05
1.15	1.20	1.25	2.26e+05
1.25	1.30	1.35	1.25e+05
1.35	1.40	1.45	4.37e+04
1.45	1.50	1.55	1.03e+05
1.55	1.60	1.65	2.46e+05
1.65	1.70	1.75	4.37e+04
1.75	1.80	1.85	4.30e+04
1.85	1.90	1.95	2.54e+04
1.95	2.00	2.05	2.20e+04
2.05	2.10	2.15	1.98e+04
2.15	2.20	2.25	1.77e+04
2.25	2.30	2.35	1.58e+04
2.35	2.40	2.45	1.40e+04
2.45	2.50	2.55	1.24e+04
2.55	2.60	2.65	5.06e+06
2.65	2.70	2.75	9.92e+03
2.75	2.80	2.85	8.95e+03
2.85	2.90	2.95	8.01e+03
2.95	3.00	3.05	7.23e+03

Table 1.3 (Cont.): Photon Spectrum			
E-min (MeV)	E-av (MeV)	E-max (MeV)	Source (ph/sec)
3.05	3.10	3.15	6.50e+03
3.15	3.20	3.25	5.92e+03
3.25	3.30	3.35	5.31e+03
3.35	3.40	3.45	4.80e+03
3.45	3.50	3.55	4.39e+03
3.55	3.60	3.65	4.00e+03
3.65	3.70	3.75	3.64e+03
3.75	3.80	3.85	3.30e+03
3.85	3.90	3.95	3.06e+03
3.95	4.00	4.05	2.81e+03
4.05	4.10	4.15	2.57e+03
4.15	4.20	4.25	2.39e+03
4.25	4.30	4.35	2.20e+03
4.35	4.40	4.45	2.01e+03
4.45	4.50	4.55	1.85e+03
4.55	4.60	4.65	1.71e+03
4.65	4.70	4.75	1.57e+03
4.75	4.80	4.85	1.47e+03
4.85	4.90	4.95	1.35e+03
4.95	5.00	5.05	1.26e+03
5.05	5.10	5.15	1.14e+03
5.15	5.20	5.25	1.04e+03
5.25	5.30	5.35	9.68e+02
5.35	5.40	5.45	9.00e+02
5.45	5.50	5.55	8.27e+02
5.55	5.60	5.65	7.62e+02
5.65	5.70	5.75	7.04e+02
5.75	5.80	5.85	6.40e+02
5.85	5.90	5.95	5.90e+02
5.95	6.00	6.05	5.41e+02
6.05	6.10	6.15	4.95e+02
6.15	6.20	6.25	4.56e+02
6.25	6.30	6.35	4.17e+02
6.35	6.40	6.45	3.81e+02
6.45	6.50	6.55	3.37e+02

Table 1.3 (Cont.): Photon Spectrum			
E-min (MeV)	E-av (MeV)	E-max (MeV)	Source (ph/sec)
6.45	6.50	6.55	3.37e+02
6.55	6.60	6.65	3.11e+02
6.65	6.70	6.75	2.79e+02
6.75	6.80	6.85	2.50e+02
6.85	6.90	6.95	2.22e+02
6.95	7.00	7.05	2.02e+02
7.05	7.10	7.15	1.77e+02
7.15	7.20	7.25	1.53e+02
7.25	7.30	7.35	1.33e+02
7.35	7.40	7.45	1.13e+02
7.45	7.50	7.55	9.41e+01
7.55	7.60	7.65	7.47e+01
Total			7.55e+08

The neutron spectrum was obtained from SOURCES/WSRCS for natural abundances of oxygen. In order to reflect the effects of the oxygen isotope exchange, the ( $\alpha,n$ ) contribution to the total was reduced until the total neutron flux reached the desired limit.

Table 1.4: Neutron Spectrum

Energy (MeV)	7000 n/s per g <sup>238</sup> Pu				7500 n/s per g <sup>238</sup> Pu			
	( $\alpha$ ,n) n/sec	fission n/sec	Total n/sec	Fraction at E	( $\alpha$ ,n) n/sec	fission n/sec	Total n/sec	Fraction at E
0.10	1.16e+03	5.15e+03	6.31e+03	8.12e-03	1.29e+03	5.15e+03	6.44e+03	7.74e-03
0.20	2.26e+03	6.98e+03	9.25e+03	1.19e-02	2.52e+03	6.98e+03	9.51e+03	1.14e-02
0.30	3.97e+03	8.13e+03	1.21e+04	1.56e-02	4.43e+03	8.13e+03	1.26e+04	1.51e-02
0.40	6.05e+03	8.89e+03	1.49e+04	1.92e-02	6.74e+03	8.89e+03	1.56e+04	1.88e-02
0.50	7.83e+03	9.41e+03	1.72e+04	2.22e-02	8.72e+03	9.41e+03	1.81e+04	2.18e-02
0.60	8.99e+03	9.74e+03	1.87e+04	2.41e-02	1.00e+04	9.74e+03	1.97e+04	2.37e-02
0.70	1.03e+04	9.92e+03	2.02e+04	2.60e-02	1.14e+04	9.92e+03	2.13e+04	2.56e-02
0.80	1.15e+04	9.99e+03	2.15e+04	2.76e-02	1.28e+04	9.99e+03	2.28e+04	2.74e-02
0.90	1.29e+04	9.97e+03	2.29e+04	2.95e-02	1.44e+04	9.97e+03	2.44e+04	2.93e-02
1.00	1.32e+04	9.88e+03	2.31e+04	2.97e-02	1.47e+04	9.88e+03	2.46e+04	2.96e-02
1.10	1.39e+04	9.73e+03	2.36e+04	3.04e-02	1.55e+04	9.73e+03	2.52e+04	3.03e-02
1.20	1.52e+04	9.54e+03	2.48e+04	3.19e-02	1.70e+04	9.54e+03	2.65e+04	3.19e-02
1.30	1.65e+04	9.30e+03	2.58e+04	3.32e-02	1.84e+04	9.30e+03	2.77e+04	3.33e-02
1.40	1.76e+04	9.04e+03	2.67e+04	3.43e-02	1.96e+04	9.04e+03	2.87e+04	3.45e-02
1.50	1.74e+04	8.76e+03	2.62e+04	3.37e-02	1.94e+04	8.76e+03	2.82e+04	3.38e-02
1.60	1.71e+04	8.46e+03	2.56e+04	3.29e-02	1.91e+04	8.46e+03	2.75e+04	3.31e-02
1.70	1.69e+04	8.15e+03	2.50e+04	3.22e-02	1.88e+04	8.15e+03	2.69e+04	3.23e-02
1.80	1.68e+04	7.83e+03	2.46e+04	3.17e-02	1.87e+04	7.83e+03	2.65e+04	3.18e-02
1.90	1.73e+04	7.50e+03	2.48e+04	3.19e-02	1.92e+04	7.50e+03	2.67e+04	3.21e-02
2.00	1.74e+04	7.18e+03	2.46e+04	3.17e-02	1.94e+04	7.18e+03	2.66e+04	3.19e-02
2.10	1.75e+04	6.85e+03	2.43e+04	3.13e-02	1.95e+04	6.85e+03	2.63e+04	3.16e-02
2.20	1.81e+04	6.53e+03	2.46e+04	3.17e-02	2.01e+04	6.53e+03	2.67e+04	3.20e-02
2.30	1.82e+04	6.21e+03	2.44e+04	3.14e-02	2.03e+04	6.21e+03	2.65e+04	3.18e-02
2.40	1.78e+04	5.91e+03	2.37e+04	3.05e-02	1.98e+04	5.91e+03	2.57e+04	3.09e-02
2.50	1.73e+04	5.60e+03	2.29e+04	2.94e-02	1.92e+04	5.60e+03	2.48e+04	2.98e-02
2.60	1.63e+04	5.31e+03	2.16e+04	2.78e-02	1.81e+04	5.31e+03	2.34e+04	2.81e-02
2.70	1.58e+04	5.03e+03	2.08e+04	2.68e-02	1.76e+04	5.03e+03	2.26e+04	2.71e-02
2.80	1.55e+04	4.75e+03	2.03e+04	2.61e-02	1.73e+04	4.75e+03	2.20e+04	2.65e-02
2.90	1.48e+04	4.49e+03	1.93e+04	2.49e-02	1.65e+04	4.49e+03	2.10e+04	2.52e-02
3.00	1.35e+04	4.23e+03	1.77e+04	2.28e-02	1.50e+04	4.23e+03	1.92e+04	2.31e-02

Table 1.4 (Cont.): Neutron Spectrum

Energy (MeV)	7000 n/s per g <sup>238</sup> Pu				7500 n/s per g <sup>238</sup> Pu			
	( $\alpha, n$ ) n/sec	fission n/sec	Total n/sec	Fraction at E	( $\alpha, n$ ) n/sec	fission n/sec	Total n/sec	Fraction at E
3.10	1.23e+04	3.99e+03	1.63e+04	2.10e-02	1.37e+04	3.99e+03	1.77e+04	2.13e-02
3.20	1.12e+04	3.75e+03	1.50e+04	1.93e-02	1.25e+04	3.75e+03	1.62e+04	1.95e-02
3.30	9.96e+03	3.53e+03	1.35e+04	1.74e-02	1.11e+04	3.53e+03	1.46e+04	1.76e-02
3.40	8.74e+03	3.32e+03	1.21e+04	1.55e-02	9.74e+03	3.32e+03	1.31e+04	1.57e-02
3.50	7.58e+03	3.12e+03	1.07e+04	1.38e-02	8.44e+03	3.12e+03	1.16e+04	1.39e-02
3.60	6.47e+03	2.92e+03	9.39e+03	1.21e-02	7.21e+03	2.92e+03	1.01e+04	1.22e-02
3.70	5.43e+03	2.74e+03	8.17e+03	1.05e-02	6.05e+03	2.74e+03	8.79e+03	1.06e-02
3.80	4.57e+03	2.57e+03	7.14e+03	9.19e-03	5.09e+03	2.57e+03	7.66e+03	9.20e-03
3.90	3.68e+03	2.40e+03	6.08e+03	7.83e-03	4.10e+03	2.40e+03	6.50e+03	7.81e-03
4.00	2.67e+03	2.25e+03	4.92e+03	6.33e-03	2.98e+03	2.25e+03	5.22e+03	6.28e-03
4.10	1.88e+03	2.10e+03	3.98e+03	5.12e-03	2.09e+03	2.10e+03	4.19e+03	5.03e-03
4.20	1.45e+03	1.96e+03	3.41e+03	4.39e-03	1.61e+03	1.96e+03	3.58e+03	4.29e-03
4.30	1.01e+03	1.83e+03	2.85e+03	3.67e-03	1.13e+03	1.83e+03	2.96e+03	3.56e-03
4.40	5.60e+02	1.71e+03	2.27e+03	2.92e-03	6.24e+02	1.71e+03	2.34e+03	2.81e-03
4.50	5.84e+02	4.47e+03	5.06e+03	6.51e-03	6.50e+02	4.47e+03	5.12e+03	6.15e-03
5.00	6.42e+02	5.62e+03	6.26e+03	8.06e-03	7.15e+02	5.62e+03	6.34e+03	7.61e-03
5.50	2.87e+02	3.90e+03	4.18e+03	5.38e-03	3.20e+02	3.90e+03	4.22e+03	5.06e-03
6.00	5.53e+01	2.67e+03	2.73e+03	3.51e-03	6.16e+01	2.67e+03	2.73e+03	3.28e-03
6.50	3.56e+01	1.82e+03	1.85e+03	2.39e-03	3.96e+01	1.82e+03	1.86e+03	2.23e-03
7.00	2.70e+01	1.23e+03	1.25e+03	1.61e-03	3.01e+01	1.23e+03	1.26e+03	1.51e-03
7.50	1.48e+01	8.22e+02	8.37e+02	1.08e-03	1.64e+01	8.22e+02	8.39e+02	1.01e-03
8.00	2.11e+00	5.48e+02	5.50e+02	7.08e-04	2.35e+00	5.48e+02	5.50e+02	6.61e-04
8.50	0.00e+00	3.63e+02	3.63e+02	4.67e-04	0.00e+00	3.63e+02	3.63e+02	4.36e-04
9.00	0.00e+00	2.39e+02	2.39e+02	3.08e-04	0.00e+00	2.39e+02	2.39e+02	2.87e-04
9.50	0.00e+00	1.57e+02	1.57e+02	2.02e-04	0.00e+00	1.57e+02	1.57e+02	1.88e-04
10.00	0.00e+00	1.39e+02	1.39e+02	1.79e-04	0.00e+00	1.39e+02	1.39e+02	1.67e-04
11.00	0.00e+00	8.83e+01	8.83e+01	1.14e-04	0.00e+00	8.83e+01	8.83e+01	1.06e-04
12.00	0.00e+00	3.67e+01	3.67e+01	4.72e-05	0.00e+00	3.67e+01	3.67e+01	4.41e-05
13.00	0.00e+00	1.51e+01	1.51e+01	1.94e-05	0.00e+00	1.51e+01	1.51e+01	1.81e-05
14.00	0.00e+00	6.12e+00	6.12e+00	7.88e-06	0.00e+00	6.12e+00	6.12e+00	7.35e-06
15.00	0.00e+00	2.46e+00	2.46e+00	3.17e-06	0.00e+00	2.46e+00	2.46e+00	2.96e-06
Total	4.88e+05	2.89e+05	7.77e+05	1.00e+00	5.44e+05	2.89e+05	8.33e+05	1.00e+00

## 2.0 DOSE RATE SHIELDING EVALUATION

### 2.1 Purpose

The neutron and photon source terms are used to evaluate dose rates for a payload configuration to be transported inside a single RTG Transportation System Package. Primary shielding for the payload is provided by self-shielding of the plutonia fuel, the RTG body, the inner containment vessel (ICV), the outer containment vessel (OCV), and the external shielding jacket.

All of this is discussed in detail in the current Chapter 5 of the SARP (Reference 21) along with the calculational technique used, and will not be repeated here. The thrust of this discussion is the changes in the dose rates from their previous values due to changing the source terms. The main item involving the dose rate discussion of Chapter 5 is that Tables 1 and 1a summarizing the dose rates with and without coolant in the jacket will be replaced by Tables 2.1, 2.2, 2.3, and 2.4. There are four tables instead of two because two different neutron source terms are involved.

### 2.2 Methodology

All shielding analyses were done with the MCNP Monte Carlo computer code (References 22 & 23).

### 2.3 Assumptions

The only change from the previous analysis was to revise the neutron and photon sources in the MCNP input files.

### 2.4 Input Data

The sources in the MCNP input files were changed to the sources of Table 1.3 and Table 1.4 in this report. These MCNP input files are listed in Appendix A.

### 2.5 Calculations

The previous calculations were repeated with MCNP using the revised source terms. Additional calculations were required since the dose rate comparisons were made for two different neutron source terms.

## 2.6 Results

The dose rates were summarized in Tables 1 and 1a in the previous analysis (Reference 21). These two tables are replaced here by Tables 2.1, 2.2, 2.3, and 2.4. There are now four tables instead of two because of the two different neutron sources in the current analyses. The revised Tables 2.1 to 2.4 all utilize the photon source of Table 1.3. The 7,000 n/s per g  $^{238}\text{Pu}$  source of Table 1.4 is used for Tables 2.1 and 2.2, while the 7,500 n/s per g  $^{238}\text{Pu}$  source of Table 1.4 is used for Tables 2.3 and 2.4. Tables 2.1 and 2.3 summarize dose rates with coolant in the jacket while Tables 2.2 and 2.4 summarize dose rates without coolant in the jacket. Note that the dose rates are the effective dose rates (or deep dose equivalent rates) and not the effective dose equivalent rates.

Table 2.1: Summary of Maximum Effective Dose Rates (mrem/hr) with coolant in the Jacket and 7,000 n/s per gram of <sup>238</sup> Pu Source.					
Normal conditions of transport location	Gamma	Neutron	Total	c	d
Side, surface of package	16.31(.18%) <sup>a</sup> 2.24(.47%) 14.07(.19%)	126.5(.33%)	142.8(.29%)		
Side, surface of semitrailer	2.68(.37%) 0.286(.79%) 2.39(.40%)	23.75(.47%)	26.43(.42%)		
Two meters from side surface of semitrailer	0.42(.17%) 0.044(.37%) 0.38(.18%)	4.34(.24%)	4.76(.22%)		
Top surface of package	12.90(1.1%) 0.84(2.5%) 12.06(1.1%)	172.80(1.2%)	185.7(1.1%)		
Top surface of semitrailer	3.01(.72%) 0.196(1.7%) 2.81(.76%)	38.81(.74%)	41.82(.69%)		
Bottom surface of semitrailer	0.14(1.4%) 0.049(2.5%) 0.093(1.6%)	14.76(.80%)	14.90(.80%)		
Trailer cab (operator's seat)	0.071(.22%) 0.0073(.36%) 0.064(.24%)	0.778(.26%)	0.85(.24%)		
Hypothetical accident conditions	Gamma	Neutron	Total		
One meter from the top surface of the package <sup>b</sup>	5.95(.60%) 0.44(1.2%) 5.51(.64%)	125.4(1.0%)	131.4(.96%)		

<sup>a</sup>( ) = One standard deviation statistical uncertainties.

<sup>b</sup>For the HAC analyses, the plutonia fuel is conservatively reconfigured as a sphere located at the package top.

<sup>c</sup>Regulatory limits are unchanged from Reference 21.

<sup>d</sup>Operational control limits used when coolant is present in package. This applies only to NCT and is the regulatory limit multiplied by the ratio of the dose rate with coolant to the dose rate without coolant.

Table 2.2: Summary of Maximum Effective Dose Rates (mrem/hr) without coolant in the Jacket and 7,000 n/s per gram of <sup>238</sup> Pu Source.				
Normal conditions of transport location	Gamma	Neutron	Total	<sup>c</sup>
Side, surface of package	16.67(.18%) <sup>a</sup> 0.61(.67%) 16.06(.18%)	254.1(.28%)	270.8(.26%)	
Side, surface of semitrailer	2.79(.37%) 0.092(1.3%) 2.70(.38%)	44.15(.47%)	46.94(.44%)	
Two meters from side surface of semitrailer	0.45(.20%) 0.015(.50%) 0.43(.20%)	7.75(.21%)	8.20(.20%)	
Top surface of package	12.59(.96%) 0.43(3.0%) 12.16(.99%)	164.66(1.2%)	177.3(1.1%)	
Top surface of semitrailer	2.89(.69%) 0.097(1.9%) 2.79(.71%)	37.11(.76%)	40.00(.71%)	
Bottom surface of semitrailer	0.12(1.3%) 0.028(2.7%) 0.095(1.5%)	15.25(.80%)	15.37(.79%)	
Trailer cab (operator's seat)	.075(.51%) .0027(.54%) 0.072(.53%)	1.38(.22%)	1.45(.21%)	
Hypothetical accident conditions	Gamma	Neutron	Total	
One meter from the top surface of the package <sup>b</sup>	5.95(.60%) 0.44(1.2%) 5.51(.64%)	125.4(1.0%)	131.4(.96%)	

<sup>a</sup> ( ) = One standard deviation statistical uncertainties.

<sup>b</sup> For the HAC analyses, the plutonia fuel is conservatively reconfigured as a sphere located at the package top.

<sup>c</sup> Regulatory limits are unchanged from Reference 21.

Table 2.3: Summary of Maximum Effective Dose Rates (mrem/hr) with coolant in the Jacket and 7,500 n/s per gram of <sup>238</sup> Pu Source.					
Normal conditions of transport location	Gamma	Neutron	Total	c	d
Side, surface of package	16.49(.18%) <sup>a</sup> 2.42(.48%) 14.07(.19%)	136.3(.33%)	152.8(.30%)		
Side, surface of semitrailer	2.69(.37%) 0.301(.79%) 2.39(.40%)	25.48(.47%)	28.17(.43%)		
Two meters from side surface of semitrailer	0.43(.17%) 0.047(.39%) 0.38(.18%)	4.65(.24%)	5.08(.22%)		
Top surface of package	12.95(1.0%) 0.89(2.5%) 12.06(1.1%)	182.93(1.2%)	195.9(1.1%)		
Top surface of semitrailer	3.03(.72%) 0.216(1.7%) 2.81(.76%)	41.00(.74%)	44.03(.69%)		
Bottom surface of semitrailer	0.14(1.4%) 0.051(2.5%) 0.093(1.6%)	15.72(.80%)	15.86(.79%)		
Trailer cab (operator's seat)	.072(.22%) .0078(.38%) 0.064(.24%)	0.836(.25%)	0.908(.23%)		
Hypothetical accident conditions	Gamma	Neutron	Total		
One meter from the top surface of the package <sup>b</sup>	5.98(.60%) 0.47(1.2%) 5.51(.64%)	131.7(.98%)	137.7(.94%)		

<sup>a</sup>( ) = One standard deviation statistical uncertainties.

<sup>b</sup>For the HAC analyses, the plutonia fuel is conservatively reconfigured as a sphere located at the package top.

<sup>c</sup>Regulatory limits are unchanged from Reference 21.

<sup>d</sup>Operational control limits used when coolant is present in package. This applies only to NCT and is the regulatory limit multiplied by the ratio of the dose rate with coolant to the dose rate without coolant.

Table 2.4: Summary of Maximum Effective Dose Rates (mrem/hr) without coolant in the Jacket and 7,500 n/s per gram of <sup>238</sup> Pu Source.				
Normal conditions of transport location	Gamma	Neutron	Total	<sup>c</sup>
Side, surface of package	16.72 (.18%) <sup>a</sup> 0.66 (.72%) 16.06 (.18%)	272.7 (.29%)	289.4 (.25%)	
Side, surface of semitrailer	2.80 (.37%) 0.098 (1.4%) 2.70 (.38%)	46.67 (.50%)	49.46 (.47%)	
Two meters from side surface of semitrailer	0.45 (.20%) 0.017 (.65%) 0.43 (.20%)	8.30 (.22%)	8.75 (.21%)	
Top surface of package	12.61 (.96%) 0.45 (3.2%) 12.16 (.99%)	174.24 (1.3%)	186.9 (1.2%)	
Top surface of semitrailer	2.90 (.69%) 0.105 (2.1%) 2.79 (.71%)	39.79 (.80%)	42.69 (.75%)	
Bottom surface of semitrailer	0.12 (1.3%) 0.029 (2.9%) 0.095 (1.5%)	16.30 (.85%)	16.42 (.84%)	
Trailer cab (operator's seat)	.075 (.51%) .0029 (.57%) 0.072 (.53%)	1.48 (.24%)	1.56 (.23%)	
Hypothetical accident conditions	Gamma	Neutron	Total	
One meter from the top surface of the package <sup>b</sup>	5.98 (.60%) 0.47 (1.2%) 5.51 (.64%)	131.7 (.98%)	137.7 (.94%)	

<sup>a</sup> ( ) = One standard deviation statistical uncertainties.

<sup>b</sup> For the HAC analyses, the plutonia fuel is conservatively reconfigured as a sphere located at the package top.

<sup>c</sup> Regulatory limits are unchanged from Reference 21.

## 2.7 Conclusions

The photon dose rates in Tables 2.1 to 2.4 have decreased by roughly a factor of four compared to the previous analysis, primarily because of the reduction of the  $^{236}\text{Pu}$  to 0.5 ppm in the determination of the photon source term. The neutron dose rates in Tables 2.1 and 2.2 have increased by about 10% compared to Tables 1 and 1a of the previous analysis, primarily because of the 7,000 n/s per gram of  $^{238}\text{Pu}$  utilized for these tables instead of 6,000 n/s per gram of  $^{238}\text{Pu}$ . Similarly, the neutron dose rates in Tables 2.3 and 2.4 have increased by typically about 17% compared to Tables 1 and 1a of the previous analysis, primarily because of the 7,500 n/s per gram of  $^{238}\text{Pu}$  used for these tables instead of 6,000 n/s per gram of  $^{238}\text{Pu}$ .

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**APPENDIX A**  
**LISTING OF MCNP INPUT FILES**

**NCT GAMMA SHIELDING MCNP INPUT FILE**

```

SHLD. CALC., GPHS-RTG, GAMMA,water, no q, p.det., jun 96 igdq
  1  0 -5 6 -1 3 -4 2 trcl=1 fill=1
  2  0 -7 8 u=1 lat=1
      fill=0:17 0:0 0:0 2 17r
  3  1 -1.9500 -9 (12 :-11 :20 )(14 :-13 :20 ) u=2
  4  1 -1.9500 -10 (12 :-11 :22 )(14 :-13 :22 ) u=2
  5  1 -1.9500 9 10 u=2
  6  2 -22.5 -12 11 -20 (-15 :16 :19 ) u=2
  7  2 -22.5 -14 13 -20 (-17 :18 :19 ) u=2
  8  3 -9.6000 -16 15 -19 u=2
  9  3 -9.6000 -18 17 -19 u=2
 10  2 -22.5 -12 11 -22 (-15 :16 :21 ) u=2
 11  2 -22.5 -14 13 -22 (-17 :18 :21 ) u=2
 12  3 -9.6000 -16 15 -21 u=2
 13  3 -9.6000 -18 17 -21 u=2
c    Astroquartz insulation and thermopile and Al shell
 14 231 -.00122 -121 134 -135 #1
 15  0 -122 133 -136 (121:-134:135)
 16 231 -.00122 -123 132 -137 (122:-133:136)
 17 12 -2.85 -124 131 -138 (123:-132:137)
c    inner containment
 21 231 -.00122 ((6 -52 -31 ):(52 -33 -53 )) (124:-131:138)
 22 201 -8.0300 51 -52 31 -32
 23 201 -8.0300 (52 -34 -54 )(33 :53 )
 24 201 -8.0300 51 -6 -31
c    outer containment
 41 231 -.00122 51 35 -64 -39
 42 231 -.00122 ((51 -35 -62 )(52 :32 ))(-52 :34 :54 )
 43 201 -8.0300 (-36 64 -63 )(62 :35 )
 44 236 -1.0 -52 65 36 -37
 45 201 -8.0300 -52 65 37 -38
 46 201 -8.0300 ((64 -65 36 51 -40 ):(-64 39 51 )):(65 38 -66 -40 )
 47 201 -8.0300 61 -51 -40
c    beyond outer containment and inside truck boundary
 71 231 -.00122 (((-52 :36 :63 ))(52 :38 :-66 ))(66 :40 :-61 )
      71 -72 73 -74 75 -76
c    beyond truck and inside large sphere, above ground
 72 231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c    ground
 73 221 -1.67 -77 -111
c    outside world
 74  0 111

```

1	py	4.659			
2	px	-4.859			
3	py	-4.659			
4	px	4.859			
5	pz	95.544			
6	pz	0.0000			
7	pz	5.30801			
8	pz	-0.00001			
9	c/y	-2.184	2.654	1.831	
10	c/y	2.184	2.654	1.831	
11	py	-3.1618			
12	py	-0.2941			
13	py	0.2941			
14	py	3.1618			
15	py	-3.1059			
16	py	-0.350			
17	py	0.350			
18	py	3.1059			
19	c/y	-2.1840	2.6540	1.3767	
20	c/y	-2.1840	2.6540	1.4326	
21	c/y	2.1840	2.6540	1.3767	
22	c/y	2.1840	2.6540	1.4326	
c	radial surfaces for inner and outer containment				
31	cz	43.1800			
32	cz	45.0850			
33	cz	43.6562			
34	cz	44.6088			
35	cz	45.5676			
36	cz	46.8376			
37	cz	50.0380			
38	cz	50.3796			
39	cz	49.6443			
40	cz	61.3410			
c	inner containment				
51	pz	-8.8138			
52	pz	127.4450			
53	sz	60.3377	88.9000		
54	sz	60.3377	89.8525		
c	outer containment				
61	pz	-12.6238			
62	sz	60.1472	90.8050		
63	sz	60.1472	92.0750		
64	kz	48.7807	1.0000	-1.0000	
65	kz	53.0733	1.0000	-1.0000	
66	pz	2.6940			
c	truck outside boundary				
71	px	-615.95			
72	px	603.25			
73	py	-127.00			
74	py	127.00			





-2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654

c gamma spectrum from Harvey jun96 , 151.7 g fueled clad

#	si9 h	sp9 d	sb9 d
	0.1500	0.0000E+00	0.0000E+00
	0.2500	0.7100E+09	0.1109E+08
	0.3500	0.1210E+08	0.5188E+06
	0.4500	0.4290E+07	0.3909E+06
	0.5500	0.2870E+07	0.1171E+07
	0.6500	0.1490E+07	0.7808E+06
	0.7500	0.7500E+07	0.4871E+07
	0.8500	0.5680E+07	0.4451E+07
	0.9500	0.3160E+07	0.2926E+07
	1.0500	0.1310E+07	0.1409E+07
	1.1500	0.1410E+06	0.1739E+06
	1.2500	0.2260E+06	0.3158E+06
	1.3500	0.1250E+06	0.1961E+06
	1.4500	0.4370E+05	0.7630E+05
	1.5500	0.1030E+06	0.1988E+06
	1.6500	0.2460E+06	0.5214E+06
	1.7500	0.4370E+05	0.1012E+06
	1.8500	0.4300E+05	0.1082E+06
	1.9500	0.2540E+05	0.6916E+05
	2.0500	0.2200E+05	0.6457E+05
	2.1500	0.1980E+05	0.6242E+05
	2.2500	0.1770E+05	0.5974E+05
	2.3500	0.1580E+05	0.5692E+05
	2.4500	0.1400E+05	0.5369E+05
	2.5500	0.1240E+05	0.5049E+05
	2.6500	0.5060E+07	0.2183E+08
	2.7500	0.9920E+04	0.4524E+05
	2.8500	0.8950E+04	0.4306E+05
	2.9500	0.8010E+04	0.4058E+05
	3.0500	0.7230E+04	0.3851E+05
	3.1500	0.6500E+04	0.3634E+05

3.2500	0.5920E+04	0.3469E+05
3.3500	0.5310E+04	0.3256E+05
3.4500	0.4800E+04	0.3076E+05
3.5500	0.4390E+04	0.2936E+05
3.6500	0.4000E+04	0.2789E+05
3.7500	0.3640E+04	0.2643E+05
3.8500	0.3300E+04	0.2493E+05
3.9500	0.3060E+04	0.2402E+05
4.0500	0.2810E+04	0.2290E+05
4.1500	0.2570E+04	0.2173E+05
4.2500	0.2390E+04	0.2094E+05
4.3500	0.2200E+04	0.1996E+05
4.4500	0.2010E+04	0.1887E+05
4.5500	0.1850E+04	0.1796E+05
4.6500	0.1710E+04	0.1715E+05
4.7500	0.1570E+04	0.1625E+05
4.8500	0.1470E+04	0.1570E+05
4.9500	0.1350E+04	0.1487E+05
5.0500	0.1260E+04	0.1430E+05
5.1500	0.1140E+04	0.1332E+05
5.2500	0.1040E+04	0.1251E+05
5.3500	0.9680E+03	0.1198E+05
5.4500	0.9000E+03	0.1145E+05
5.5500	0.8270E+03	0.1081E+05
5.6500	0.7620E+03	0.1023E+05
5.7500	0.7040E+03	0.9707E+04
5.8500	0.6400E+03	0.9056E+04
5.9500	0.5900E+03	0.8563E+04
6.0500	0.5410E+03	0.8051E+04
6.1500	0.4950E+03	0.7549E+04
6.2500	0.4560E+03	0.7125E+04
6.3500	0.4170E+03	0.6673E+04
6.4500	0.3810E+03	0.6241E+04
6.5500	0.3370E+03	0.5649E+04
6.6500	0.3110E+03	0.5333E+04
6.7500	0.2790E+03	0.4893E+04
6.8500	0.2500E+03	0.4482E+04
6.9500	0.2220E+03	0.4068E+04
7.0500	0.2020E+03	0.3781E+04
7.1500	0.1770E+03	0.3384E+04
7.2500	0.1530E+03	0.2987E+04
7.3500	0.1330E+03	0.2650E+04
7.4500	0.1130E+03	0.2298E+04
7.5500	0.9410E+02	0.1952E+04
7.6500	0.7470E+02	0.1581E+04

c total = 0.75467E+09  
 c total = 7.5467E+08 x 72 = 5.4336E+10  
 ctme 2400  
 nps 5446924  
 c nps 619115

```

prdmp      j -960 1
e0         .2 .6 .8 2. 20.
fc2        p dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f2:p       73 74
fs2        -81 84 -82 83 -89 -90 -91 -92 t
sd2        142172 138738 16219 16219 3679 3600 2r 1740 329567
           142172 138738 16219 16219 3679 3600 2r 1740 329567
c          ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de2        0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
           0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
           1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
           4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
           13.0 15.0
df2        3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
           8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
           1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
           5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
           1.18-2 1.33-2
fc12       p dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f12:p      71 72
fs12       -85 88 -86 87 -89 -90 -91 -92 t
sd12       10002 10002 16219 16219 3679 3600 2r 1740 68660
           10002 10002 16219 16219 3679 3600 2r 1740 68660
c          ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de12       0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
           0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
           1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
           4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
           13.0 15.0
df12       3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
           8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
           1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
           5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
           1.18-2 1.33-2
fc22       p dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f22:p      75 76
fs22       -81 84 -82 83 -85 -86 -87 -88 t
sd22       133591 130366 15240 15240 2220 3600 2r 2220 309677
           133591 130366 15240 15240 2220 3600 2r 2220 309677
c          ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de22       0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
           0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
           1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
           4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
           13.0 15.0
df22       3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
           8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
           1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
           5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
           1.18-2 1.33-2

```

fc102 p dose rates (mrem/hr) on side of package, 2nd entry  
 f102:p 38  
 fs102 -132 -90 -93 -94 -91 -138 t  
 sd102 1 5j 1 1  
 c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm\*\*2/s)  
 del02 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
 1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
 4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
 13.0 15.0  
 df102 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
 8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
 1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
 5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
 1.18-2 1.33-2  
 fc122 p dose rates (mrem/hr) on top of package, 1st entry  
 f122:p 63  
 fs122 -95 t  
 c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm\*\*2/s)  
 del22 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
 1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
 4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
 13.0 15.0  
 df122 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
 8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
 1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
 5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
 1.18-2 1.33-2  
 fc5 p dose rates (mrem/hr) at detectors, 2 m, driver  
 f5:p 0. 327.00 79. 100.  
 847.09 0. 79. 100.  
 c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm\*\*2/s)  
 de5 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
 1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
 4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
 13.0 15.0  
 df5 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
 8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
 1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
 5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
 1.18-2 1.33-2  
 ft5 icd  
 fu5 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 21 22 23 24  
 41 42 43 44 45 46 47 71 72 73

HAC GAMMA SHIELDING MCNP INPUT FILE

SHLD. CALC., GPHS-RTG, GAMMA, , accident igaci

```
c   sphere of PuO2 for accident condition
1   3 -9.60 -100
c   inner containment
21  231 -.00122 ((6 -52 -31):(52 -33 -53 )) 100
22  201 -8.0300 51 -52 31 -32
23  201 -8.0300 (52 -34 -54 )(33 :53 )
24  201 -8.0300 51 -6 -31
c   outer containment
41  231 -.00122 51 35 -64 -39
42  231 -.00122 ((51 -35 -62 )(52 :32 ))(-52 :34 :54 )
43  201 -8.0300 (-36 64 -63 )(62 :35 )
44  236 -1.0 -52 65 36 -37
45  201 -8.0300 -52 65 37 -38
46  201 -8.0300 ((64 -65 36 51 -40 ):(-64 39 51 )):(65 38 -66 -40 )
47  201 -8.0300 61 -51 -40
c   beyond outer containment and inside truck boundary
71  231 -.00122 (((-52 :36 :63 ))(52 :38 :-66 ))(66 :40 :-61 )
    71 -72 73 -74 75 -76
c   beyond truck and inside large sphere, above ground
72  231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c   ground
73  221 -1.67 -77 -111
c   outside world
74  0 111

1   py 4.659
2   px -4.859
3   py -4.659
4   px 4.859
5   pz 95.544
6   pz 0.0000
7   pz 5.30801
8   pz -0.00001
9   c/y -2.184 2.654 1.831
10  c/y 2.184 2.654 1.831
11  py -3.1618
12  py -0.2941
13  py 0.2941
14  py 3.1618
15  py -3.1059
16  py -0.350
17  py 0.350
18  py 3.1059
19  c/y -2.1840 2.6540 1.3767
20  c/y -2.1840 2.6540 1.4326
21  c/y 2.1840 2.6540 1.3767
```

22 c/y 2.1840 2.6540 1.4326  
c radial surfaces for inner and outer containment  
31 cz 43.1800  
32 cz 45.0850  
33 cz 43.6562  
34 cz 44.6088  
35 cz 45.5676  
36 cz 46.8376  
37 cz 50.0380  
38 cz 50.3796  
39 cz 49.6443  
40 cz 61.3410  
c inner containment  
51 pz -8.8138  
52 pz 127.4450  
53 sz 60.3377 88.9000  
54 sz 60.3377 89.8525  
c outer containment  
61 pz -12.6238  
62 sz 60.1472 90.8050  
63 sz 60.1472 92.0750  
64 kz 48.7807 1.0000 -1.0000  
65 kz 53.0733 1.0000 -1.0000  
66 pz 2.6940  
c truck outside boundary  
71 px -615.95  
72 px 603.25  
73 py -127.00  
74 py 127.00  
75 pz -72.3138  
76 pz 198.0  
77 pz -184.0738  
c tally fs surfaces on outside of truck  
81 px -90.0  
82 px -30.0  
83 px 30.0  
84 px 90.0  
85 py -90.0  
86 py -30.0  
87 py 30.0  
88 py 90.0  
89 pz -11.0  
90 pz 49.0  
91 pz 109.0  
92 pz 169.0  
93 pz 63.76  
94 pz 94.24  
95 cz 15.24  
100 s 0. 0. 142.6 6.5508  
c outside world.

111 so 5000.0000

```

*tr1 0 0 31.4560
mode p
m1 6000.01p -1.950000
m2 77000.01p -22.500000
m3 94000.01p -8.463 8000.01p -1.137
m201 26000.01p 67.970001 24000.01p 20.000000 28000.01p 10.000000
      25000.01p 2.000000 6000.01p 0.030000
m221 8000.01p -0.511000 14000.01p -0.278200 20000.01p -0.071700
      26000.01p -0.109100 13000.01p -0.083260 12000.01p -0.031420
      19000.01p -0.011550 11000.01p -0.020220 22000.01p -0.016550
      25000.01p -0.001781 15000.01p -0.002400
m231 7000.01p -0.765000 8000.01p -0.235000
m236 1000.01p 0.666700 8000.01p 0.333300
imp:p 1 4 3r 16 $ 1, 41
      8r 8 0 $ 42, 73
print 10 30 40 50 60 100 110 120 126 170
phys:p j 1
cut:p j j 0. 0.
sdef rad d4 erg=d9
      pos 0. 0. 142.6 wgt=5.4336e10
si4 6.5508
sp4 -21 2
c gamma spectrum from Table 5-4, 157 g fueled clad
# si9 sp9 sb9
  l d d
  0.1500 0.0000E+00 0.0000E+00
  0.2500 0.7100E+09 0.1109E+08
  0.3500 0.1210E+08 0.5188E+06
  0.4500 0.4290E+07 0.3909E+06
  0.5500 0.2870E+07 0.1171E+07
  0.6500 0.1490E+07 0.7808E+06
  0.7500 0.7500E+07 0.4871E+07
  0.8500 0.5680E+07 0.4451E+07
  0.9500 0.3160E+07 0.2926E+07
  1.0500 0.1310E+07 0.1409E+07
  1.1500 0.1410E+06 0.1739E+06
  1.2500 0.2260E+06 0.3158E+06
  1.3500 0.1250E+06 0.1961E+06
  1.4500 0.4370E+05 0.7630E+05
  1.5500 0.1030E+06 0.1988E+06
  1.6500 0.2460E+06 0.5214E+06
  1.7500 0.4370E+05 0.1012E+06
  1.8500 0.4300E+05 0.1082E+06
  1.9500 0.2540E+05 0.6916E+05
  2.0500 0.2200E+05 0.6457E+05
  2.1500 0.1980E+05 0.6242E+05
  2.2500 0.1770E+05 0.5974E+05
  2.3500 0.1580E+05 0.5692E+05
  
```

2.4500	0.1400E+05	0.5369E+05
2.5500	0.1240E+05	0.5049E+05
2.6500	0.5060E+07	0.2183E+08
2.7500	0.9920E+04	0.4524E+05
2.8500	0.8950E+04	0.4306E+05
2.9500	0.8010E+04	0.4058E+05
3.0500	0.7230E+04	0.3851E+05
3.1500	0.6500E+04	0.3634E+05
3.2500	0.5920E+04	0.3469E+05
3.3500	0.5310E+04	0.3256E+05
3.4500	0.4800E+04	0.3076E+05
3.5500	0.4390E+04	0.2936E+05
3.6500	0.4000E+04	0.2789E+05
3.7500	0.3640E+04	0.2643E+05
3.8500	0.3300E+04	0.2493E+05
3.9500	0.3060E+04	0.2402E+05
4.0500	0.2810E+04	0.2290E+05
4.1500	0.2570E+04	0.2173E+05
4.2500	0.2390E+04	0.2094E+05
4.3500	0.2200E+04	0.1996E+05
4.4500	0.2010E+04	0.1887E+05
4.5500	0.1850E+04	0.1796E+05
4.6500	0.1710E+04	0.1715E+05
4.7500	0.1570E+04	0.1625E+05
4.8500	0.1470E+04	0.1570E+05
4.9500	0.1350E+04	0.1487E+05
5.0500	0.1260E+04	0.1430E+05
5.1500	0.1140E+04	0.1332E+05
5.2500	0.1040E+04	0.1251E+05
5.3500	0.9680E+03	0.1198E+05
5.4500	0.9000E+03	0.1145E+05
5.5500	0.8270E+03	0.1081E+05
5.6500	0.7620E+03	0.1023E+05
5.7500	0.7040E+03	0.9707E+04
5.8500	0.6400E+03	0.9056E+04
5.9500	0.5900E+03	0.8563E+04
6.0500	0.5410E+03	0.8051E+04
6.1500	0.4950E+03	0.7549E+04
6.2500	0.4560E+03	0.7125E+04
6.3500	0.4170E+03	0.6673E+04
6.4500	0.3810E+03	0.6241E+04
6.5500	0.3370E+03	0.5649E+04
6.6500	0.3110E+03	0.5333E+04
6.7500	0.2790E+03	0.4893E+04
6.8500	0.2500E+03	0.4482E+04
6.9500	0.2220E+03	0.4068E+04
7.0500	0.2020E+03	0.3781E+04
7.1500	0.1770E+03	0.3384E+04
7.2500	0.1530E+03	0.2987E+04
7.3500	0.1330E+03	0.2650E+04

```

    7.4500    0.1130E+03    0.2298E+04
    7.5500    0.9410E+02    0.1952E+04
    7.6500    0.7470E+02    0.1581E+04
c      total =    0.75467E+09
c      total = 7.5467E+08 x 72 = 5.4336E+10
ctme    300
nps     1480365
prdmpr  j -960
e0      .2 .6 .8 2. 20.
fc2     p dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f2:p    73 74
fs2     -81 84 -82 83 -89 -90 -91 -92 t
sd2     142172 138738 16219 16219 3679 3600 2r 1740 329567
        142172 138738 16219 16219 3679 3600 2r 1740 329567
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de2     0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
        0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
        1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
        4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
        13.0 15.0
df2     3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
fc12    p dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f12:p   71 72
fs12    -85 88 -86 87 -89 -90 -91 -92 t
sd12    10002 10002 16219 16219 3679 3600 2r 1740 68660
        10002 10002 16219 16219 3679 3600 2r 1740 68660
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de12    0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
        0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
        1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
        4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
        13.0 15.0
df12    3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
fc22    p dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f22:p   75 76
fs22    -81 84 -82 83 -85 -86 -87 -88 t
sd22    133591 130366 15240 15240 2220 3600 2r 2220 309677
        133591 130366 15240 15240 2220 3600 2r 2220 309677
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de22    0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
        0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
        1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25

```

		4.75	5.00	5.25	5.75	6.25	6.75	7.50	9.00	11.0
		13.0	15.0							
df22		3.96-3	5.82-4	2.90-4	2.58-4	2.83-4	3.79-4	5.01-4	6.31-4	7.59-4
		8.78-4	9.85-4	1.08-3	1.17-3	1.27-3	1.36-3	1.44-3	1.52-3	1.68-3
		1.98-3	2.51-3	2.99-3	3.42-3	3.82-3	4.01-3	4.41-3	4.83-3	5.23-3
		5.60-3	5.80-3	6.01-3	6.37-3	6.74-3	7.11-3	7.66-3	8.77-3	1.03-2
		1.18-2	1.33-2							
fc102	p dose rates (mrem/hr) on side of package, 2nd entry									
f102:p		38								
fs102		-93 -94 t								
c	ansi/ans-6.1.1-1977 fluence-to-dose, photons(mrem/hr)/(p/cm**2/s)									
de102		0.01	0.03	0.05	0.07	0.10	0.15	0.20	0.25	0.30
		0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.80
		1.00	1.40	1.80	2.20	2.60	2.80	3.25	3.75	4.25
		4.75	5.00	5.25	5.75	6.25	6.75	7.50	9.00	11.0
		13.0	15.0							
df102		3.96-3	5.82-4	2.90-4	2.58-4	2.83-4	3.79-4	5.01-4	6.31-4	7.59-4
		8.78-4	9.85-4	1.08-3	1.17-3	1.27-3	1.36-3	1.44-3	1.52-3	1.68-3
		1.98-3	2.51-3	2.99-3	3.42-3	3.82-3	4.01-3	4.41-3	4.83-3	5.23-3
		5.60-3	5.80-3	6.01-3	6.37-3	6.74-3	7.11-3	7.66-3	8.77-3	1.03-2
		1.18-2	1.33-2							
fc122	p dose rates (mrem/hr) on top of package, 1st entry									
f122:p		63								
fs122		-95 t								
c	ansi/ans-6.1.1-1977 fluence-to-dose, photons(mrem/hr)/(p/cm**2/s)									
de122		0.01	0.03	0.05	0.07	0.10	0.15	0.20	0.25	0.30
		0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.80
		1.00	1.40	1.80	2.20	2.60	2.80	3.25	3.75	4.25
		4.75	5.00	5.25	5.75	6.25	6.75	7.50	9.00	11.0
		13.0	15.0							
df122		3.96-3	5.82-4	2.90-4	2.58-4	2.83-4	3.79-4	5.01-4	6.31-4	7.59-4
		8.78-4	9.85-4	1.08-3	1.17-3	1.27-3	1.36-3	1.44-3	1.52-3	1.68-3
		1.98-3	2.51-3	2.99-3	3.42-3	3.82-3	4.01-3	4.41-3	4.83-3	5.23-3
		5.60-3	5.80-3	6.01-3	6.37-3	6.74-3	7.11-3	7.66-3	8.77-3	1.03-2
		1.18-2	1.33-2							
fc5	p dose rates (mrem/hr) at detectors, 1 m above top s									
f5:p		0. 0. 252.22 50.								
c	ansi/ans-6.1.1-1977 fluence-to-dose, photons(mrem/hr)/(p/cm**2/s)									
de5		0.01	0.03	0.05	0.07	0.10	0.15	0.20	0.25	0.30
		0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.80
		1.00	1.40	1.80	2.20	2.60	2.80	3.25	3.75	4.25
		4.75	5.00	5.25	5.75	6.25	6.75	7.50	9.00	11.0
		13.0	15.0							
df5		3.96-3	5.82-4	2.90-4	2.58-4	2.83-4	3.79-4	5.01-4	6.31-4	7.59-4
		8.78-4	9.85-4	1.08-3	1.17-3	1.27-3	1.36-3	1.44-3	1.52-3	1.68-3
		1.98-3	2.51-3	2.99-3	3.42-3	3.82-3	4.01-3	4.41-3	4.83-3	5.23-3
		5.60-3	5.80-3	6.01-3	6.37-3	6.74-3	7.11-3	7.66-3	8.77-3	1.03-2
		1.18-2	1.33-2							

NCT NEUTRON SHIELDING MCNP INPUT FILE FOR 7,000 N/S-G <sup>238</sup>Pu Source

SHLD. CALC., 7000 A,N, N-GAMMA, water, no q, p.det., jun 96 i0ndq

```
1 0 -5 6 -1 3 -4 2 trcl=1 fill=1
2 0 -7 8 u=1 lat=1
   fill=0:17 0:0 0:0 2 17r
3 1 -1.9500 -9 (12 :-11 :20 )(14 :-13 :20 ) u=2
4 1 -1.9500 -10 (12 :-11 :22 )(14 :-13 :22 ) u=2
5 1 -1.9500 9 10 u=2
6 2 -22.5 -12 11 -20 (-15 :16 :19 ) u=2
7 2 -22.5 -14 13 -20 (-17 :18 :19 ) u=2
8 3 -9.6000 -16 15 -19 u=2
9 3 -9.6000 -18 17 -19 u=2
10 2 -22.5 -12 11 -22 (-15 :16 :21 ) u=2
11 2 -22.5 -14 13 -22 (-17 :18 :21 ) u=2
12 3 -9.6000 -16 15 -21 u=2
13 3 -9.6000 -18 17 -21 u=2
c Astroquartz insulation and thermopile and Al shell
14 231 -.00122 -121 134 -135 #1
15 0 -122 133 -136 (121:-134:135)
16 231 -.00122 -123 132 -137 (122:-133:136)
17 12 -2.85 -124 131 -138 (123:-132:137)
c inner containment
21 231 -.00122 ((6 -52 -31 ):(52 -33 -53 )) (124:-131:138)
22 201 -8.0300 51 -52 31 -32
23 201 -8.0300 (52 -34 -54 )(33 :53 )
24 201 -8.0300 51 -6 -31
c outer containment
41 231 -.00122 51 35 -64 -39
42 231 -.00122 ((51 -35 -62 )(52 :32 ))(-52 :34 :54 )
43 201 -8.0300 (-36 64 -63 )(62 :35 )
44 236 -1.0 -52 65 36 -37
45 201 -8.0300 -52 65 37 -38
46 201 -8.0300 ((64 -65 36 51 -40 ):(-64 39 51 )):(65 38 -66 -40 )
47 201 -8.0300 61 -51 -40
c beyond outer containment and inside truck boundary
71 231 -.00122 (((-52 :36 :63 ))(52 :38 :-66 ))(66 :40 :-61 )
   71 -72 73 -74 75 -76
c beyond truck and inside large sphere, above ground
72 231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c ground
73 221 -1.67 -77 -111
c outside world
74 0 111

1 py 4.659
2 px -4.859
3 py -4.659
4 px 4.859
```

5 pz 95.544  
6 pz 0.0000  
7 pz 5.30801  
8 pz -0.00001  
9 c/y -2.184 2.654 1.831  
10 c/y 2.184 2.654 1.831  
11 py -3.1618  
12 py -0.2941  
13 py 0.2941  
14 py 3.1618  
15 py -3.1059  
16 py -0.350  
17 py 0.350  
18 py 3.1059  
19 c/y -2.1840 2.6540 1.3767  
20 c/y -2.1840 2.6540 1.4326  
21 c/y 2.1840 2.6540 1.3767  
22 c/y 2.1840 2.6540 1.4326  
c radial surfaces for inner and outer containment  
31 cz 43.1800  
32 cz 45.0850  
33 cz 43.6562  
34 cz 44.6088  
35 cz 45.5676  
36 cz 46.8376  
37 cz 50.0380  
38 cz 50.3796  
39 cz 49.6443  
40 cz 61.3410  
c inner containment  
51 pz -8.8138  
52 pz 127.4450  
53 sz 60.3377 88.9000  
54 sz 60.3377 89.8525  
c outer containment  
61 pz -12.6238  
62 sz 60.1472 90.8050  
63 sz 60.1472 92.0750  
64 kz 48.7807 1.0000 -1.0000  
65 kz 53.0733 1.0000 -1.0000  
66 pz 2.6940  
c truck outside boundary  
71 px -615.95  
72 px 603.25  
73 py -127.00  
74 py 127.00  
75 pz -72.3138  
76 pz 198.0  
77 pz -184.0738  
c tally fs surfaces on outside of truck

81 px -90.0  
 82 px -30.0  
 83 px 30.0  
 84 px 90.0  
 85 py -90.0  
 86 py -30.0  
 87 py 30.0  
 88 py 90.0  
 89 pz -11.0  
 90 pz 49.0  
 91 pz 109.0  
 92 pz 169.0  
 93 pz 63.76  
 94 pz 94.24  
 95 cz 15.24

c outside world.  
 111 so 5000.0000  
 121 cz 7.1165  
 122 cz 8.8945  
 123 cz 10.6426  
 124 cz 10.7950  
 131 pz 23.348  
 132 pz 23.5004  
 133 pz 29.6725  
 134 pz 31.4505  
 135 pz 127.0055  
 136 pz 128.7835  
 137 pz 134.9556  
 138 pz 135.108

\*tr1 0 0 31.4560  
 mode n p  
 m1 6000.50 -1.950000  
 m2 77000.55 -22.500000  
 m3 94238.50 -6.765000 94239.55 -1.698000 8016.50 -1.137000  
 m11 8016.50c -9631 14000.50c -.8452 42000.50c -.3391 \$ ins.+therm.  
 m12 13027.50c -1.  
 m201 26000.55c 67.970001 24000.50c 20.000000 28000.50c 10.000000  
 25055.50c 2.000000 6000.50c 0.030000  
 c Hanford hwvp soil  
 m221 8016.50c -0.511000 14000.50c -0.278200 20000.50c -0.071700  
 26000.55c -0.109100 13027.50c -0.083260 12000.50c -0.031420  
 19000.50c -0.011550 11023.50c -0.020220 22000.50c -0.016550  
 25055.50c -0.001781 15031.50c -0.002400  
 m231 7014.50c -0.765000 8016.50c -0.235000  
 m236 1001.50c 0.666700 8016.50c 0.333300  
 imp:n 1 16r 4 3r 16 \$ 1, 41  
 8r 8 0 \$ 42, 73  
 imp:p 1 16r 4 3r 16 \$ 1, 41  
 8r 8 0 \$ 42, 73



-2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654

c Harvey's new neutron spectrum , 157 g fueled clad

#	s19 h	sp9 d
	0.0000	0.0000E+00
	0.1000	0.6310E+04
	0.2000	0.9250E+04
	0.3000	0.1210E+05
	0.4000	0.1490E+05
	0.5000	0.1720E+05
	0.6000	0.1870E+05
	0.7000	0.2020E+05
	0.8000	0.2150E+05
	0.9000	0.2290E+05
	1.0000	0.2310E+05
	1.1000	0.2360E+05
	1.2000	0.2480E+05
	1.3000	0.2580E+05
	1.4000	0.2670E+05
	1.5000	0.2620E+05
	1.6000	0.2560E+05
	1.7000	0.2500E+05
	1.8000	0.2460E+05
	1.9000	0.2480E+05
	2.0000	0.2460E+05
	2.1000	0.2430E+05
	2.2000	0.2460E+05
	2.3000	0.2440E+05
	2.4000	0.2370E+05
	2.5000	0.2290E+05
	2.6000	0.2160E+05
	2.7000	0.2080E+05
	2.8000	0.2030E+05
	2.9000	0.1930E+05
	3.0000	0.1770E+05

	3.1000	0.1630E+05
	3.2000	0.1500E+05
	3.3000	0.1350E+05
	3.4000	0.1210E+05
	3.5000	0.1070E+05
	3.6000	0.9390E+04
	3.7000	0.8170E+04
	3.8000	0.7140E+04
	3.9000	0.6080E+04
	4.0000	0.4920E+04
	4.1000	0.3980E+04
	4.2000	0.3410E+04
	4.3000	0.2850E+04
	4.4000	0.2270E+04
	4.5000	0.5060E+04
	5.0000	0.6260E+04
	5.5000	0.4180E+04
	6.0000	0.2730E+04
	6.5000	0.1850E+04
	7.0000	0.1250E+04
	7.5000	0.8370E+03
	8.0000	0.5500E+03
	8.5000	0.3630E+03
	9.0000	0.2390E+03
	9.5000	0.1570E+03
	10.0000	0.1390E+03
	11.0000	0.8830E+02
	12.0000	0.3670E+02
	13.0000	0.1510E+02
	14.0000	0.6120E+01
	15.0000	0.2460E+01
c	total =	0.77703E+06 x 72 = 5.5946e+7
c	this jun	96 source is for 7000 n/gs a,n
ctme	1200	
nps	330000	
prdmp	j -960	
e0	.2 .6 .8 2. 20.	
fc2	p dose rates (mrem/hr) on sides of truck, 7th entry = nearest	
f2:p	73 74	
fs2	-81 84 -82 83 -89 -90 -91 -92 t	
sd2	142172 138738 16219 16219 3679 3600 2r 1740 329567	
	142172 138738 16219 16219 3679 3600 2r 1740 329567	
c	ansi/ans-6.1.1-1977	fluence-to-dose, photons(mrem/hr)/(p/cm**2/s)
de2	0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30	
	0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80	
	1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25	
	4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0	
	13.0 15.0	
df2	3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4	
	8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3	

1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc12 p dose rates (mrem/hr) on ends of truck, 7th entry = nearest  
f12:p 71 72  
fs12 -85 88 -86 87 -89 -90 -91 -92 t  
sd12 10002 10002 16219 16219 3679 3600 2r 1740 68660  
10002 10002 16219 16219 3679 3600 2r 1740 68660

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)  
de12 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df12 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc22 p dose rates (mrem/hr) on bottom and top, 7th entry = nearest  
f22:p 75 76  
fs22 -81 84 -82 83 -85 -86 -87 -88 t  
sd22 133591 130366 15240 15240 2220 3600 2r 2220 309677  
133591 130366 15240 15240 2220 3600 2r 2220 309677

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)  
de22 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df22 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc102 p dose rates (mrem/hr) on side of package, 2nd entry  
f102:p 38  
fs102 -132 -90 -93 -94 -91 -138 t  
sd102 1 5j 1 1

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)  
de102 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df102 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

```

fc122  p dose rates (mrem/hr) on top of package, 1st entry
fl22:p  63
fs122  -95 t
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm**2/s)
de122  0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
        0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
        1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
        4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
        13.0  15.0
df122  3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
fc32  n dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f32:n  73 74
fs32  -81 84 -82 83 -89 -90 -91 -92 t
sd32  142172 138738 16219 16219 3679 3600 2r 1740 329567
        142172 138738 16219 16219 3679 3600 2r 1740 329567
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de32  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df32  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc42  n dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f42:n  71 72
fs42  -85 88 -86 87 -89 -90 -91 -92 t
sd42  10002 10002 16219 16219 3679 3600 2r 1740 68660
        10002 10002 16219 16219 3679 3600 2r 1740 68660
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de42  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df42  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc52  n dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f52:n  75 76
fs52  -81 84 -82 83 -85 -86 -87 -88 t
sd52  133591 130366 15240 15240 2220 3600 2r 2220 309677
        133591 130366 15240 15240 2220 3600 2r 2220 309677
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de52  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df52  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227

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fc132  n dose rates (mrem/hr) on side of package, 2nd entry
fl32:n  38
fs132  -132 -90 -93 -94 -91 -138 t
sdl32  1 5j 1 1
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de132  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df132  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc152  n dose rates (mrem/hr) on top of package, 1st entry
fl52:n  63
fs152  -95 t
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de152  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df152  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc5    p dose rates (mrem/hr) at detectors, 2 m, driver
f5:p   0. 327.00 79. 100.
        847.09 0. 79. 100.
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de5    0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
        0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
        1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
        4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
        13.0 15.0
df5    3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
ft5    icd
fu5    3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 21 22 23 24
        41 42 43 44 45 46 47 71 72 73
fc15   n dose rates (mrem/hr) at detectors, 2 m, driver
fl15:n 0. 327.00 79. 100.
        847.09 0. 79. 100.
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de15   log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001 .01 .1 .5 1.0
        2.5 5.0 7.0 10.0 14.0 20.0
df15   log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
ft15   icd
ful5   3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 21 22 23 24
  
```

41 42 43 44 45 46 47 71 72 73

NCT NEUTRON SHIELDING MCNP INPUT FILE FOR 7,500 N/S-G <sup>238</sup>Pu Source

```

SHLD. CALC., 7500 a,n,N-GAMMA, water, no q,p.det., jun 96 i5ndq
  1  0 -5 6 -1 3 -4 2 trcl=1 fill=1
  2  0 -7 8 u=1 lat=1
      fill=0:17 0:0 0:0 2 17r
  3  1 -1.9500 -9 (12 :-11 :20 )(14 :-13 :20 ) u=2
  4  1 -1.9500 -10 (12 :-11 :22 )(14 :-13 :22 ) u=2
  5  1 -1.9500 9 10 u=2
  6  2 -22.5 -12 11 -20 (-15 :16 :19 ) u=2
  7  2 -22.5 -14 13 -20 (-17 :18 :19 ) u=2
  8  3 -9.6000 -16 15 -19 u=2
  9  3 -9.6000 -18 17 -19 u=2
 10  2 -22.5 -12 11 -22 (-15 :16 :21 ) u=2
 11  2 -22.5 -14 13 -22 (-17 :18 :21 ) u=2
 12  3 -9.6000 -16 15 -21 u=2
 13  3 -9.6000 -18 17 -21 u=2
c   Astroquartz insulation and thermopile and Al shell
 14 231 -.00122 -121 134 -135 #1
 15  0 -122 133 -136 (121:-134:135)
 16 231 -.00122 -123 132 -137 (122:-133:136)
 17 12 -2.85 -124 131 -138 (123:-132:137)
c   inner containment
 21 231 -.00122 ((6 -52 -31 ):(52 -33 -53 )) (124:-131:138)
 22 201 -8.0300 51 -52 31 -32
 23 201 -8.0300 (52 -34 -54 )(33 :53 )
 24 201 -8.0300 51 -6 -31
c   outer containment
 41 231 -.00122 51 35 -64 -39
 42 231 -.00122 ((51 -35 -62 )(52 :32 ))(-52 :34 :54 )
 43 201 -8.0300 (-36 64 -63 )(62 :35 )
 44 236 -1.0 -52 65 36 -37
 45 201 -8.0300 -52 65 37 -38
 46 201 -8.0300 ((64 -65 36 51 -40 ):(-64 39 51 )):(65 38 -66 -40 )
 47 201 -8.0300 61 -51 -40
c   beyond outer containment and inside truck boundary
 71 231 -.00122 (((-52 :36 :63 ))(52 :38 :-66 ))(66 :40 :-61 )
      71 -72 73 -74 75 -76
c   beyond truck and inside large sphere, above ground
 72 231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c   ground
 73 221 -1.67 -77 -111
c   outside world
 74  0 111

  1  py  4.659
  2  px -4.859
  3  py -4.659
  4  px  4.859

```

5	pz	95.544		
6	pz	0.0000		
7	pz	5.30801		
8	pz	-0.00001		
9	c/y	-2.184	2.654	1.831
10	c/y	2.184	2.654	1.831
11	py	-3.1618		
12	py	-0.2941		
13	py	0.2941		
14	py	3.1618		
15	py	-3.1059		
16	py	-0.350		
17	py	0.350		
18	py	3.1059		
19	c/y	-2.1840	2.6540	1.3767
20	c/y	-2.1840	2.6540	1.4326
21	c/y	2.1840	2.6540	1.3767
22	c/y	2.1840	2.6540	1.4326
c	radial surfaces for inner and outer containment			
31	cz	43.1800		
32	cz	45.0850		
33	cz	43.6562		
34	cz	44.6088		
35	cz	45.5676		
36	cz	46.8376		
37	cz	50.0380		
38	cz	50.3796		
39	cz	49.6443		
40	cz	61.3410		
c	inner containment			
51	pz	-8.8138		
52	pz	127.4450		
53	sz	60.3377	88.9000	
54	sz	60.3377	89.8525	
c	outer containment			
61	pz	-12.6238		
62	sz	60.1472	90.8050	
63	sz	60.1472	92.0750	
64	kz	48.7807	1.0000	-1.0000
65	kz	53.0733	1.0000	-1.0000
66	pz	2.6940		
c	truck outside boundary			
71	px	-615.95		
72	px	603.25		
73	py	-127.00		
74	py	127.00		
75	pz	-72.3138		
76	pz	198.0		
77	pz	-184.0738		
c	tally fs surfaces on outside of truck			

81 px -90.0  
 82 px -30.0  
 83 px 30.0  
 84 px 90.0  
 85 py -90.0  
 86 py -30.0  
 87 py 30.0  
 88 py 90.0  
 89 pz -11.0  
 90 pz 49.0  
 91 pz 109.0  
 92 pz 169.0  
 93 pz 63.76  
 94 pz 94.24  
 95 cz 15.24  
 c outside world.  
 111 so 5000.0000  
 121 cz 7.1165  
 122 cz 8.8945  
 123 cz 10.6426  
 124 cz 10.7950  
 131 pz 23.348  
 132 pz 23.5004  
 133 pz 29.6725  
 134 pz 31.4505  
 135 pz 127.0055  
 136 pz 128.7835  
 137 pz 134.9556  
 138 pz 135.108

\*tr1 0 0 31.4560  
 mode n p  
 m1 6000.50 -1.950000  
 m2 77000.55 -22.500000  
 m3 94238.50 -6.765000 94239.55 -1.698000 8016.50 -1.137000  
 m11 8016.50c -0.9631 14000.50c -0.8452 42000.50c -0.3391 \$ ins.+therm.  
 m12 13027.50c -1.  
 m201 26000.55c 67.970001 24000.50c 20.000000 28000.50c 10.000000  
 25055.50c 2.000000 6000.50c 0.030000  
 c Hanford hwpv soil  
 m221 8016.50c -0.511000 14000.50c -0.278200 20000.50c -0.071700  
 26000.55c -0.109100 13027.50c -0.083260 12000.50c -0.031420  
 19000.50c -0.011550 11023.50c -0.020220 22000.50c -0.016550  
 25055.50c -0.001781 15031.50c -0.002400  
 m231 7014.50c -0.765000 8016.50c -0.235000  
 m236 1001.50c 0.666700 8016.50c 0.333300  
 imp:n 1 16r 4 3r 16 \$ 1, 41  
 8r 8 0 \$ 42, 73  
 imp:p 1 16r 4 3r 16 \$ 1, 41  
 8r 8 0 \$ 42, 73



2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654  
 -2.184 -3.1059 2.654 -2.184 .35 2.654  
 2.184 -3.1059 2.654 2.184 .35 2.654

c Harvey's new neutron spectrum , 157 g fueled clad

#	si9 h	sp9 d
	0.0000	0.0000E+00
	0.1000	0.6440E+04
	0.2000	0.9510E+04
	0.3000	0.1260E+05
	0.4000	0.1560E+05
	0.5000	0.1810E+05
	0.6000	0.1970E+05
	0.7000	0.2130E+05
	0.8000	0.2280E+05
	0.9000	0.2440E+05
	1.0000	0.2460E+05
	1.1000	0.2520E+05
	1.2000	0.2650E+05
	1.3000	0.2770E+05
	1.4000	0.2870E+05
	1.5000	0.2820E+05
	1.6000	0.2750E+05
	1.7000	0.2690E+05
	1.8000	0.2650E+05
	1.9000	0.2670E+05
	2.0000	0.2660E+05
	2.1000	0.2630E+05
	2.2000	0.2670E+05
	2.3000	0.2650E+05
	2.4000	0.2570E+05
	2.5000	0.2480E+05
	2.6000	0.2340E+05
	2.7000	0.2260E+05
	2.8000	0.2200E+05
	2.9000	0.2100E+05

3.0000 0.1920E+05  
 3.1000 0.1770E+05  
 3.2000 0.1620E+05  
 3.3000 0.1460E+05  
 3.4000 0.1310E+05  
 3.5000 0.1160E+05  
 3.6000 0.1010E+05  
 3.7000 0.8790E+04  
 3.8000 0.7660E+04  
 3.9000 0.6500E+04  
 4.0000 0.5220E+04  
 4.1000 0.4190E+04  
 4.2000 0.3580E+04  
 4.3000 0.2960E+04  
 4.4000 0.2340E+04  
 4.5000 0.5120E+04  
 5.0000 0.6340E+04  
 5.5000 0.4220E+04  
 6.0000 0.2730E+04  
 6.5000 0.1860E+04  
 7.0000 0.1260E+04  
 7.5000 0.8390E+03  
 8.0000 0.5500E+03  
 8.5000 0.3630E+03  
 9.0000 0.2390E+03  
 9.5000 0.1570E+03  
 10.0000 0.1390E+03  
 11.0000 0.8830E+02  
 12.0000 0.3670E+02  
 13.0000 0.1510E+02  
 14.0000 0.6120E+01  
 15.0000 0.2460E+01

c total = 0.83226E+06 x 72 = 5.9923e+7

c this jun 96 source is for 7500 n/gs a,n

ctme 1200

nps 330000

prdmp j -960

e0 .2 .6 .8 2. 20.

fc2 p dose rates (mrem/hr) on sides of truck, 7th entry = nearest

f2:p 73 74

fs2 -81 84 -82 83 -89 -90 -91 -92 t

sd2 142172 138738 16219 16219 3679 3600 2r 1740 329567

142172 138738 16219 16219 3679 3600 2r 1740 329567

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)

de2 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30

0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80

1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25

4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0

13.0 15.0

df2 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4

8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc12 p dose rates (mrem/hr) on ends of truck, 7th entry = nearest

f12:p 71 72

fs12 -85 88 -86 87 -89 -90 -91 -92 t

sd12 10002 10002 16219 16219 3679 3600 2r 1740 68660

10002 10002 16219 16219 3679 3600 2r 1740 68660

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)

de12 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df12 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc22 p dose rates (mrem/hr) on bottom and top, 7th entry = nearest

f22:p 75 76

fs22 -81 84 -82 83 -85 -86 -87 -88 t

sd22 133591 130366 15240 15240 2220 3600 2r 2220 309677

133591 130366 15240 15240 2220 3600 2r 2220 309677

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)

de22 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df22 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2  
1.18-2 1.33-2

fc102 p dose rates (mrem/hr) on side of package, 2nd entry

f102:p 38

fs102 -132 -90 -93 -94 -91 -138 t

sd102 1 5j 1 1

c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm\*\*2/s)

de102 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30  
0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80  
1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25  
4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0  
13.0 15.0

df102 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4  
8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3  
1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3  
5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2

```

1.18-2 1.33-2
fc122 p dose rates (mrem/hr) on top of package, 1st entry
f122:p 63
fs122 -95 t
c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
del22 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
      0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
      1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
      4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
      13.0 15.0
df122 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
      8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
      1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
      5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
      1.18-2 1.33-2
fc32 n dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f32:n 73 74
fs32 -81 84 -82 83 -89 -90 -91 -92 t
sd32 142172 138738 16219 16219 3679 3600 2r 1740 329567
      142172 138738 16219 16219 3679 3600 2r 1740 329567
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de32 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df32 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
      .125 .156 .147 .147 .208 .227
fc42 n dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f42:n 71 72
fs42 -85 88 -86 87 -89 -90 -91 -92 t
sd42 10002 10002 16219 16219 3679 3600 2r 1740 68660
      10002 10002 16219 16219 3679 3600 2r 1740 68660
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de42 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df42 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
      .125 .156 .147 .147 .208 .227
fc52 n dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f52:n 75 76
fs52 -81 84 -82 83 -85 -86 -87 -88 t
sd52 133591 130366 15240 15240 2220 3600 2r 2220 309677
      133591 130366 15240 15240 2220 3600 2r 2220 309677
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de52 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df52 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132

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    .125 .156 .147 .147 .208 .227
fc132 n dose rates (mrem/hr) on side of package, 2nd entry
f132:n 38
fs132 -132 -90 -93 -94 -91 -138 t
sd132 1 5j 1 1
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
del32 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
    .001 .01 .1 .5 1.0
    2.5 5.0 7.0 10.0 14.0 20.0
df132 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
    3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
    .125 .156 .147 .147 .208 .227
fc152 n dose rates (mrem/hr) on top of package, 1st entry
f152:n 63
fs152 -95 t
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
del152 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
    .001 .01 .1 .5 1.0
    2.5 5.0 7.0 10.0 14.0 20.0
df152 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
    3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
    .125 .156 .147 .147 .208 .227
fc5 p dose rates (mrem/hr) at detectors, 2 m, driver
f5:p 0. 327.00 79. 100.
    847.09 0. 79. 100.
c ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de5 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
    0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
    1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
    4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
    13.0 15.0
df5 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
    8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
    1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
    5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
    1.18-2 1.33-2
ft5 icd
fu5 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 21 22 23 24
    41 42 43 44 45 46 47 71 72 73
fc15 n dose rates (mrem/hr) at detectors, 2 m, driver
f15:n 0. 327.00 79. 100.
    847.09 0. 79. 100.
c ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
del15 log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
    .001 .01 .1 .5 1.0
    2.5 5.0 7.0 10.0 14.0 20.0
df15 log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
    3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
    .125 .156 .147 .147 .208 .227
ft15 icd

```

fu15 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 21 22 23 24  
41 42 43 44 45 46 47 71 72 73

NAC NEUTRON SHIELDING MCNP INPUT FILE FOR 7,000 N/S-G <sup>238</sup>Pu Source

```
SHLD. CALC., GPHS-RTG, NEUTRON-GAMMA, 7000, accident ingacio
c   sphere of PuO2 for accident condition
  1   3 -9.60 -100
c   inner containment
 21  231 -.00122 ((6 -52 -31):(52 -33 -53)) 100
 22  201 -8.0300 51 -52 31 -32
 23  201 -8.0300 (52 -34 -54)(33 :53 )
 24  201 -8.0300 51 -6 -31
c   outer containment
 41  231 -.00122 51 35 -64 -39
 42  231 -.00122 ((51 -35 -62)(52 :32))(-52 :34 :54 )
 43  201 -8.0300 (-36 64 -63)(62 :35 )
 44  236 -1.0 -52 65 36 -37
 45  201 -8.0300 -52 65 37 -38
 46  201 -8.0300 ((64 -65 36 51 -40):(-64 39 51 )):(65 38 -66 -40 )
 47  201 -8.0300 61 -51 -40
c   beyond outer containment and inside truck boundary
 71  231 -.00122 (((-52 :36 :63))(52 :38 :-66))(66 :40 :-61 )
      71 -72 73 -74 75 -76
c   beyond truck and inside large sphere, above ground
 72  231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c   ground
 73  221 -1.67 -77 -111
c   outside world
 74  0 111

  1   py  4.659
  2   px -4.859
  3   py -4.659
  4   px  4.859
  5   pz 95.544
  6   pz 0.0000
  7   pz 5.30801
  8   pz -0.00001
  9   c/y -2.184 2.654 1.831
 10   c/y  2.184 2.654 1.831
 11   py -3.1618
 12   py -0.2941
 13   py  0.2941
 14   py  3.1618
 15   py -3.1059
 16   py -0.350
 17   py  0.350
 18   py  3.1059
 19   c/y -2.1840 2.6540 1.3767
 20   c/y -2.1840 2.6540 1.4326
 21   c/y  2.1840 2.6540 1.3767
```

22 c/y 2.1840 2.6540 1.4326  
c radial surfaces for inner and outer containment  
31 cz 43.1800  
32 cz 45.0850  
33 cz 43.6562  
34 cz 44.6088  
35 cz 45.5676  
36 cz 46.8376  
37 cz 50.0380  
38 cz 50.3796  
39 cz 49.6443  
40 cz 61.3410  
c inner containment  
51 pz -8.8138  
52 pz 127.4450  
53 sz 60.3377 88.9000  
54 sz 60.3377 89.8525  
c outer containment  
61 pz -12.6238  
62 sz 60.1472 90.8050  
63 sz 60.1472 92.0750  
64 kz 48.7807 1.0000 -1.0000  
65 kz 53.0733 1.0000 -1.0000  
66 pz 2.6940  
c truck outside boundary  
71 px -615.95  
72 px 603.25  
73 py -127.00  
74 py 127.00  
75 pz -72.3138  
76 pz 198.0  
77 pz -184.0738  
c tally fs surfaces on outside of truck  
81 px -90.0  
82 px -30.0  
83 px 30.0  
84 px 90.0  
85 py -90.0  
86 py -30.0  
87 py 30.0  
88 py 90.0  
89 pz -11.0  
90 pz 49.0  
91 pz 109.0  
92 pz 169.0  
93 pz 63.76  
94 pz 94.24  
95 cz 15.24  
100 s 0. 0. 142.6 6.5508  
c outside world.

111 so 5000.0000

```

*tr1 0 0 31.4560
mode n p
m1 6000.50 -1.950000
m2 75187.50 -22.500000
m3 94238.50 -6.765000 94239.55 -1.698000 8016.50 -1.137000
m201 26000.55c 67.970001 24000.50c 20.000000 28000.50c 10.000000
      25055.50c 2.000000 6000.50c 0.030000
c Hanford hwvp soil
m221 8016.50c -0.511000 14000.50c -0.278200 20000.50c -0.071700
      26000.55c -0.109100 13027.50c -0.083260 12000.50c -0.031420
      19000.50c -0.011550 11023.50c -0.020220 22000.50c -0.016550
      25055.50c -0.001781 15031.50c -0.002400
m231 7014.50c -0.765000 8016.50c -0.235000
m236 1001.50c 0.666700 8016.50c 0.333300
imp:n 1 4 3r 16 $ 1, 41
      8r 8 0 $ 42, 73
imp:p 1 4 3r 16 $ 1, 41
      8r 8 0 $ 42, 73
print 10 30 40 50 60 100 110 120 126 170
phys:p j l
cut:p j j 0. 0.
cut:n j j 0. 0.
sdef rad d4 erg=d9
      pos 0. 0. 142.6 wgt=5.5946e7
si4 6.5508
sp4 -21 2
c neutron spectrum from Harvey 10-3-95, 157 g fueled clad
# si9 sp9
  h d
  0.0000 0.0000E+00
  0.1000 0.6310E+04
  0.2000 0.9250E+04
  0.3000 0.1210E+05
  0.4000 0.1490E+05
  0.5000 0.1720E+05
  0.6000 0.1870E+05
  0.7000 0.2020E+05
  0.8000 0.2150E+05
  0.9000 0.2290E+05
  1.0000 0.2310E+05
  1.1000 0.2360E+05
  1.2000 0.2480E+05
  1.3000 0.2580E+05
  1.4000 0.2670E+05
  1.5000 0.2620E+05
  1.6000 0.2560E+05
  1.7000 0.2500E+05
  1.8000 0.2460E+05

```

1.9000	0.2480E+05
2.0000	0.2460E+05
2.1000	0.2430E+05
2.2000	0.2460E+05
2.3000	0.2440E+05
2.4000	0.2370E+05
2.5000	0.2290E+05
2.6000	0.2160E+05
2.7000	0.2080E+05
2.8000	0.2030E+05
2.9000	0.1930E+05
3.0000	0.1770E+05
3.1000	0.1630E+05
3.2000	0.1500E+05
3.3000	0.1350E+05
3.4000	0.1210E+05
3.5000	0.1070E+05
3.6000	0.9390E+04
3.7000	0.8170E+04
3.8000	0.7140E+04
3.9000	0.6080E+04
4.0000	0.4920E+04
4.1000	0.3980E+04
4.2000	0.3410E+04
4.3000	0.2850E+04
4.4000	0.2270E+04
4.5000	0.5060E+04
5.0000	0.6260E+04
5.5000	0.4180E+04
6.0000	0.2730E+04
6.5000	0.1850E+04
7.0000	0.1250E+04
7.5000	0.8370E+03
8.0000	0.5500E+03
8.5000	0.3630E+03
9.0000	0.2390E+03
9.5000	0.1570E+03
10.0000	0.1390E+03
11.0000	0.8830E+02
12.0000	0.3670E+02
13.0000	0.1510E+02
14.0000	0.6120E+01
15.0000	0.2460E+01

c total = 0.77703E+06  
c total = 0.77703E+06 x 72 = 5.5946E+7

ctme 400

nps 60000

prdmp j -960

e0 .2 .6 .8 2. 20.

fc2 p dose rates (mrem/hr) on sides of truck, 7th entry = nearest

```

f2:p      73 74
fs2      -81 84 -82 83 -89 -90 -91 -92 t
sd2      142172 138738 16219 16219 3679 3600 2r 1740 329567
          142172 138738 16219 16219 3679 3600 2r 1740 329567
c        ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de2      0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df2      3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc12     p dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f12:p    71 72
fs12     -85 88 -86 87 -89 -90 -91 -92 t
sd12     10002 10002 16219 16219 3679 3600 2r 1740 68660
          10002 10002 16219 16219 3679 3600 2r 1740 68660
c        ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de12     0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df12     3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc22     p dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f22:p    75 76
fs22     -81 84 -82 83 -85 -86 -87 -88 t
sd22     133591 130366 15240 15240 2220 3600 2r 2220 309677
          133591 130366 15240 15240 2220 3600 2r 2220 309677
c        ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de22     0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df22     3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc32     n dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f32:n    73 74
fs32     -81 84 -82 83 -89 -90 -91 -92 t
  
```

```

sd32 142172 138738 16219 16219 3679 3600 2r 1740 329567
      142172 138738 16219 16219 3679 3600 2r 1740 329567
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de32  log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df32  log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
      .125 .156 .147 .147 .208 .227
fc42  n dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f42:n 71 72
fs42  -85 88 -86 87 -89 -90 -91 -92 t
sd42 10002 10002 16219 16219 3679 3600 2r 1740 68660
      10002 10002 16219 16219 3679 3600 2r 1740 68660
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de42  log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df42  log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
      .125 .156 .147 .147 .208 .227
fc52  n dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f52:n 75 76
fs52  -81 84 -82 83 -85 -86 -87 -88 t
sd52 133591 130366 15240 15240 2220 3600 2r 2220 309677
      133591 130366 15240 15240 2220 3600 2r 2220 309677
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de52  log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
      .001 .01 .1 .5 1.0
      2.5 5.0 7.0 10.0 14.0 20.0
df52  log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
      3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
      .125 .156 .147 .147 .208 .227
fc102 p dose rates (mrem/hr) on side of package, 2nd entry
f102:p 38
fs102 -93 -94 t
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de102 0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
      0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
      1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
      4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
      13.0 15.0
df102 3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
      8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
      1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
      5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
      1.18-2 1.33-2
fc122 p dose rates (mrem/hr) on top of package, 1st entry
f122:p 63
fs122 -95 t

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c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de122  0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
        0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
        1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
        4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
        13.0  15.0
df122  3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
fc132  n dose rates (mrem/hr) on side of package, 2nd entry
f132:n  38
fs132  -93 -94 t
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de132  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001  .01  .1  .5  1.0
        2.5  5.0  7.0  10.0  14.0  20.0
df132  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc152  n dose rates (mrem/hr) on top of package, 1st entry
f152:n  63
fs152  -95 t
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de152  log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001  .01  .1  .5  1.0
        2.5  5.0  7.0  10.0  14.0  20.0
df152  log  3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
        3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
        .125 .156 .147 .147 .208 .227
fc5    p dose rates (mrem/hr) at detectors, 1 m above top s
f5:p   0. 0. 252.22 50.
c      ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de5    0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
        0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
        1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
        4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
        13.0  15.0
df5    3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
        8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
        1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
        5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
        1.18-2 1.33-2
fc15   n dose rates (mrem/hr) at detectors, 1 m above top s
f15:n  0. 0. 252.22 50.
c      ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de15   log  2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
        .001  .01  .1  .5  1.0
        2.5  5.0  7.0  10.0  14.0  20.0

```

df15	log	3.67e-3	3.67e-3	4.46e-3	4.54e-3	4.18e-3			
		3.76e-3	3.56e-3	2.17e-2	9.26e-2	.132			
		.125	.156	.147	.147	.208	.227		

NAC NEUTRON SHIELDING MCNP INPUT FILE FOR 7,500 N/S-G <sup>238</sup>Pu Source

```
SHLD. CALC., GPHS-RTG, NEUTRON-GAMMA, 7500, accident ingaci5
c   sphere of PuO2 for accident condition
  1   3 -9.60 -100
c   inner containment
 21  231 -.00122 ((6 -52 -31):(52 -33 -53)) 100
 22  201 -8.0300 51 -52 31 -32
 23  201 -8.0300 (52 -34 -54)(33 :53 )
 24  201 -8.0300 51 -6 -31
c   outer containment
 41  231 -.00122 51 35 -64 -39
 42  231 -.00122 ((51 -35 -62)(52 :32))(-52 :34 :54 )
 43  201 -8.0300 (-36 64 -63)(62 :35 )
 44  236 -1.0 -52 65 36 -37
 45  201 -8.0300 -52 65 37 -38
 46  201 -8.0300 ((64 -65 36 51 -40):(-64 39 51 )):(65 38 -66 -40 )
 47  201 -8.0300 61 -51 -40
c   beyond outer containment and inside truck boundary
 71  231 -.00122 (((-52 :36 :63))(52 :38 :-66 ))(66 :40 :-61 )
      71 -72 73 -74 75 -76
c   beyond truck and inside large sphere, above ground
 72  231 -.00122 (-71:72:-73:74:-75:76) 77 -111
c   ground
 73  221 -1.67 -77 -111
c   outside world
 74  0 111

  1   py  4.659
  2   px -4.859
  3   py -4.659
  4   px  4.859
  5   pz 95.544
  6   pz 0.0000
  7   pz 5.30801
  8   pz -0.00001
  9   c/y -2.184 2.654 1.831
 10  c/y 2.184 2.654 1.831
 11  py -3.1618
 12  py -0.2941
 13  py 0.2941
 14  py 3.1618
 15  py -3.1059
 16  py -0.350
 17  py 0.350
 18  py 3.1059
 19  c/y -2.1840 2.6540 1.3767
 20  c/y -2.1840 2.6540 1.4326
 21  c/y 2.1840 2.6540 1.3767
```

22 c/y 2.1840 2.6540 1.4326  
c radial surfaces for inner and outer containment  
31 cz 43.1800  
32 cz 45.0850  
33 cz 43.6562  
34 cz 44.6088  
35 cz 45.5676  
36 cz 46.8376  
37 cz 50.0380  
38 cz 50.3796  
39 cz 49.6443  
40 cz 61.3410  
c inner containment  
51 pz -8.8138  
52 pz 127.4450  
53 sz 60.3377 88.9000  
54 sz 60.3377 89.8525  
c outer containment  
61 pz -12.6238  
62 sz 60.1472 90.8050  
63 sz 60.1472 92.0750  
64 kz 48.7807 1.0000 -1.0000  
65 kz 53.0733 1.0000 -1.0000  
66 pz 2.6940  
c truck outside boundary  
71 px -615.95  
72 px 603.25  
73 py -127.00  
74 py 127.00  
75 pz -72.3138  
76 pz 198.0  
77 pz -184.0738  
c tally fs surfaces on outside of truck  
81 px -90.0  
82 px -30.0  
83 px 30.0  
84 px 90.0  
85 py -90.0  
86 py -30.0  
87 py 30.0  
88 py 90.0  
89 pz -11.0  
90 pz 49.0  
91 pz 109.0  
92 pz 169.0  
93 pz 63.76  
94 pz 94.24  
95 cz 15.24  
100 s 0. 0. 142.6 6.5508  
c outside world.

111 so 5000.0000

```
*tr1 0 0 31.4560
mode n p
m1 6000.50 -1.950000
m2 75187.50 -22.500000
m3 94238.50 -6.765000 94239.55 -1.698000 8016.50 -1.137000
m201 26000.55c 67.970001 24000.50c 20.000000 28000.50c 10.000000
      25055.50c 2.000000 6000.50c 0.030000
c Hanford hwvp soil
m221 8016.50c -0.511000 14000.50c -0.278200 20000.50c -0.071700
      26000.55c -0.109100 13027.50c -0.083260 12000.50c -0.031420
      19000.50c -0.011550 11023.50c -0.020220 22000.50c -0.016550
      25055.50c -0.001781 15031.50c -0.002400
m231 7014.50c -0.765000 8016.50c -0.235000
m236 1001.50c 0.666700 8016.50c 0.333300
imp:n 1 4 3r 16 $ 1, 41
      8r 8 0 $ 42, 73
imp:p 1 4 3r 16 $ 1, 41
      8r 8 0 $ 42, 73
print 10 30 40 50 60 100 110 120 126 170
```

```
phys:p j 1
cut:p j j 0. 0.
cut:n j j 0. 0.
sdef rad d4 erg=d9
      pos 0. 0. 142.6 wgt=5.9923e7
```

```
si4 6.5508
sp4 -21 2
c neutron spectrum from Harvey 10-3-95, 157 g fueled clad
```

```
# si9 sp9
h d
0.0000 0.0000E+00
0.1000 0.6440E+04
0.2000 0.9510E+04
0.3000 0.1260E+05
0.4000 0.1560E+05
0.5000 0.1810E+05
0.6000 0.1970E+05
0.7000 0.2130E+05
0.8000 0.2280E+05
0.9000 0.2440E+05
1.0000 0.2460E+05
1.1000 0.2520E+05
1.2000 0.2650E+05
1.3000 0.2770E+05
1.4000 0.2870E+05
1.5000 0.2820E+05
1.6000 0.2750E+05
1.7000 0.2690E+05
```

1.8000	0.2650E+05
1.9000	0.2670E+05
2.0000	0.2660E+05
2.1000	0.2630E+05
2.2000	0.2670E+05
2.3000	0.2650E+05
2.4000	0.2570E+05
2.5000	0.2480E+05
2.6000	0.2340E+05
2.7000	0.2260E+05
2.8000	0.2200E+05
2.9000	0.2100E+05
3.0000	0.1920E+05
3.1000	0.1770E+05
3.2000	0.1620E+05
3.3000	0.1460E+05
3.4000	0.1310E+05
3.5000	0.1160E+05
3.6000	0.1010E+05
3.7000	0.8790E+04
3.8000	0.7660E+04
3.9000	0.6500E+04
4.0000	0.5220E+04
4.1000	0.4190E+04
4.2000	0.3580E+04
4.3000	0.2960E+04
4.4000	0.2340E+04
4.5000	0.5120E+04
5.0000	0.6340E+04
5.5000	0.4220E+04
6.0000	0.2730E+04
6.5000	0.1860E+04
7.0000	0.1260E+04
7.5000	0.8390E+03
8.0000	0.5500E+03
8.5000	0.3630E+03
9.0000	0.2390E+03
9.5000	0.1570E+03
10.0000	0.1390E+03
11.0000	0.8830E+02
12.0000	0.3670E+02
13.0000	0.1510E+02
14.0000	0.6120E+01
15.0000	0.2460E+01

c total = 0.83226E+06  
 c total = 0.83226E+06 x 72 = 5.9923E+7  
 ctme 400  
 nps 60000  
 prdmp j -960  
 e0 .2 .6 .8 2. 20.

```

fc2  p dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f2:p  73 74
fs2   -81 84 -82 83 -89 -90 -91 -92 t
sd2   142172 138738 16219 16219 3679 3600 2r 1740 329567
      142172 138738 16219 16219 3679 3600 2r 1740 329567
c     ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de2   0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
      0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
      1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
      4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
      13.0  15.0
df2   3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
      8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
      1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
      5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
      1.18-2 1.33-2
fc12  p dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f12:p 71 72
fs12  -85 88 -86 87 -89 -90 -91 -92 t
sd12  10002 10002 16219 16219 3679 3600 2r 1740 68660
      10002 10002 16219 16219 3679 3600 2r 1740 68660
c     ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de12  0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
      0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
      1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
      4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
      13.0  15.0
df12  3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
      8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
      1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
      5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
      1.18-2 1.33-2
fc22  p dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f22:p 75 76
fs22  -81 84 -82 83 -85 -86 -87 -88 t
sd22  133591 130366 15240 15240 2220 3600 2r 2220 309677
      133591 130366 15240 15240 2220 3600 2r 2220 309677
c     ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de22  0.01  0.03  0.05  0.07  0.10  0.15  0.20  0.25  0.30
      0.35  0.40  0.45  0.50  0.55  0.60  0.65  0.70  0.80
      1.00  1.40  1.80  2.20  2.60  2.80  3.25  3.75  4.25
      4.75  5.00  5.25  5.75  6.25  6.75  7.50  9.00  11.0
      13.0  15.0
df22  3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
      8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
      1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
      5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
      1.18-2 1.33-2
fc32  n dose rates (mrem/hr) on sides of truck, 7th entry = nearest
f32:n 73 74

```

```

fs32      -81 84 -82 83 -89 -90 -91 -92 t
sd32     142172 138738 16219 16219 3679 3600 2r 1740 329567
          142172 138738 16219 16219 3679 3600 2r 1740 329567
c         ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de32     log   2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001      .01      .1      .5      1.0
          2.5      5.0      7.0     10.0    14.0   20.0
df32     log   3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
          3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
          .125    .156    .147    .147    .208    .227
fc42     n dose rates (mrem/hr) on ends of truck, 7th entry = nearest
f42:n    71 72
fs42     -85 88 -86 87 -89 -90 -91 -92 t
sd42     10002 10002 16219 16219 3679 3600 2r 1740 68660
          10002 10002 16219 16219 3679 3600 2r 1740 68660
c         ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de42     log   2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001      .01      .1      .5      1.0
          2.5      5.0      7.0     10.0    14.0   20.0
df42     log   3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
          3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
          .125    .156    .147    .147    .208    .227
fc52     n dose rates (mrem/hr) on bottom and top, 7th entry = nearest
f52:n    75 76
fs52     -81 84 -82 83 -85 -86 -87 -88 t
sd52     133591 130366 15240 15240 2220 3600 2r 2220 309677
          133591 130366 15240 15240 2220 3600 2r 2220 309677
c         ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr)/(n/cm**2/s)
de52     log   2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001      .01      .1      .5      1.0
          2.5      5.0      7.0     10.0    14.0   20.0
df52     log   3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
          3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
          .125    .156    .147    .147    .208    .227
fc102    p dose rates (mrem/hr) on side of package, 2nd entry
f102:p   38
fs102    -93 -94 t
c         ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr)/(p/cm**2/s)
de102    0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df102    3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc122    p dose rates (mrem/hr) on top of package, 1st entry
f122:p   63
  
```

```

fs122      -95 t
c          ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm**2/s)
de122     0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df122     3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc132     n dose rates (mrem/hr) on side of package, 2nd entry
f132:n    38
fs132     -93 -94 t
c          ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de132     log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001 .01 .1 .5 1.0
          2.5 5.0 7.0 10.0 14.0 20.0
df132     log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
          3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
          .125 .156 .147 .147 .208 .227
fc152     n dose rates (mrem/hr) on top of package, 1st entry
f152:n    63
fs152     -95 t
c          ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de152     log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001 .01 .1 .5 1.0
          2.5 5.0 7.0 10.0 14.0 20.0
df152     log 3.67e-3 3.67e-3 4.46e-3 4.54e-3 4.18e-3
          3.76e-3 3.56e-3 2.17e-2 9.26e-2 .132
          .125 .156 .147 .147 .208 .227
fc5       p dose rates (mrem/hr) at detectors, 1 m above top s
f5:p      0. 0. 252.22 50.
c          ansi/ans-6.1.1-1977 fluence-to-dose,photons(mrem/hr/(p/cm**2/s)
de5       0.01 0.03 0.05 0.07 0.10 0.15 0.20 0.25 0.30
          0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.80
          1.00 1.40 1.80 2.20 2.60 2.80 3.25 3.75 4.25
          4.75 5.00 5.25 5.75 6.25 6.75 7.50 9.00 11.0
          13.0 15.0
df5       3.96-3 5.82-4 2.90-4 2.58-4 2.83-4 3.79-4 5.01-4 6.31-4 7.59-4
          8.78-4 9.85-4 1.08-3 1.17-3 1.27-3 1.36-3 1.44-3 1.52-3 1.68-3
          1.98-3 2.51-3 2.99-3 3.42-3 3.82-3 4.01-3 4.41-3 4.83-3 5.23-3
          5.60-3 5.80-3 6.01-3 6.37-3 6.74-3 7.11-3 7.66-3 8.77-3 1.03-2
          1.18-2 1.33-2
fc15     n dose rates (mrem/hr) at detectors, 1 m above top s
f15:n    0. 0. 252.22 50.
c          ansi/ans-6.1.1-1977 fluence-to-dose,neutrons(mrem/hr/(n/cm**2/s)
de15     log 2.5e-08 1.0e-07 1.0e-06 1.0e-05 1.0e-04
          .001 .01 .1 .5 1.0
  
```

		2.5	5.0	7.0	10.0	14.0	20.0
df15	log	3.67e-3	3.67e-3	4.46e-3	4.54e-3	4.18e-3	
		3.76e-3	3.56e-3	2.17e-2	9.26e-2	.132	
		.125	.156	.147	.147	.208	.227

ARCHIVAL STORAGE OF MCNP INPUT FILES:

These MCNP input files are permanently stored in bluegate in subdirectory /v93586/rtg/jun96/ with names:

- igdq The NCT photon (source) input file with water in jacket.
- igaci The HAC photon (source) input file.
- i0ndq The NCT neutron (7,000 source) input file with water in jacket.
- i5ndq The NCT neutron (7,500 source) input file with water in jacket.
- inaci0 The HAC neutron (7,000 source) input file.
- inaci5 The HAC neutron (7,500 source) input file.

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

DOCUMENT REVIEWED

NUMBER: WHC-SD-TP-CN-001, Rev. 0

TITLE: REVISED RTG SOURCE TERM AND DOSE RATE SHIELDING EVALUATION

AUTHOR(s): H. J. Goldberg and L. L. Carter

I. Method(s) of Review

- Input data checked for accuracy
- Independent calculation performed
  - Hand calculation
  - Alternate computer code: \_\_\_\_\_
- Comparison to experiment or previous results
- Alternate method (define) Writing checked for correctness

II. Checklist (either check or enter NA if not applied)

- Task completely defined
- Activity consistent with task specification
- Necessary assumptions explicitly stated and supported
- Resources properly identified and referenced
- Resource documentation appropriate for this application
- Input data explicitly stated
- Input data verified to be consistent with original source
- Geometric model adequate representation of actual geometry
- Material properties appropriate and reasonable
- Mathematical derivations checked including dimensional consistency
- Hand calculations checked for errors
- Assumptions explicitly stated and justified
- Computer software appropriate for task and used within range of validity
- Use of resource outside range of established validity is justified
- Software runstreams correct and consistent with results
- Software output consistent with input
- Results consistent with applicable previous experimental or analytical findings
- Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- Conclusions consistent with analytical results and established limits
- Uncertainty assesment appropriate and reasonable
- Other (define) \_\_\_\_\_

III. Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

IV. REVIEWER: D.E.Lessor [Signature] DATE: 7-26-96

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

DOCUMENT REVIEWED

NUMBER: WHC-SD-TP-CN-001, Rev. 0

TITLE: REVISED RTG SOURCE TERM AND DOSE RATE SHIELDING EVALUATION

AUTHOR(s): H. J. Goldberg and L. L. Carter


I. Method(s) of Review

- Input data checked for accuracy
- Independent calculation performed
  - Hand calculation
  - Alternate computer code: \_\_\_\_\_
- Comparison to experiment or previous results
- Alternate method (define) \_\_\_\_\_

II. Checklist (either check or enter NA if not applied)

- Task completely defined
- Activity consistent with task specification
- Necessary assumptions explicitly stated and supported
- Resources properly identified and referenced
- Resource documentation appropriate for this application
- Input data explicitly stated
- Input data verified to be consistent with original source
- Geometric model adequate representation of actual geometry
- Material properties appropriate and reasonable
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- Hand calculations checked for errors
- Assumptions explicitly stated and justified
- Computer software appropriate for task and used within range of validity
- Use of resource outside range of established validity is justified
- Software runstreams correct and consistent with results
- Software output consistent with input
- Results consistent with applicable previous experimental or analytical findings
- Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- Conclusions consistent with analytical results and established limits
- Uncertainty assesment appropriate and reasonable
- Other (define) \_\_\_\_\_

III. Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

IV. REVIEWER: S. R. Gedeon  DATE: 18 July 96

## DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Criticality and Shielding	Date July 22, 1996
Project Title/Work Order		EDT No. 616561
Revised RTG Source Term and Dose Rate Shielding Evaluation		ECN No. NA

Name	MSIN	Text With All Attach.	Text Only	Attach./Appendix Only	EDT/ECN Only
------	------	-----------------------	-----------	-----------------------	--------------

L. L. Carter	H0-35	X			
S. R. Gedeon	H0-35	X			
H. J. Goldberg	H0-35	X			
J. Greenborg	H0-35	X			
D. E. Lessor	H0-35	X			
A. L. Ramble	A3-38	X			
R. L. Simons	H0-35	X			
Central Files (3 + Original)	A3-88	X			