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APEX-707

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Efficiency Studies with Gamma Ray Portion of Specialized Reactor-Shield Monte Carlo Program 18-0

M. A. Capo

GENERAL ELECTRIC

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APEX 707
(Informal)

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EFFICIENCY STUDIES WITH GAMMA RAY PORTION OF SPECIALIZED REACTOR-SHIELD MONTE CARLO PROGRAM 18-0

M. A. Capo

May 26, 1961

UNITED STATES AIR FORCE CONTRACT NO. AF 33(600)-38062

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ABSTRACT

Application studies were made with Specialized Reactor-Shield Monte Carlo Program 18-0 to determine the efficiency and feasibility of calculating energy deposition due to primary core gamma rays throughout the XNJ140E-1 reactor-shield assembly. Monte Carlo results are presented in tabular form for all geometrical regions used to describe the shield. Described here is a means of obtaining adequate and valid heating rates in about 47 hours on the IBM-704 digital computer. Comparison of Monte Carlo and point kernel data are included.

ACKNOWLEDGMENTS

The author wishes to acknowledge that this study was carried out under the direction of Dr. John E. MacDonald of the Shielding Unit, ANPD.

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1. INTRODUCTION

Application studies were made with Specialized Reactor-Shield Monte Carlo Program 18-0[1] to determine the efficiency and feasibility of calculating energy deposition due to primary core gamma rays throughout the XNJ140E-1 reactor-shield assembly.

Throughout this report it is assumed that the reader is familiar with the Monte Carlo Program 18-0 and the source generator Program 20-0[2].

Initially, an inner shield assembly and front and rear plug assemblies were studied independently. Monte Carlo energy deposition data for all geometrical regions which describe these three configurations are presented in tabular form. The use of splitting on location at region boundaries was investigated and is discussed here in detail.

The entire reactor-shield assembly was also described. In addition to energy deposition data, energy-angle bin distribution data for the point source equivalent to the assembly were also obtained in this case.

Shielding Computer Program 20-0 was used to generate and write on tape the source particle parameters used as input to Program 18-0. The source particle spatial coordinates were chosen from appropriate radial and longitudinal power density distributions for the XNJ140E-1 reactor core using a systematic method.

During the study it was determined that the gamma ray fission spectrum must be divided into several energy groups. In each energy group, 10,000 source particles were generated.

Where possible, comparisons are made between the Monte Carlo heating rates and those obtained with the point kernel method. All these comparisons show excellent agreement.

From this study, it was concluded that reliable energy deposition data due to primary core gamma rays throughout the XNJ140E-1 reactor-shield could be feasibly obtained in about 47 hours on the IBM-704 digital computer.

2. SOURCE DESCRIPTION

Program 20-0 was used to generate and write on tape the source particle parameters to be used as input for the Specialized Monte Carlo Program 18-0. Seven source parameters are required to define a source particle. These state parameters are the spatial coordinates, X, Y, and Z, the respective direction cosines, α, β, and γ, and the energy. All parameters except the direction cosines are chosen by Program 20-0; the direction cosines are chosen by the Monte Carlo program. In addition to the state parameters, two parameters uniquely specifying the source tube and region in which a source particle originates are included in the output.

In this study, the quasi-homogeneous situation was encountered, that is, the entire reactor core was treated as a single source tube. The core was considered a homogeneous mixture of materials, and was approximated as a right circular cylinder generated by rotating fifteen convex quadrilaterals about the reactor axis. The core was divided into several regions so that energy deposition in various parts of the core could be examined. However, the entire core could be described as one region if so desired.

The systematic method was utilized for selecting source particles in preference to the random method. It is generally believed, but not yet proven, that the systematic method better approximates the spatial distribution with fewer particles than does the random method. This behavior will be examined further in future studies using the Monte Carlo code.

In Program 20-0, the source distribution is approximated by using the total power and spatial power density distributions for the reactor core. It is assumed that the spatial power density distribution is independent of the polar angle and is separable into an axial and a radial power density distribution. These distributions are normalized to corresponding probabilities or probability densities by the program. When the systematic method for distributing source particles is used, the single source tube (reactor core) is divided into toroidal volume elements of dimensions determined by input values of r and Z that establish that axial and radial power density mesh. The program considers each of these volumes in order and determines the proper number of particles to be started from each.

The actual radial and axial power density distributions which describe the XNJ140E-1 reactor core are shown in Figures 1 and 2. The radial distribution was approximated in the program by twenty-eight input values and the axial, by forty-nine values. The mesh size of the radial coordinate was kept nearly constant at about 1.3 cm., but the axial mesh size was varied with values more closely spaced at the front and rear faces of the core where the distribution radically changes shape. A total of 1296 toroidal volume elements were described.

A source tape was prepared on which were stored parameters for 10,000 gamma ray particles. Before using a tape as input for the Monte Carlo code, some effort should be made to ascertain how well the parameters approximate the spatial distributions. (The energy distribution will be discussed in detail later in this report.)

One method of analyzing the adequacy of the spatial parameters is described here. It is easily shown that

$$N_{ij} = 2\pi \int_r \int_Z nr\ dr\ dZ = K \int_{r_j}^{r_{j+1}} p(r_j)\ r_j\ dr \int_{Z_i}^{Z_{i+1}} p(Z_i)\ dZ \qquad \text{(Eq. 1)}$$

where

N_{ij} = the number of source particles generated in a volume element, ΔV_{ij},

n = the number density of source particles at a radius, r, and axial position, Z,

$p(r_j)$ = radial power density distribution at radius, r,

$p(Z_i)$ = axial power density distribution at axial location, Z, and

K = proportionality constant.

Then

$$\sum_j N_{ij} = K \sum_j \int_{r_j}^{r_{j+1}} p(r_j)\ r_j\ dr \int_{Z_i}^{Z_{i+1}} p(Z_i)\ dZ$$

$$= K \int_{Z_i}^{Z_{i+1}} p(Z_i)\ dZ \sum_j \int_{r_j}^{r_{j+1}} p(r_j)\ r_j\ dr$$

$$= K' \sum_j \int_{r_j}^{r_{j+1}} p(r_j)\ r_j\ dr \quad .$$

[redacted]

[redacted]

Let $r_{j+1} = r_j + \Delta r_j$ and $p(r_j)$ equal a constant a_j between r_j and $r_j + \Delta r_j$. Values of a_j were determined from the radial power density distribution curve at $\frac{R_{j+1} - R_j}{2}$.

Then

$$\sum_j N_{ij} = K' \sum_j a_j \left|\frac{r_j^2}{2}\right|_{r_j}^{r_j+\Delta r_j}$$

$$= K' \sum_j a_j \left((r_j + \Delta r_j)^2 - r_j^2\right)$$

$$= K' \sum_j a_j \, \Delta r_j \left(r_j + \frac{\Delta r_j}{2}\right)$$

Assuming that Δr_j is a constant,

$$\sum_j N_{ij} = \eta_i = K'' \sum_j a_j \left(r_j + \frac{\Delta r_j}{2}\right) = K''' \sum_j B_j \qquad \text{(Eq. 2)}$$

From equation 1 we have

$$\sum_i N_{ij} = K \int_{r_j}^{r_{j+1}} p(r_j)\, r_j \, dr \sum_i \int_{Z_i}^{Z_{i+1}} p(Z_i)\, dZ$$

Let $Z_{i+1} = Z_i + \Delta Z$ and $p(Z_i)$ equal a constant b_i over the range $Z_i + \Delta Z$. Values of b_i were determined from the longitudinal power density distribution curve at $\frac{Z_{i+1} - Z_i}{2}$.

Then

$$\sum_i N_{ij} = \eta_j = K'''' \sum_i b_i \, \Delta Z_i = K''''' \sum A_i \qquad \text{(Eq. 3)}$$

The η_i terms can then be normalized to the appropriate radial distribution term B_j, and the η_j terms can be normalized to the appropriate axial distribution term A_i.

This method is not exact, of course, due to the assumption that p(r) and p(Z) are flat over the range of interest. It is desirable to code a program to perform more accurate analyses of source particle parameters to avoid the vast amount of hand calculations necessary in processing the source particle data.

[redacted]

The source particle tape mentioned previously was analyzed using the above method. In Table 1 are listed analyses of the axial power distribution with axial source particle distribution for three cases. The first η_j is for the entire active core from a radius of 21.872 to 57.15 cm. The second η_j applies to an inner shell between a radius of 21.872 and 24.539 cm., and the third set is for an outer shell between a radius of 54.636 and 57.15 cm. The same data are shown graphically in Figure 3; all data were normalized at Z_i = 0.9375 cm. Since the actual representation of the axial power distribution, A_i, and the normalized quantity $\frac{A_i}{\eta_j}$ for the entire core are so similar, the solid curve in Figure 3 can be interpreted as either quantity. In this figure, the X's represent data for the inner shell of source particles, and the +'s represent data for the outer shell. The particle distribution is apparently quite sensitive to the volume of the source ring. Ten thousand particles, however, adequately represent the axial power distribution.

In Table 2 similar data are presented for analyses of the radial power distribution. The first column of η_i's refers to a ΔZ of 1.875 cm. located at Z_i = 0.9375 cm. The second set of η_i's refer to a ΔZ of 2.1 cm. located at the forward end of the core from Z_i = -38.1 to Z_i = -36 cm. The same data are shown graphically in Figure 4; all data were normalized at r = 44.536 cm. In this figure the X's represent data for the ΔZ = 1.875 cm., and the +'s for ΔZ = 2.1 cm.

It appears more difficult to obtain a good representation of the radial power distribution on the basis of the data given here. But, these data are for only a small ΔZ mesh along the core axis. The larger the ΔZ term, the better agreement one can obtain with the actual power distribution. The problem as to how large or small a ΔZ one should analyze has not yet been determined. The problem involves a great deal of hand calculations at the present time. A code is being written to facilitate the solution of this problem.

Program 20-0 also requires as input the energy distribution in the form of a sequence of values of the function corresponding to an energy sequence. A normalized cumulative distribution is formed by the program and energies are selected by a random method.

In this study, 77 values were used to describe the gamma ray fission spectrum shown graphically in Figure 5 and tabulated in Table 3. The prompt fission spectrum below 0.5 Mev was obtained from a paper given by F. C. Maienschein at the Seventh Semiannual Shielding Information Meeting[3]. Similar data above 0.5 Mev were obtained from J. G. Carver[4]. The latter reference was also used to determine the fission product decay gamma spectrum (delayed gamma rays). Two assumptions were made concerning the delayed gamma rays. If the energy group was specified for 0 to 0.4 Mev, for example, it was assumed that the spectrum value applied to all energies within the energy group. At the boundary of two energy groups, an average value was assumed. The same assumptions were applied to the neutron capture gamma ray spectrum for the XNJ140E-1 core obtained from N. L. Scheidler.

An integration procedure was used to determine the fraction of the total spectrum within twelve energy groups over the range 0.01 to 10 Mev. These fractions are given in Table 4. Five thousand of the ten thousand source particle energies on the source tape were tabulated and grouped into the same twelve energy levels. This comparison, shown in Table 4, shows excellent agreement up to 8 Mev where the spectrum ceases to be of importance in this study. Agreement would be better if all 10,000 energies were analyzed. However, this is a tedious task that will eventually be incorporated into the program mentioned previously for source particle parameter analysis.

A listing of the input data for Program 20-0 is given in Appendix A.

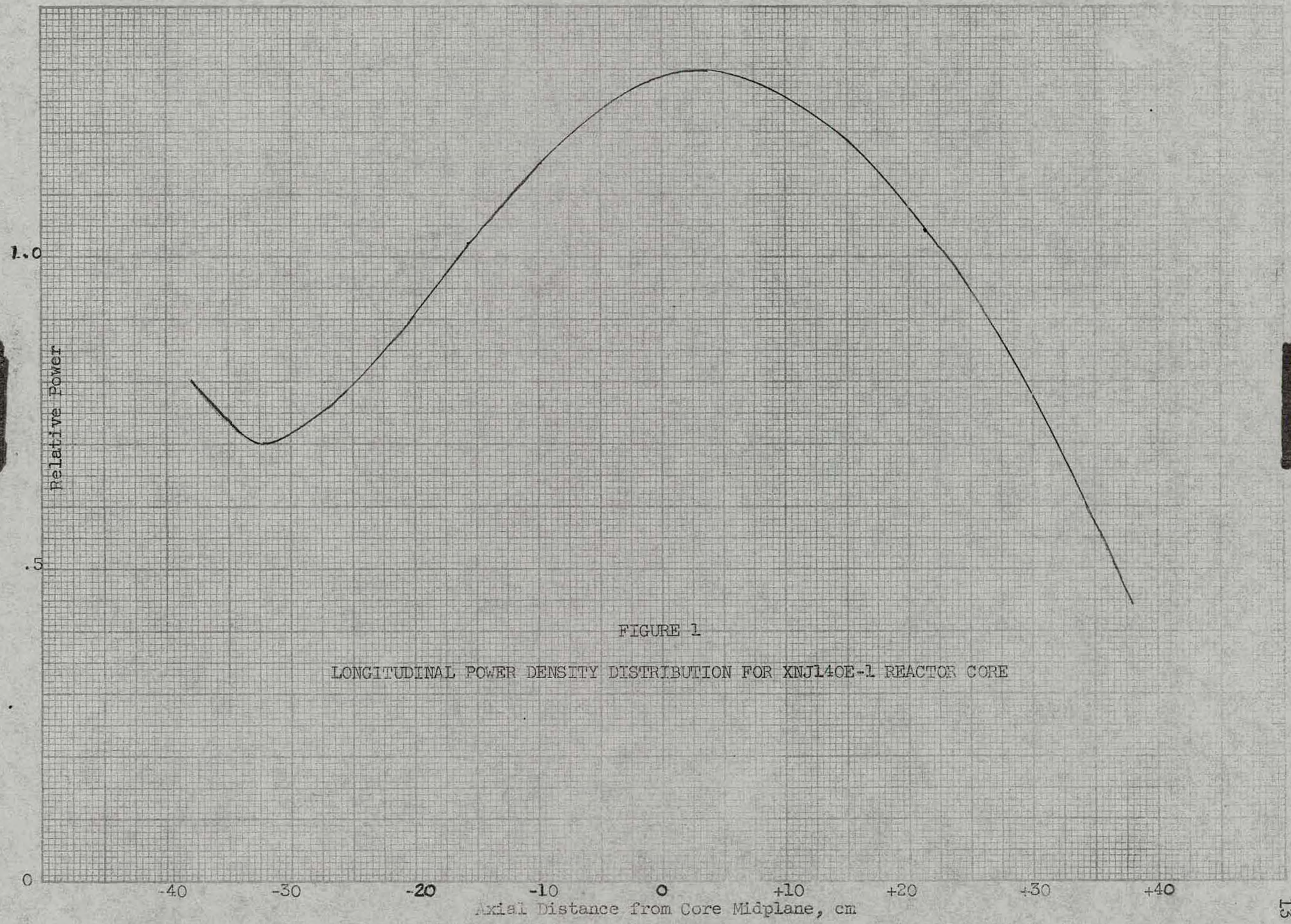

FIGURE 1

LONGITUDINAL POWER DENSITY DISTRIBUTION FOR XNJ140E-1 REACTOR CORE

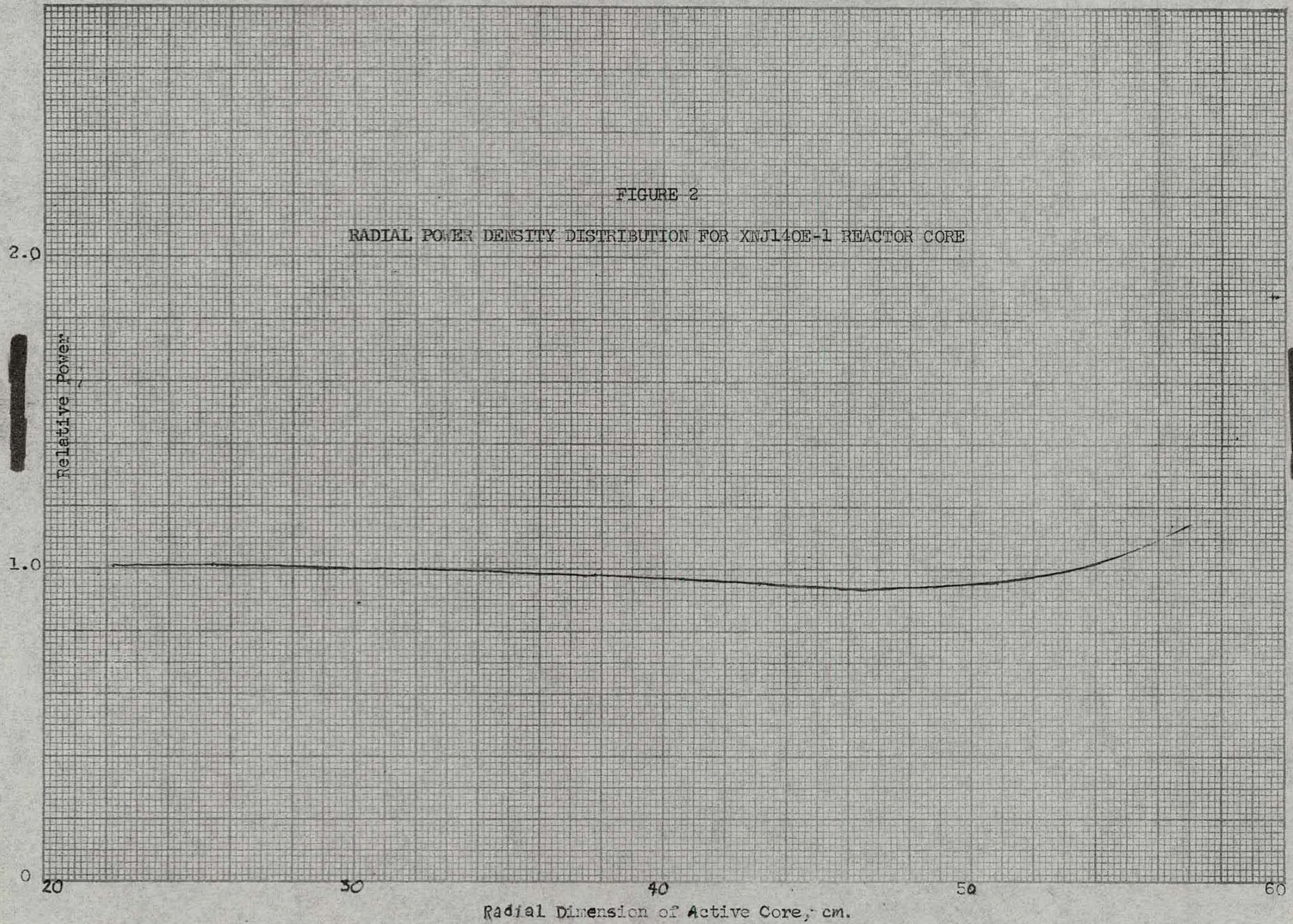

FIGURE 2

RADIAL POWER DENSITY DISTRIBUTION FOR XNJ140E-1 REACTOR CORE

[redacted]

15

TABLE 1

COMPARISON OF AXIAL POWER DISTRIBUTION AND SOURCE PARTICLE DISTRIBUTION

z_i, cm, Axial Dimension	ΔZ_i	$b_i = p(Z_i)$	$A_i = (\Delta Z_i)\cdot(p(Z_i))$	η_j r_j=21.872 to 57.15 cm	$\frac{A_i}{\eta_j}$	η_j r_j=21.872 to 24.539 cm	$\frac{A_i}{\eta_j}$	η_j r_j=54.636 to 57.15 cm	$\frac{A_i}{\eta_j}$
-37.85	0.5	0.805	0.4075	52	0.396	2	0.348	6	0.406
-37.35	0.5	0.792	0.396	52	0.396	2	0.348	6	0.406
-36.55	1.1	0.767	0.8437	111	0.844	5	0.869	12	0.811
-35.50	1.0	0.745	0.745	99	0.753	5	0.869	11	0.744
-34.50	1.0	0.728	0.728	95	0.723	3	0.522	10	0.676
-33.25	1.5	0.709	1.0635	139	1.057	7	1.217	15	1.014
-31.75	1.5	0.702	1.053	139	1.057	6	1.043	16	1.082
-30.25	1.75	0.718	1.077	141	1.072	5	0.869	15	1.014
-28.625	1.75	0.735	1.286	170	1.293	8	1.391	17	1.149
-26.875	1.75	0.760	1.33	175	1.331	8	1.391	19	1.285
-25.125	1.75	0.785	1.374	177	1.346	9	1.565	21	1.419
-23.375	1.875	0.821	1.437	190	1.445	9	1.565	21	1.419
-21.5625	1.875	0.872	1.635	217	1.651	10	1.738	23	1.555
-19.6875	1.875	0.922	1.728	228	1.734	11	1.912	26	1.758
-17.8125	1.875	0.973	1.824	240	1.825	11	1.912	27	1.825
-15.9375	1.875	1.02	1.913	251	1.909	11	1.912	28	1.893
-14.0625	1.875	1.06	1.99	262	1.993	12	2.086	29	1.961
-12.1875	1.875	1.105	2.072	272	2.069	12	2.086	31	2.096
-10.3125	1.875	1.14	2.138	291	2.213	12	2.086	31	2.096
-8.4375	1.875	1.18	2.213	290	2.206	13	2.260	32	2.164
-6.5625	1.875	1.21	2.269	298	2.267	14	2.434	33	2.231
-4.6875	1.875	1.23	2.325	307	2.335	14	2.434	35	2.366
-2.8125	1.875	1.27	2.381	313	2.381	14	2.434	35	2.366
-0.9375	1.875	1.29	2.419	317	2.411	15	2.608	36	2.434
0.9375	1.875	1.298	2.434	320	2.434	14	2.434	36	2.434
2.8125	1.875	1.30	2.437	321	2.442	15	2.608	36	2.434
4.6875	1.875	1.30	2.437	321	2.442	15	2.608	36	2.434
6.5625	1.875	1.29	2.419	319	2.426	14	2.434	36	2.434
8.4375	1.875	1.28	2.40	314	2.388	14	2.434	35	2.366
10.3125	1.875	1.26	2.363	311	2.365	14	2.434	35	2.366
12.1875	1.875	1.24	2.325	306	2.327	14	2.434	34	2.299
14.0625	1.875	1.21	2.269	298	2.267	13	2.260	33	2.231
15.9375	1.875	1.17	2.194	290	2.206	13	2.260	32	2.164
17.8125	1.875	1.135	2.128	279	2.122	13	2.260	31	2.096
19.6875	1.875	1.09	2.044	272	2.069	12	2.086	30	2.028
21.5625	1.875	1.04	1.95	253	1.924	12	2.086	29	1.961
23.375	1.75	0.991	1.734	229	1.742	10	1.738	25	1.690
25.125	1.75	0.946	1.656	218	1.658	10	1.738	24	1.623
26.875	1.75	0.887	1.552	205	1.559	9	1.565	23	1.555
28.625	1.75	0.831	1.454	190	1.445	9	1.565	21	1.419
30.25	1.5	0.773	1.159	153	1.164	7	1.217	17	1.149
31.75	1.5	0.715	1.073	142	1.080	7	1.217	16	1.082
33.25	1.5	0.662	0.993	131	0.996	6	1.043	14	0.947
34.5	1.0	0.610	0.610	81	0.616	4	0.695	9	0.608
35.5	1.0	0.575	0.575	76	0.578	4	0.695	9	0.608
36.55	1.1	0.534	0.587	79	0.601	3	0.522	9	0.608
37.35	0.5	0.505	0.253	33	0.251	1	0.173	4	0.270
37.85	0.5	0.489	0.245	31	0.236	2	0.348	2	0.135

[redacted]

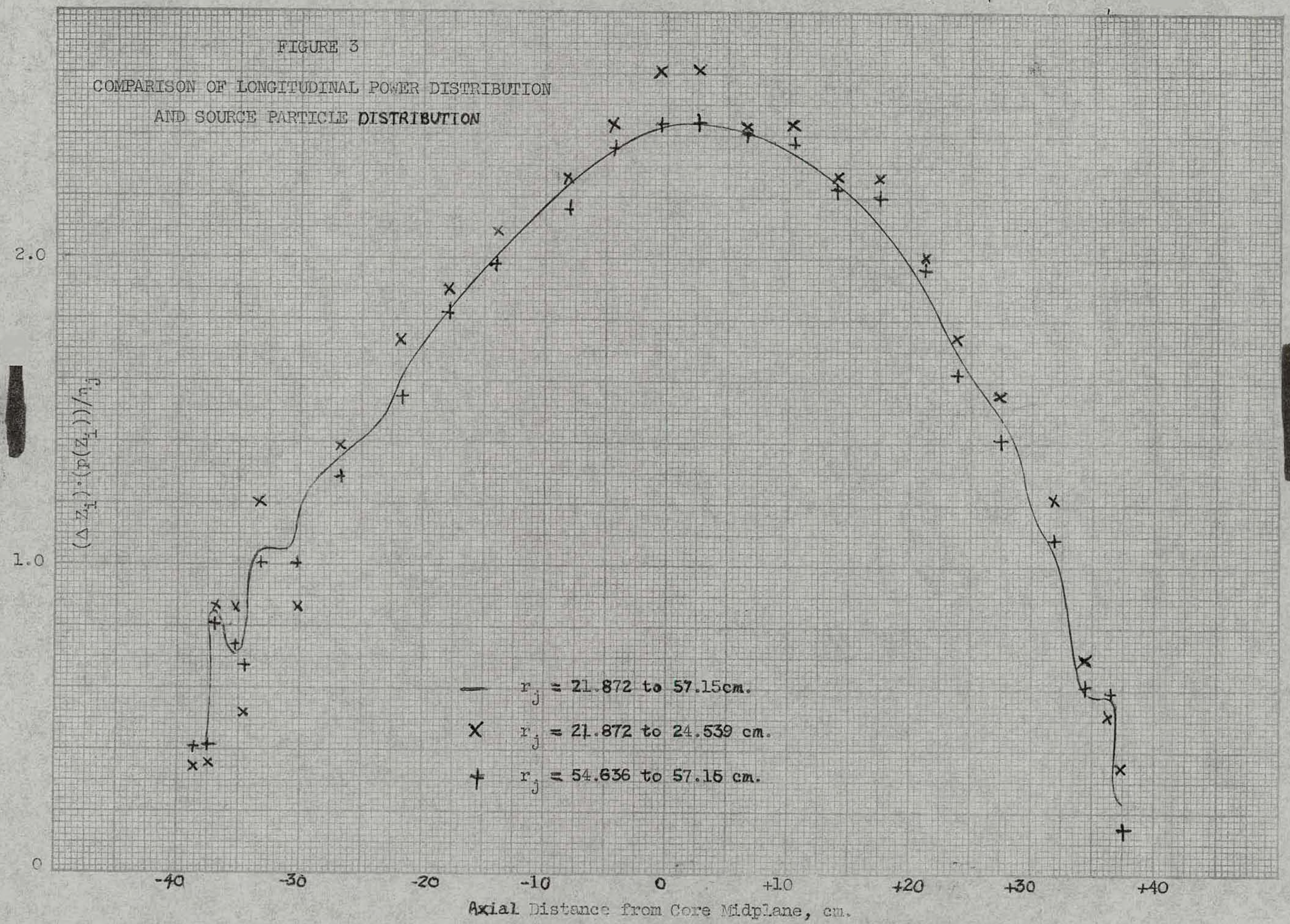
FIGURE 3
COMPARISON OF LONGITUDINAL POWER DISTRIBUTION
AND SOURCE PARTICLE DISTRIBUTION
$(\Delta z_i)\cdot(p(z_i))/n_j$
2.0
1.0
0
— r_j = 21.872 to 57.15cm.
× r_j = 21.872 to 24.539 cm.
+ r_j = 54.636 to 57.16 cm.
-40
-30
-20
-10
0
+10
+20
+30
+40
Axial Distance from Core Midplane, cm.

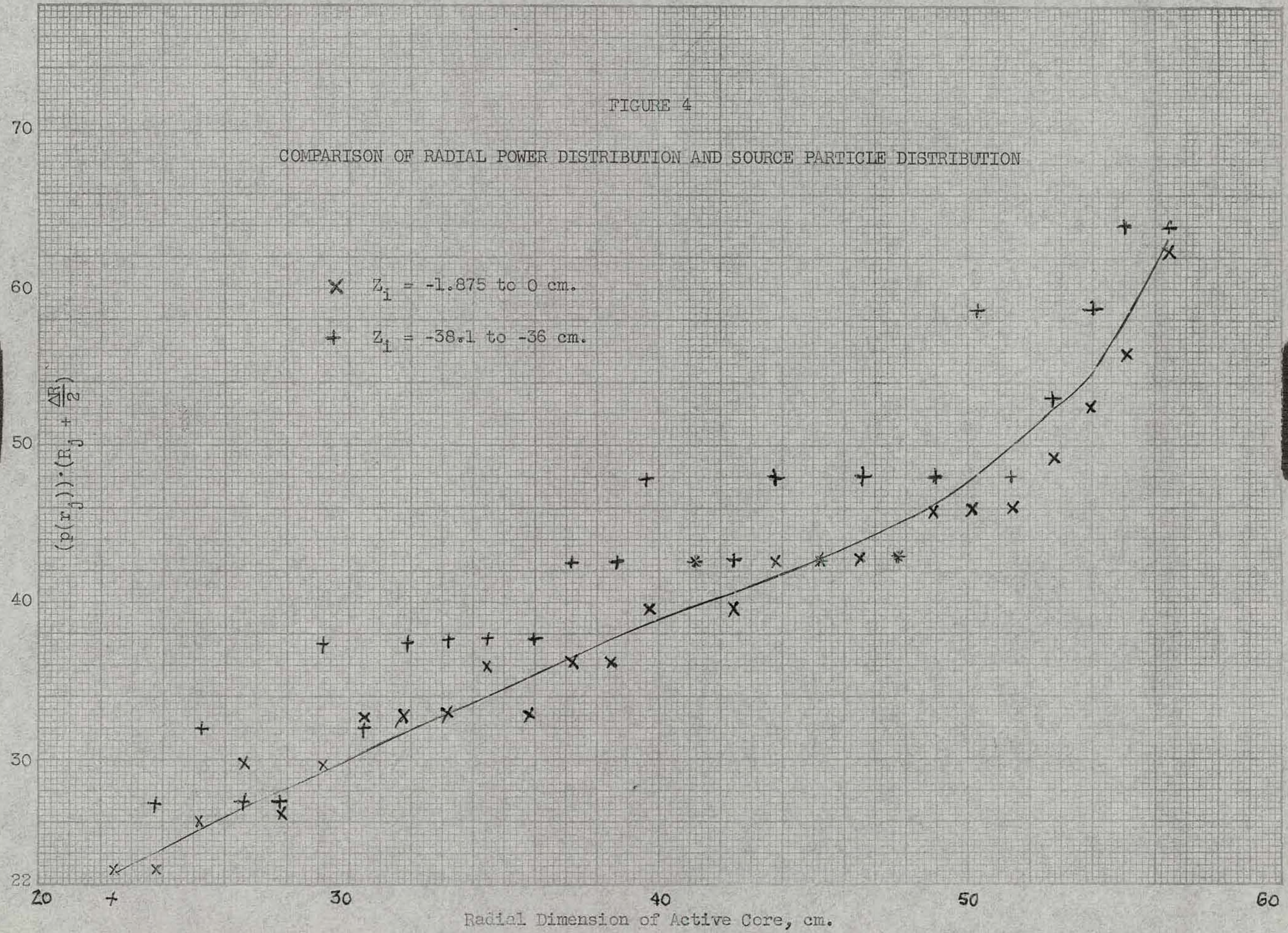
FIGURE 4
COMPARISON OF RADIAL POWER DISTRIBUTION AND SOURCE PARTICLE DISTRIBUTION
× Z_i = -1.875 to 0 cm.
+ Z_i = -38.1 to -36 cm.
(p(r_j))·(R_j + ΔR/2)
22
30
40
50
60
70
20
30
40
50
60
Radial Dimension of Active Core, cm.

TABLE 2

COMPARISON OF RADIAL POWER DISTRIBUTION AND SOURCE PARTICLE DISTRIBUTION

[redacted]

R_j	ΔR_j	$R_j+\frac{\Delta R_j}{2}$	$A_j=p(R_j)$ at $\frac{R_{j+1}-R_j}{2}$	$B_j=(p(R_j))^{\circ}(R_j+\frac{\Delta R_j}{2})$	η_i $Z_i=-1.875$ to 0 cm	$\frac{B_j}{\eta_i}$	η_i $Z_i=-38.1$ to -36 cm	$\frac{B_j}{\eta_i}$
21.872	1.333	22.538	1.01	22.763	7	22.999	4	21.357
23.205	1.334	23.871	1.015	24.229	7	22.999	5	26.696
24.539	1.333	25.205	1.01	25.457	8	26.285	6	32.036
25.872	1.333	26.538	1.01	26.803	9	29.570	5	26.696
27.205	1.334	27.871	1.005	28.010	8	26.285	5	26.696
28.539	1.333	29.205	1.0	29.265	9	29.570	7	37.375
29.872	1.333	30.537	0.999	30.506	10	32.856	6	32.036
31.205	1.333	31.870	0.999	31.838	10	32.856	7	37.375
32.538	1.334	33.203	0.99	32.871	10	32.856	7	37.375
33.872	1.333	34.536	0.985	34.018	11	36.142	7	37.375
35.205	1.333	35.869	0.98	35.152	10	32.856	7	37.375
36.538	1.333	37.202	0.98	36.458	11	36.142	8	42.714
37.871	1.333	38.535	0.975	37.572	11	36.142	8	42.714
39.204	1.333	39.868	0.97	38.672	12	39.427	9	48.053
40.537	1.333	41.201	0.96	39.553	13	42.713	8	42.714
41.87	1.333	42.534	0.958	40.748	12	39.427	8	42.714
43.203	1.333	43.867	0.95	41.674	13	42.714	9	48.053
44.536	1.336	45.200	0.945	42.714	13	42.714	8	42.714
45.872	1.252	46.498	0.94	43.708	13	42.714	9	48.053
47.124	1.252	47.750	0.94	44.885	13	42.714	8	42.714
48.376	1.252	49.002	0.943	46.209	14	45.998	9	48.053
49.628	1.252	50.254	0.960	48.244	14	45.998	11	58.732
50.88	1.252	51.506	0.970	49.961	14	45.998	9	48.053
52.132	1.252	52.768	0.99	52.230	15	49.284	10	53.392
53.384	1.252	54.010	1.02	55.090	16	52.569	11	58.732
54.636	1.252	55.262	1.06	58.578	17	55.855	12	64.071
55.88	1.262	56.519	1.12	63.301	19	62.426	12	64.071
57.15								

[redacted]

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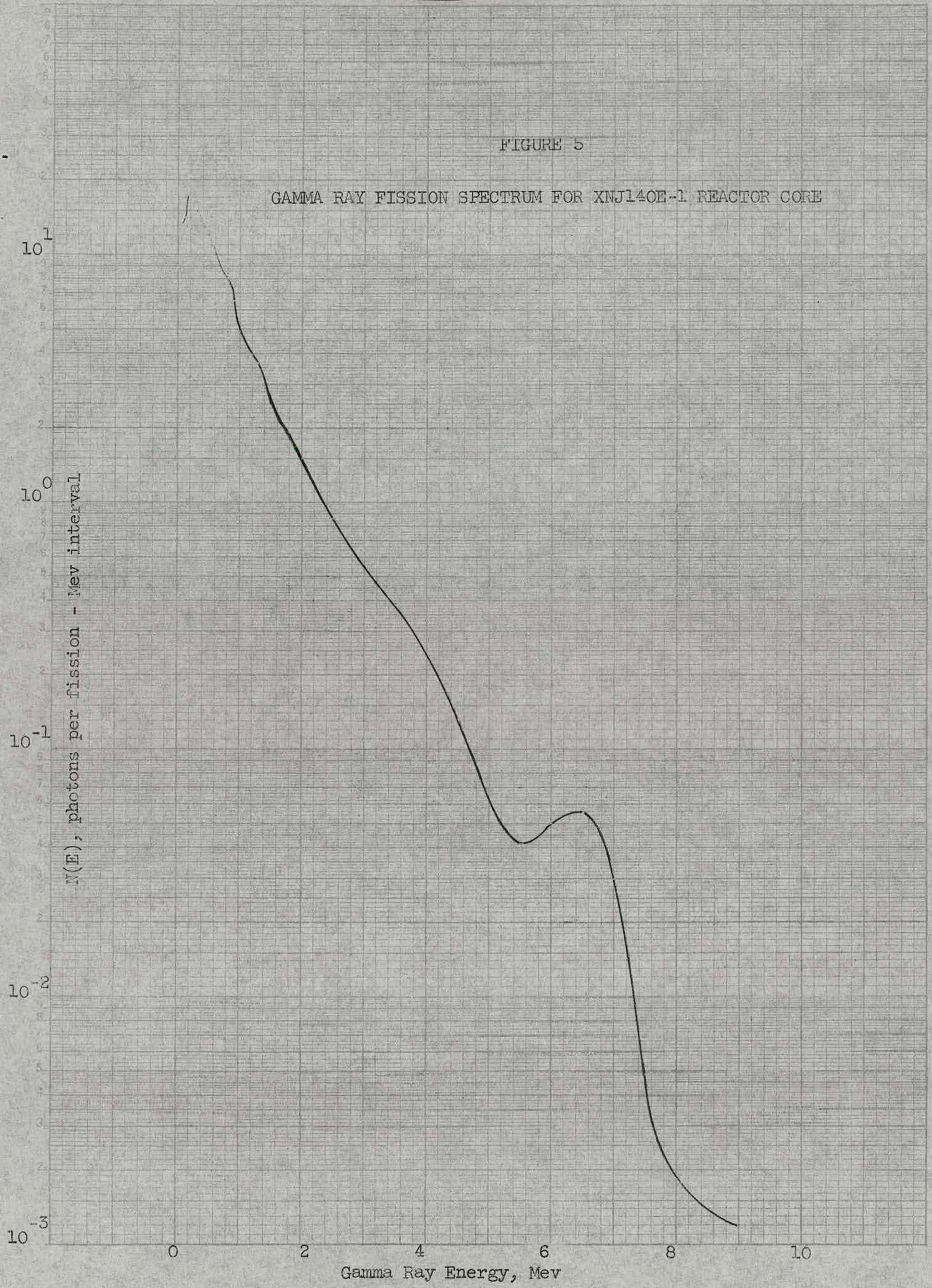

FIGURE 5

GAMMA RAY FISSION SPECTRUM FOR XNJ140E-1 REACTOR CORE

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TABLE 3

GAMMA RAY SOURCE ENERGY SPECTRUM

Photons per Fission-Mev Interval

Energy Mev	Prompt Gamma Rays	Delayed Gamma Rays	Capture Gamma Rays	Total
0.01	10.0	2.0935	1.1936	13.2871
.015	15.0	2.0935	1.1936	18.2871
.02	9.0	2.0935	1.1936	12.2871
.03	25.0	2.0935	1.1936	28.2871
.04	7.0	2.0935	1.1936	10.2871
.05	6.0	2.0935	1.1936	9.2871
.06	6.0	2.0935	1.1936	9.2871
.07	6.8	2.0935	1.1936	10.0871
.08	7.2	2.0935	1.1936	10.4871
.09	8.0	2.0935	1.1936	11.2871
.10	10.0	2.0935	1.1936	13.2871
.15	13.0	2.0935	1.1936	16.2871
.20	15.0	2.0935	1.1936	18.2871
.25	10.0	2.0935	1.1936	13.2871
.30	12.5	2.0935	1.1936	15.7871
.35	15.0	2.0935	1.1936	18.2871
.40	11.0	2.3366	1.1936	14.5302
.45	9.05	2.5797	1.1936	12.8233
.50	8.1	2.5797	1.1936	11.8733
.55	7.2	2.5797	1.1936	10.9733
.60	6.55	2.5797	1.1936	10.3233
.65	5.81	2.5797	1.1936	9.5833
.70	5.26	2.5797	1.1936	9.0333
.75	4.76	2.5797	1.1936	8.5333
.80	4.27	2.5797	1.1936	8.0433
.85	3.80	2.5797	1.1936	7.5733
.90	3.50	1.811675	1.1936	6.50528
.95	3.25	1.04365	1.1936	5.48725
1.0	2.98	1.04365	0.841145	4.864795
1.1	2.69	1.04365	0.48869	4.22234
1.2	2.45	1.04365	0.48869	3.98234
1.3	2.14	1.04365	0.48869	3.67234
1.4	1.72	0.6682	0.48869	2.87689
1.5	1.31	0.6682	0.48869	2.46689
1.6	1.11	0.6682	0.48869	2.26689
1.7	1.02	0.6682	0.48869	2.17689
1.8	0.943	0.501125	0.48869	1.93282
1.9	0.897	0.33405	0.48869	1.71974
2.0	0.835	0.33405	0.48869	1.504135
2.1	0.758	0.33405	0.18148	1.27353

[redacted]

[redacted]

TABLE 3 (Contd.)

Energy Mev	Prompt Gamma Rays	Delayed Gamma Rays	Capture Gamma Rays	Total
2.2	.675	.27867	.18148	1.13515
2.3	.599	.22329	.18148	1.00377
2.4	.517	.22329	.18148	.92177
2.5	.455	.22329	.18148	.85977
2.6	.408	.17437	.18148	.76385
2.7	.364	.12545	.18148	.67093
2.8	.323	.12545	.18148	.62993
2.9	.288	.12545	.18148	.59493
3.0	.255	.14192	.129752	.52667
3.25	.205	.15839	.078024	.44141
3.5	.155	.15839	.078024	.39141
3.75	.121	.15839	.078024	.35741
4.0	.095	.10316	.052355	.25052
4.25	.079	.04793	.026686	.15362
4.5	.056	.04793	.026686	.13062
4.75	.037	.04793	.026686	.11162
5.0	.021	.027601	.0188875	.067489
5.25	.024	.007272	.011089	.04236
5.5	.023	.007272	.011089	.04136
5.75	.018	.007272	.011089	.036361
6.0	.012	.007272	.0308905	.0501625
6.25	.008	---	.050692	.058692
6.5	.005	---	.050692	.055692
6.75	.004	---	.050692	.054692
7.0	.004	---	.0262325	.0302325
7.25	.005	---	.001773	.006773
7.5	.003	---	.001773	.004773
7.75	---	---	.001773	.001773
8.0	---	---	.001839	.001839
8.25	---	---	.001905	.001905
8.5	---	---	.001905	.001905
8.75	---	---	.001905	.001905
9.0	---	---	.00119985	.00119985
9.25	---	---	.0004947	.0004947
9.5	---	---	.0004947	.0004947
9.75	---	---	.0004947	.0004947
10.0	---	---	.0004947	.0004947

[redacted]

TABLE 4

COMPARISON OF ACTUAL AND COMPUTED GAMMA RAY SOURCE ENERGY SPECTRUM

Gamma Ray Source Energy Mev	Actual Fraction of Gamma Rays in Each Energy Group	Number of Source Particles in Each Group	Fraction of Total in Each Group
0.01-0.5	0.4598	2312	0.4624
0.5-1.0	.2675	1346	.2692
1.0-1.5	.1138	567	.1134
1.5-2.0	.06154	309	.0618
2.0-3.0	.0569	259	.0518
3.0-4.0	.02517	129	.0258
4.0-5.0	.00857	44	.0088
5.0-6.0	.00276	16	.0032
6.0-7.0	.00332	13	.0026
7.0-8.0	.000407	1	.0002
8.0-9.0	.000119	4	.0008
9.0-10.0	.0000326	0	0
TOTAL		5000	

[redacted]

3. INNER SHIELD ASSEMBLY

Since this is the first application of the Monte Carlo method to a realistic reactor-shield assembly, it is apparent that the study had to be pursued cautiously. Thus, initially gamma ray histories were traced through what is called the inner shield assembly of the XNJ140E-1 power plant.

The geometrical configuration which describes this portion of the shield is shown in Figure 6. Table 5 contains the material volume fractions applicable to this configuration. Thirty-two energy groups over the range 0.01 to 10 Mev were used to describe the latest available gamma ray cross section data. The energy cutoff used throughout this study was 0.01 Mev.

Two source tapes were prepared according to the method described in Section 2 of this report. One tape contained parameters of 20,000 source particles; and the other contained parameters for 10,000 particles. Two straightforward runs were made with each tape. Results are given in Table 6. No significant differences were observed that were not due to statistical fluctuations only. Therefore, the less costly method of utilizing only 10,000 source particles was followed throughout this study. It should be noted that in Table 6 no energy deposition data are listed for regions 16 or 29 since these regions were considered void regions, that is, they contained no material. This same scheme is used throughout this report; all regions not containing material were deleted from all tables.

Computer time required to run 10,000 histories in the inner shield assembly was 0.61 hours, and 1.25 hours for 20,000 histories.

During this study, it became evident that reliable statistics could not be obtained with 10,000 source particles distributed over the entire gamma ray fission spectrum from 0.01 to 10 Mev. Although these particles adequately described the spectrum as shown in Table 4, too few particles were available on the source tape with energies between 1 and 10 Mev for reliable calculations. Considering the shape of the fission spectrum curve, and considering the behavior of the cross section data, the source spectrum was broken up into five energy groups as follows:

1. 0.01 to 0.5 Mev
2. 0.5 to 1.0 Mev
3. 1.0 to 2.0 Mev
4. 2.0 to 4.0 Mev
5. 4.0 to 7.0 Mev

[redacted]

[redacted]

Ten thousand particles were generated in each group since this number is believed to have described adequately the spatial distributions.

That part of the spectrum lying between 7 and 10 Mev was not investigated in this study because it is believed to be a relatively small contributor to the total gamma heating. In an actual analysis of heating rates, however, it would be advisable to ascertain its actual importance.

One run using the straightforward sampling method was made for each source energy group on the inner shield assembly. Results are shown in Table 7. The total energy deposition is obtained by summing the contributions from each group. This total compares favorably with those results obtained when the entire energy range from 0.01 to 10 Mev was considered.

These five runs also yielded the number of gamma ray particles escaping the inner shield in various angle bins. The angle refers to the point source equivalent of the reactor-shield assembly with the rear of the assembly located at 0°. The angle bin data are listed in Table 8. Leakage data are useful in determining if or how to apply importance techniques throughout the shield. Since only 146 out of 10,000 particles originating between 0.01 and 0.5 Mev escape the inner shield, these histories could not contribute significantly to gamma ray heating in portions of the plugs distant from the source. Straightforward sampling is probably adequate for this portion of the fission spectrum. However, for the higher source energy groups, an importance sampling technique must be applied to follow these histories through the shield. Two reasons for this are: (1) an insufficient number of particles escape to continue running on a straightforward basis, and (2) these histories are the major contributor to gamma heating in the shield.

Computer times required for these runs on the inner shield assembly ranged from 0.5 hours for the 0.01 to 0.5 Mev source energy group to 0.8 hours for the 4 to 7 Mev group.

It would be useful to describe here how the Monte Carlo output data must be handled to obtain a correct total heating rate in Mev units (or Mev per particle) when separate runs for each source energy group are made. The following terms must be defined:

A_i = area under the fission spectrum between E_i and E_{i+1},

N_i = number of source particles generated between E_i and E_{i+1},

φ_i = Monte Carlo result for source energy group between E_i and E_{i+1},

A_T = total area under the fission spectrum between E_o and E_{max} = $\sum_{i=1}^{I} A_i$.

[redacted]

Then $\frac{A_i}{A_T}$ is the fraction of the total area in source group E_i to E_{i+1}.

It follows that

$$\varphi_{total} = \sum_{i=0}^{I} \left(\frac{A_i}{A_T}\right) \cdot \left(\frac{\varphi_i}{N_i}\right)$$

In this study, all N_i's equalled 10,000 which may not always be the case. The Monte Carlo results should be treated with care to assure valid total energy deposition data.

The following fractions were applied to the Monte Carlo output to obtain the data given in Table 7 and to obtain all other energy deposition data tabulated in the remaining sections of this report:

E_i	E_{i+1}	$\frac{A_i}{A_T}$
0.01 Mev	0.5 Mev	0.4598
0.5	1.0	0.2675
1.0	2.0	0.1753
2.0	4.0	0.082
4.0	7.0	0.01465

If the region weights applied to those regions in Program 18-0 in which source particles are generated differ from those used in Program 20-0, a further correction to the Monte Carlo output is necessary. For example, if all source regions were given a weight of two in Program 18-0 and a weight of one in Program 20-0, then φ_{total} must be divided by two to yield correct energy deposition data.

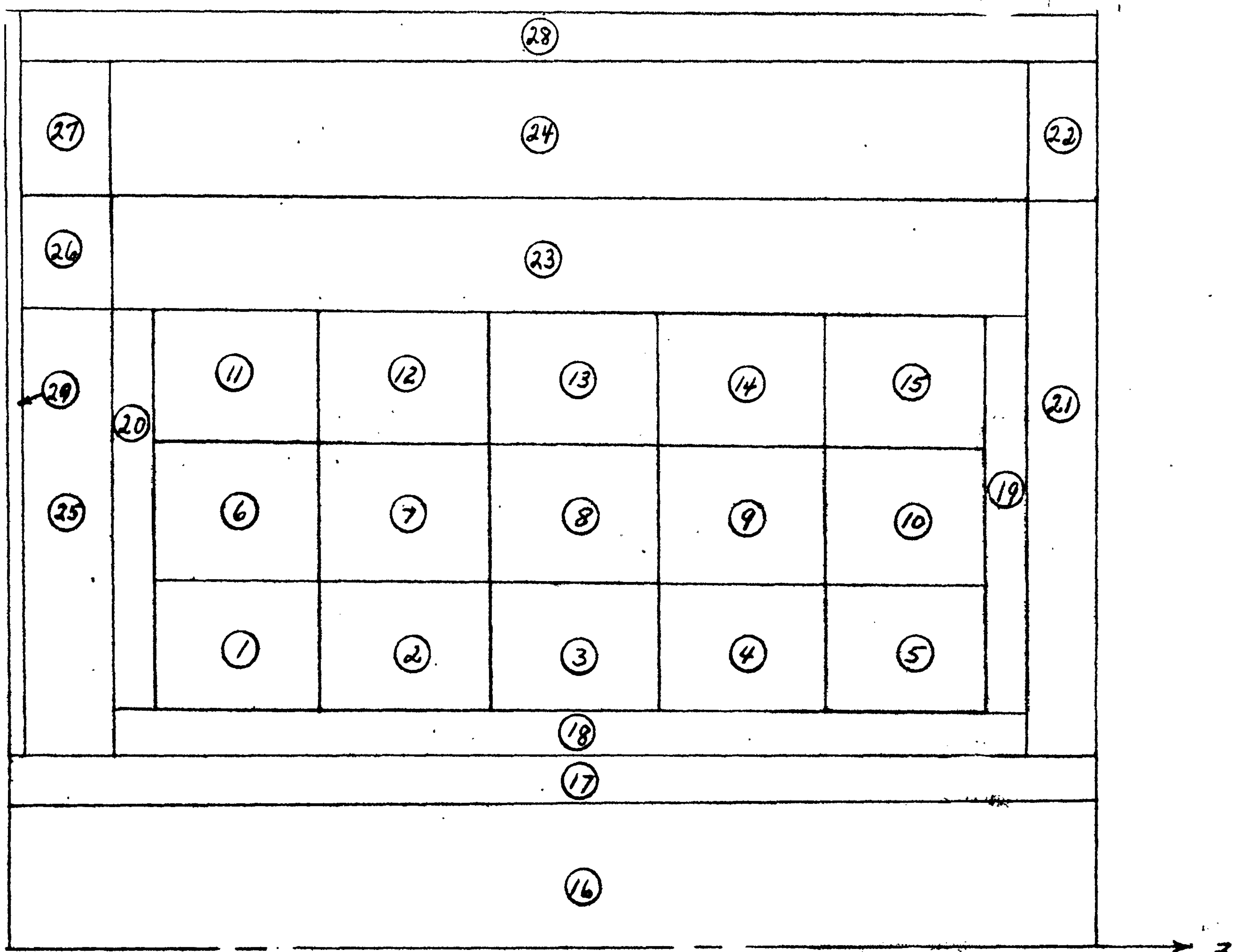

FIGURE 6

INNER SHIELD ASSEMBLY

Scale 1/5

O Region Numbers

TABLE 5

MATERIAL VOLUME FRACTIONS FOR INNER SHIELD ASSEMBLY

Region No.	Composition No.	Material							
		Void	Inconel-X	Al_2O_3	BeO	Hastelloy	SS-304	Be	UO_2
1	1	0.4527			0.5327				0.0146
2	1								
3	1								
4	1								
5	1								
6	1								
7	1								
8	1								
9	1								
10	1								
11	1								
12	1								
13	1								
14	1								
15	1								
16	2	1.0							
17	3	0.8486	0.1514						
18	4	0.12		0.88					
19	5	0.4245			0.5755				
20	5								
21	6	0.843	0.033			0.124			
22	7	0.7804				0.2196			
23	8	0.2078			0.7922				
24	9	0.0367			0.8813		0.082		
25	10	0.456						0.544	
26	11	0.2422						0.7578	
27	12	0.0853						0.9147	
28	13	0.7725	0.1315			0.106			
29	2								

[redacted]

TABLE 6

EFFECT OF SOURCE PARTICLE DENSITY ON GAMMA RAY ENERGY DEPOSITION IN INNER SHIELD REGIONS, MEV PER PARTICLE
(Straightforward Sampling Technique)

Region No.	Average of Two Runs of 20,000 Source Particles Each	Average of Two Runs of 10,000 Source Particles Each
1	.0227	.0219
2	.0321	.0272
3	.0349	.0332
4	.0335	.0306
5	.0219	.0213
6	.0288	.0307
7	.0440	.0443
8	.0527	.0521
9	.0459	.0517
10	.0315	.0289
11	.0304	.0316
12	.0435	.0421
13	.0508	.0518
14	.0478	.0495
15	.0330	.0343
17	.0124	.0119
18	.0394	.0423
19	.00920	.0101
20	.00996	.00903
21	.0111	.00995
22	.00773	.0125
23	.103	.107
24	.0414	.0378
25	.00679	.00739
26	.00198	.00176
27	.00195	.00123
28	.00564	.00678

[redacted]

TABLE 7

GAMMA RAY ENERGY DEPOSITION FROM VARIOUS SOURCE ENERGY SPECTRA GROUPS, MEV PER PARTICLE
(Straightforward Sampling Technique, 10,000 Source Particles per Run)

Region No.	Gamma Ray Source Energy Spectral Group, Mev					Total	Average of Two Runs with 10,000 Source Spectrum from .01 - 10 Mev
	.01 - .5	.5 - 1	1 - 2	2 - 4	4 - 7		
1	.003980	.005000	.005685	.004475	.00140	.0205	.0219
2	.005120	.007225	.007640	.006299	.001875	.0282	.0272
3	.006100	.008560	.008439	.007290	.002256	.0326	.0332
4	.005760	.008060	.008610	.006680	.002062	.0312	.0306
5	.003830	.005590	.006075	.004859	.001460	.0218	.0213
6	.005260	.007510	.008360	.006999	.002050	.0302	.0307
7	.007680	.009820	.011920	.009740	.003018	.0392	.0443
8	.008920	.012850	.014880	.011510	.003001	.0482	.0521
9	.008260	.011690	.012550	.010090	.003088	.0457	.0517
10	.005760	.008260	.009090	.006975	.002195	.0323	.0289
11	.005930	.008190	.008020	.006251	.001933	.0303	.0316
12	.008290	.010950	.012020	.009321	.002721	.0433	.0421
13	.009790	.012850	.013490	.010780	.003048	.0499	.0518
14	.009690	.012090	.013000	.010530	.002998	.0483	.0495
15	.006480	.008010	.008610	.007610	.002122	.0328	.0343
17	.000716	.002099	.003380	.003353	.001125	.0107	.0119
18	.002430	.008359	.012900	.012010	.004140	.0398	.0423
19	.000526	.001860	.025900	.003382	.000785	.00914	.0101
20	.000664	.002380	.0029980	.003962	.000921	.0109	.00903
21	.000695	.001685	.0031610	.003243	.001202	.00999	.00995
22	.000053	.000189	.000348	.000435	.000222	.00125	.00125
23	.006820	.020820	.035850	.031420	.001052	.09596	.107
24	.001899	.006460	.012500	.013920	.005450	.0402	.0378
25	.000397	.001375	.002090	.002110	.000637	.00661	.00739
26	.000077	.000367	.000475	.000639	.000237	.00180	.00176
27	.000027	.000144	.002420	.000424	.000269	.00328	.00123
28	.000119	.000639	.001980	.002499	.001300	.00654	.00678

TABLE 8

GAMMA RAY PARTICLES ESCAPING INNER SHIELD

Gamma Ray Source Energy Group, Mev	Angle Bin, degrees			Total
	0-60	60-120	120-180	(0^o-180^o)
.01 - .5	40	25	81	146
.5 - 1	227	172	326	725
1 - 2	435	350	506	1291
2 - 4	691	691	810	2192
4 - 7	841	1027	1004	2872

[redacted]

4. REAR PLUG ASSEMBLY

Presented in Figure 7 is the geometrical configuration describing the XNJ140E-1 rear plug and side shield. The encircled numbers refer to region numbers; other integers refer to current count boundaries. At current count boundary positions, the number of gamma ray particles crossing the specified boundaries are printed out by the Monte Carlo code. In this study, only those particles moving in a direction away from the source were tabulated.

Ninety-two convex quadrilaterals rotated about the reactor axis were used to describe the shield. The program assembly in use when this problem was run permitted only 100 regions as input. Therefore, a compromise was necessary in describing the physical make-up of the shield, the size of the regions in which the energy is deposited, and sufficient regions for splitting on location at region boundaries.

Material volume fractions are listed in Table 9. For convenience, Table 10 contains the composition applicable to each shield region. Gamma ray cross section data were approximated by twenty-five energy groups over the range 0.01 to 10 Mev. The number of energy groups is less than that used for the inner shield assembly because of program memory limitations. A listing of the actual input is given in Appendix B.

Initial calculations for the rear plug assembly involved 10,000 source particles distributed over the fission spectrum between 0.01 and 10 Mev. The straightforward sampling technique was employed. Six runs were made with computer time of 0.63 hour per run. These runs were made to verify the necessity of breaking the source energy spectrum into various energy groups. Notice that this time is comparable to equivalent runs involving only the inner shield assembly. In Table 11 the Monte Carlo results for these runs are tabulated. The average referred to in that table is an accumulated average.

Results of these runs indicate that better statistics were obtained in larger regions. When the region is far from the source, regardless of region size, radical statistical fluctuations were evident as in region 89. Statistical fluctuations are also a strong function of the solid angle subtended by the region in relation to the source.

[redacted]

[redacted]

Two runs for each of the five source energy groups described in Section 3 were then made using straightforward sampling to establish valid current counts. Computer time ranged from 0.6 hours for the 0.01 to 0.5 Mev group to one hour for the 4 to 7 Mev group. Results are presented in Table 12.

In Table 13, the average energy deposition for each group is given as well as the total in each region. The latter total is comparable to the last column in the table which represents results for 10,000 source particles distributed over the entire fission spectrum from 0.01 to 10 Mev. This table exemplifies the importance of each source group in each region.

The importance technique of splitting on location at region boundaries (region splitting) was next investigated, cautiously at first. This option was applied only to the source energy group between 2 and 4 Mev because this group contributed significantly to the energy deposition in all shield regions. Several combinations of region weights were tried. These combinations are referred to as splitting scheme #1, #2, etc. The region weights (W_{γ}) applicable to the gamma ray particles for the various splitting schemes are presented in Table 14.

Although a number of guides concerning splitting are available, it is difficult to conform to such rules when applying the technique to a realistic flight-type reactor-shield. In this study, region splitting was used to enhance the number of particles reaching the rear plug regions where heating is a significant design problem. The region weights in Table 14 illustrate this "directional" splitting. Also, in describing a shield such as the XNJ 140E-1, the limitation on the allowable number of geometrical regions forces a compromise between adequate physical description and adequate region splitting boundaries. The radical material changes throughout the shield further increases the difficulty of efficient splitting. One of the most reliable guides for splitting in reactor shields of this type appears to be the particle current counts. After experimenting with several different splitting schemes and studying the current counts, splitting scheme #4 was selected as adequate, but certainly not optimum, for heating rate calculations in the rear plug. This scheme effected good results, but not necessarily the best results for a minimum amount of computer time. The region splitting problem should be included in future detailed studies using the gamma ray portion of Program 18-0.

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Using a "cautious" approach, three runs were made with splitting scheme #1. Since the computer time (1.05 hours per run) was about equivalent to that for a straightforward run, and since severe statistical fluctuations were evident, it was obvious that an insufficient number of particles were available at the boundary where region splitting was begun. One run was made with splitting scheme #2 (1.18 hours) with similar fluctuations. These results are given in Table 15 and can be compared legitimately to the average of straightforward runs #1 and #2.

One run was made with splitting scheme #3 in 1.25 hours, about a 25 per cent increase over that for a straightforward run. This scheme effected significant changes in energy deposition in many regions, such as #40, #60, and #85 (Table 16).

Splitting scheme #4 was then investigated. The differences between schemes #4 and #3 are that the source regions were given a weight of two and the particles were doubled as soon as they crossed the rear face of the active core and entered the rear reflector, region #19. In neither scheme was splitting applied to the side shielding. Three runs with scheme #4 were made (2.06 hours per run) with excellent results shown in Table 16.

The use of particle current counts in determining adequate region splitting cannot be over-emphasized. Table 17 is presented to illustrate the increase in the number of gamma ray particles at various positions due to scheme #4 as compared to straightfoward calculations.

Having established valid energy deposition data in the rear plug regions, the lithium hydride was removed to: (1) determine any albedo effect, and (2) determine any variation in computer time. One run was made in 1.78 hours, a decrease of 0.28 hour. Results are given in Table 18 and can be compared to the average values from Table 17. No significant changes in energy deposition data occurred except in the pressure vessel region #68.

Also presented in Table 18 are results for one run (1.32 hours) in which only one-half of the source particles were used. These source particles were located from the center to the rear face of the core. Rather significant changes in the energy deposition data were noted, indicating that it is safer to utilize source particles distributed over the entire core volume. This run was made in the event that it would be necessary to run the shield in parts, such as a rear plug assembly.

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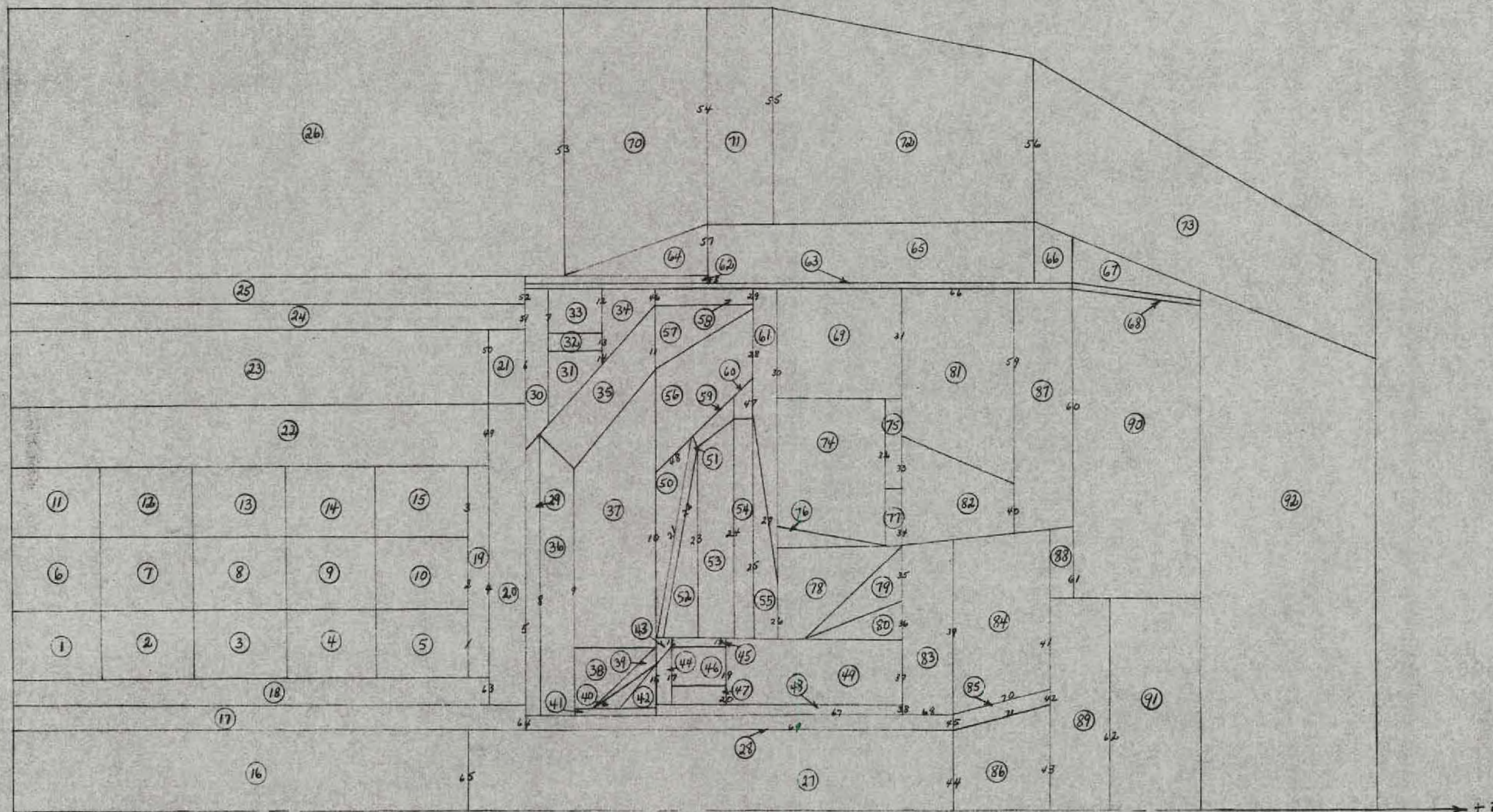

SCALE 1/5

Figure 7

REAR PLUG ASSEMBLY

○ REGION NUMBERS

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TABLE 9

MATERIAL VOLUME FRACTIONS FOR REAR PLUG ASSEMBLY

Composition No.	Material								
	Void	Inconel-X	Al_2O_3	BeC	Hastelloy	SS304	Be	LiH	UO_2
1	0.4527			0.5327					0.0146
2	1.0								
3	0.8486	0.1514							
4	0.12		0.88						
5	0.4245			0.5755					
6	0.843	0.033			0.124				
7	0.7804				0.2196				
8	0.2078			0.7922					
9	0.0367			0.8813		0.82			
10	0.456						0.544		
11		1.0							
12	0.0853						0.9147		
13	0.7725	0.1315			0.106				
14								1.0	
15	0.50	0.50							
16							1.0		

[redacted]

TABLE 10

REAR PLUG REGION-COMPOSITION TABLE

Region No.	Composition No.	Region No.	Composition No.
1-15	1	51	3
16	2	52-55	16
17	3	56	2
18	4	57	16
19	5	58	2
20	6	59-60	3
21	7	61-62	2
22	8	63	11
23	9	64-67	2
24	13	68	11
25	3	69	2
26	14	70-73	14
27	12	74	16
28	15	75	12
29-31	2	76	15
32	16	77	3
33-34	2	78	16
35	16	79	3
36-38	2	80	16
39	15	81	2
40-41	2	82-83	12
42	16	84	16
43	3	85	15
44	16	86	12
45	2	87	2
46	16	88-89	10
47-50	2	90-92	2

[redacted]

TABLE 11

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS, MEV

Number of Particles per Run: 10,000
Source Spectrum: .01 - 10 Mev
Technique: Straightforward Sampling

Region No.	Run No. 1	Run No. 2	Average	Run No. 3	Average*	Run No. 4	Average	Run No. 5	Average	Run No. 6	Average
1	219.11	203.61	211.36	203.87	206.77	189.69	204.07	209.09	205.07	205.76	205.19
2	317.99	282.06	300.03	295.85	295.65	322.99	304.72	291.72	302.12	280.71	298.56
3	371.20	368.13	369.67	387.51	371.86	386.19	378.26	366.68	375.94	333.95	368.95
4	346.60	294.98	320.79	296.01	312.49	326.17	315.94	342.48	321.25	297.52	317.36
5	232.20	221.99	227.09	210.36	221.49	209.04	218.39	209.89	216.69	201.12	214.14
6	279.94	294.50	287.22	284.33	286.23	305.16	290.98	303.56	293.49	306.21	295.68
7	476.99	457.00	466.99	398.06	443.97	410.18	435.56	381.31	424.71	420.04	424.01
8	477.44	527.08	502.26	507.52	503.96	502.19	503.56	478.73	498.59	482.15	495.87
9	483.77	450.84	467.31	474.65	469.71	464.52	468.45	498.09	474.37	473.89	474.39
10	314.44	302.29	308.37	313.04	309.89	317.48	311.81	292.29	307.91	306.74	307.77
11	289.35	295.40	292.38	299.85	294.84	286.49	292.77	323.38	298.89	309.98	300.80
12	464.60	423.51	444.06	414.25	434.08	431.74	433.53	475.36	441.89	445.34	442.56
13	539.18	522.59	530.89	491.19	517.60	508.57	515.38	523.18	516.94	520.04	517.62
14	496.70	469.31	483.01	506.64	490.83	478.25	487.73	460.25	482.23	495.09	484.47
15	351.81	336.57	344.19	345.05	343.98	326.69	339.78	351.28	342.08	351.28	343.68
17	87.25	101.74	94.50	101.28	96.75	112.56	100.71	66.18	93.80	90.57	93.28
18	385.36	395.43	390.39	419.61	400.10	417.15	404.39	361.66	395.84	384.48	394.03
19	101.35	109.36	105.36	87.35	99.34	97.51	98.89	106.04	100.32	117.67	103.23
20	109.03	104.10	106.57	89.95	101.02	108.41	102.87	105.07	103.31	92.89	101.59
21	18.69	12.74	15.72	7.73	13.05	16.92	14.02	11.22	13.46	11.95	13.21
22	1094.64	1084.89	1089.77	1153.40	1110.87	1093.65	1106.65	1125.81	1110.48	1133.65	1114.56
23	345.61	363.06	354.34	393.34	367.29	376.06	369.52	387.50	373.11	350.42	369.41
24	53.31	47.32	50.32	51.91	50.84	47.74	50.07	46.26	49.31	37.81	47.40
25	20.06	43.36	31.71	24.17	29.19	32.05	29.91	30.90	30.11	16.06	27.75
26	54.93	49.88	52.41	56.03	53.61	76.09	59.23	56.87	58.76	58.36	58.71
27	19.74	9.68	14.71	16.16	15.19	13.09	14.67	21.41	16.02	12.94	15.51
28	11.84	8.49	10.17	17.31	12.55	26.87	16.13	5.89	14.08	19.26	14.95
32	2.72	2.31	2.52	1.04	2.02	1.78	1.96	1.02	1.77	2.91	1.96
35	27.00	25.81	26.41	11.35	21.38	27.52	22.92	20.98	22.53	12.35	20.84
39	6.09	7.05	6.57	2.28	5.14	7.05	5.62	6.02	5.69	5.77	5.71

* Accumulated average, that is, average of Runs 1, 2, and 3.

TABLE 11 (Contd.)

Region No.	Run No. 1	Run No. 2	Average	Run No. 3	Average*	Run No. 4	Average	Run No. 5	Average	Run No. 6	Average
40	0.354	0.60	0.477	0.293	0.416	0.447	0.424	1.14	0.567	1.38	0.702
42	0.369	2.29	1.33	0.382	1.014	3.921	1.74	1.34	1.66	4.33	2.11
44	0.383	0.28	0.331	2.79	1.151	1.649	1.28	1.77	1.37	0.0552	1.15
46	0.679	0.47	0.575	3.18	1.443	3.329	1.91	1.78	1.89	1.43	1.81
51	9.05	6.34	7.69	6.70	7.36	7.873	7.49	1.27	6.25	2.92	5.69
52	17.26	15.38	16.32	13.46	15.37	12.08	14.55	13.38	14.31	30.69	17.05
53	16.33	22.99	19.66	12.13	17.15	18.93	17.60	28.07	19.69	30.38	21.48
54	12.31	10.38	11.35	10.45	11.05	8.87	10.50	10.49	10.50	11.91	10.74
55	6.57	4.36	5.47	7.02	5.98	5.33	5.82	4.16	5.49	4.94	5.39
57	1.31	2.19	1.75	8.79	4.09	6.81	4.78	3.01	4.42	3.88	4.33
59	0.788	6.77	3.78	2.51	3.36	2.87	3.24	3.13	3.21	6.29	3.73
60	1.75	0.27	1.01	0.845	0.955	2.19	1.26	1.19	1.25	1.05	1.22
63	10.30	30.51	20.41	15.95	18.92	10.34	16.78	11.09	15.64	28.43	17.77
68	0	0.63	0.315	1.31	0.647	1.63	0.89	0.0789	0.73	2.08	0.955
70	8.48	8.05	8.27	5.07	7.19	22.68	11.07	4.50	9.76	2.99	8.63
71	2.29	1.75	2.02	2.70	2.25	4.08	2.71	1.58	2.48	1.32	2.29
72	9.19	13.26	11.23	14.07	12.17	9.39	11.48	10.98	11.38	16.99	12.32
73	9.40	16.45	12.93	5.10	10.32	5.76	9.18	14.43	10.23	3.48	9.11
74	14.74	9.51	12.13	17.59	13.95	11.67	13.38	30.37	16.78	20.97	17.48
75	0.671	0.002	0.337	0.895	0.523	0.294	0.466	0.124	0.397	1.63	0.603
76	3.88	7.06	5.47	1.56	4.17	2.33	3.71	2.67	3.50	2.78	3.38
77	0.197	0.190	0.194	0.341	0.243	0.062	0.198	0.0947	0.177	0.638	0.254
78	3.38	16.28	9.83	5.09	8.25	5.03	7.45	2.65	6.49	5.93	6.39
79	0.54	4.14	2.34	0.567	1.75	4.22	2.37	0.611	2.02	0.632	1.79
80	0.069	1.13	0.60	0.805	0.668	0.293	0.574	0.219	0.503	0.701	0.536
82	4.61	0.057	2.33	0.879	1.85	3.69	2.31	0.888	2.02	4.64	2.46
83	4.47	2.08	3.28	2.38	2.98	2.62	2.89	3.89	3.09	3.58	3.17
84	0.61	4.35	2.48	1.26	2.07	3.62	2.46	0.309	2.03	6.51	2.78
85	0	0.072	0.036	0.034	0.0353	0.531	0.159	0.422	0.212	0.582	0.273
86	0.039	0	0.0195	0	0.0130	0.322	0.0903	0.595	0.191	0.272	0.205
89	0.06	0.87	0.465	0	0.31	0.324	0.313	0	0.251	0.0253	0.213

* Accumulated average, that is, average of Runs 1, 2, and 3.

[redacted]

TABLE 12

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS FROM VARIOUS SOURCE SPECTRA ENERGY GROUPS, MEV

Number of Source Particles per Run: 10,000
Technique: Straightforward Sampling

Region No.	Source Energy, 0.01 - 0.5 Mev			Source Energy, 0.5 - 1 Mev			Source Energy, 1.0 - 2.0 Mev			Source Energy, 2.0 - 4.0 Mev			Source Energy, 1.0 - 7.0 Mev		
	Run #1	Run #2	Average	Run #1	Run #2	Average	Run #1	Run #2	Average	Run #1	Run #2	Average	Run #1	Run #2	Average
1	34.07	34.85	34.47	46.60	47.37	46.99	50.71	56.50	53.61	41.28	45.02	43.15	13.86	14.01	13.94
2	49.56	52.54	51.05	74.71	72.06	73.39	76.42	84.90	80.66	61.31	63.47	62.39	19.37	17.89	18.63
3	61.24	65.67	63.46	87.68	82.86	85.27	90.22	91.80	91.01	75.97	67.87	71.92	23.37	21.58	22.48
4	55.59	57.76	56.67	79.54	72.19	75.87	87.33	91.00	89.17	74.43	66.59	70.51	21.13	21.20	21.17
5	38.62	38.98	38.80	55.02	55.74	55.38	53.92	57.10	55.51	47.58	42.89	47.04	[illegible]	[illegible]	14.96
6	53.70	53.14	53.42	71.72	73.93	72.83	76.90	83.60	80.25	66.20	65.78	65.99	19.56	21.77	20.67
7	74.95	75.12	75.04	101.53	104.38	102.96	114.67	123.10	118.89	90.80	93.37	92.09	26.61	29.59	28.10
8	95.90	95.84	95.87	123.89	128.50	126.19	136.35	131.20	133.78	109.06	120.96	115.01	33.32	29.91	[illegible]
9	85.63	82.33	83.98	114.66	118.91	116.79	134.62	125.50	130.06	104.93	102.11	103.52	30.74	30.36	30.55
10	53.23	55.99	54.61	79.86	80.10	79.98	88.93	87.50	88.21	65.74	66.60	66.17	20.18	20.99	[illegible]
11	54.28	54.28	54.28	82.63	72.12	77.38	81.44	75.20	78.32	76.03	62.73	69.38	19.22	20.18	19.70
12	87.88	78.99	83.44	113.70	112.78	113.24	111.21	117.10	114.16	89.75	93.98	91.87	27.56	27.32	27.44
13	100.41	98.34	99.38	134.02	133.20	133.61	142.98	151.10	147.04	116.50	113.29	114.89	31.66	30.76	32.71
14	92.20	95.16	93.68	118.91	127.33	123.12	126.73	129.00	127.87	99.19	103.56	101.38	31.58	31.66	31.62
15	58.91	63.42	61.17	81.28	84.18	82.73	90.69	91.00	90.85	71.40	71.03	71.22	20.35	22.11	21.23
17	5.72	6.12	5.92	16.57	19.34	17.96	32.52	31.40	21.96	31.63	31.02	31.33	10.71	11.04	10.88
18	25.12	24.94	25.03	79.29	85.09	82.19	127.91	133.00	130.46	130.54	129.39	129.97	39.61	38.00	38.81
19	6.15	4.91	5.53	21.10	18.23	19.67	29.37	27.80	28.59	28.67	28.91	28.79	8.07	8.73	8.40
20	8.49	6.89	7.69	22.68	20.29	21.49	35.69	26.40	31.05	36.23	33.07	34.65	13.68	11.32	12.5[illegible]
21	0.248	0.456	0.352	1.39	1.39	1.39	3.16	3.39	3.28	5.97	5.46	5.72	1.77	2.42	2.10
22	72.27	71.35	71.81	223.79	220.30	222.05	365.96	351.00	358.48	332.38	337.82	335.10	109.22	107.59	108.41
23	16.33	16.51	16.42	57.38	58.13	57.76	110.18	116.80	113.49	125.05	137.75	131.40	51.38	49.18	50.28
24	0.69	0.428	0.559	5.44	7.54	6.49	14.96	14.55	14.76	23.09	23.93	23.51	9.89	10.63	10.26
25	0.607	0	0.304	2.11	2.22	2.17	8.13	7.54	7.84	11.53	12.57	12.05	5.09	5.79	5.44
26	0.367	0	0.184	3.78	2.53	3.16	16.85	16.85	16.85	27.91	28.97	28.44	13.96	13.81	13.89
27	0.453	0.394	0.424	1.47	0.905	1.19	2.49	3.49	2.99	3.21	4.85	4.02	1.27	2.02	1.65
28	0.419	0.560	0.489	1.73	1.64	1.69	3.67	3.81	3.74	4.68	4.15	4.42	2.24	2.51	2.38
32	0.063	0.192	0.128	0.504	0.588	0.546	0.845	1.15	0.99	1.19	0.183	0.686	0.32	0.48	0.40
35	0.837	0.778	0.808	2.21	3.12	2.67	7.73	7.35	7.54	5.16	6.00	5.58	3.45	2.88	3.17
39	0.339	0.272	0.306	1.03	0.969	0.999	1.70	1.61	1.66	1.79	1.12	1.46	0.72	0.71	0.715
40	0.073	0.078	0.076	0.097	0.115	0.106	0.318	0.322	0.32	0.579	0.095	0.337	0.13	0.19	0.16
42	0	0.115	0.058	0.273	0.298	0.286	0.731	0.437	0.584	0.709	0.464	0.587	0.23	0.19	0.21
44	0.093	0.063	0.078	0.106	0.288	0.197	0.353	0.265	0.309	0.357	0.193	0.275	0.0039	0.22	0.112
46	0	0.035	0.018	0.445	0.251	0.348	0.804	0.739	0.772	0.639	2.12	1.38	0.45	0.39	0.42
51	0.653	0.332	0.493	1.96	1.73	1.85	3.26	3.16	3.21	3.32	2.39	2.86	1.24	1.12	1.18
52	0.502	0.355	0.429	1.83	1.87	1.85	4.49	4.03	4.26	6.01	3.29	4.65	1.33	1.50	1.42
53	0.334	0.653	0.494	3.21	3.58	3.40	6.92	6.85	6.89	10.08	8.54	9.31	2.63	2.49	2.56
54	0.295	0.255	0.275	1.44	0.741	1.09	2.56	3.56	3.06	3.58	3.68	3.63	1.32	1.13	1.23
55	0.052	0.0232	0.0376	0.459	0.225	0.342	1.25	1.73	1.49	1.69	2.04	1.87	0.52	0.49	0.51
57	0.089	0.088	0.0885	0.681	0.298	0.490	0.603	1.02	0.812	2.24	1.74	1.99	0.75	0.61	0.68
59	0.0805	0.136	0.108	0.668	0.531	0.599	1.25	0.661	0.956	1.67	0.443	1.08	0.33	0.28	0.31
60	0.0263	0.0168	0.0216	0.324	0.279	0.301	0.539	0.634	0.587	0.293	0.282	0.288	0.25	0.098	0.174
63	0.252	1.08	0.666	2.70	2.28	2.49	4.75	5.99	5.37	6.67	5.55	6.11	2.55	2.675	2.6[illegible]
68	0	0	0	0.0167	0.0268	0.0218	0.213	0.209	0.211	0.287	0.235	0.261	0.22	0.11	0.165
70	0.058	0	0.029	0.962	0.959	0.961	2.75	2.42	2.59	5.24	4.24	4.74	1.37	2.19	1.76
71	0.049	0.152	0.101	0.185	0.468	0.327	0.57	1.76	1.17	1.53	1.72	1.63	0.60	0.54	0.57
72	0.345	0.177	0.261	1.95	1.69	1.82	5.54	3.21	4.38	7.08	7.23	7.16	3.11	3.05	3.08
73	0	0.012	0.006	0.505	0.197	0.351	1.58	2.87	2.23	4.05	2.78	3.42	1.49	1.04	1.27
74	0.121	0.107	0.114	0.627	0.749	0.688	5.02	3.75	4.39	6.26	6.20	6.23	1.52	2.21	1.87
75	0	0.0002	0.0001	0.0169	0.035	0.0259	0.216	0.089	0.153	0.149	0.389	0.269	0.106	0.076	0.091
76	0.135	0.068	0.102	0.26	0.203	0.232	1.12	1.36	1.24	2.02	1.398	1.71	0.54	0.44	0.49
77	0.0296	0	0.0148	0.0101	0.0183	0.0142	0.0687	0.212	0.14	0.114	0.190	0.152	0.018	0.074	0.046
78	0.0067	0.211	0.109	0.251	0.454	0.353	1.04	1.05	1.045	1.83	2.74	2.29	0.55	0.75	0.65
79	0	0.010	0.005	0.099	0.108	0.104	0.524	0.584	0.554	0.182	0.394	0.288	0.27	0.47	0.37
80	0	0.0078	0.0039	0.0509	0.0065	0.0287	0.557	0.0629	0.309	0.305	0.437	0.371	0.20	0.11	0.155
82	0	0.00044	0.00022	0.085	0.0149	0.0499	0.808	0.624	0.716	1.10	1.47	1.29	0.26	0.49	0.375
83	0	0.092	0.046	0.262	0.0654	0.164	1.01	0.674	0.842	0.604	0.485	0.545	0.42	0.54	0.48
84	0	0.0124	0.0062	0.199	0.090	0.145	0.983	0.447	0.715	2.04	0.479	1.26	0.30	0.63	0.465
85	0	0	0	0.0505	0	0.0253	0.349	0.336	0.343	0.192	0.0027	0.097	0.0029	0.056	0.0295
86	0	0	0	0	0	0	0	0	0	0.092	0	0.046	0.0114	0.043	0.0272
89	0	0.0164	0.0082	0.0065	0	0.0033	0.0147	0	0.00735	0.0096	0.1195	0.0645	0.0251	0.00045	0.01278

[redacted]

TABLE 13

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS FROM VARIOUS SOURCE ENERGY SPECTRUM GROUPS, MEV

Technique: Straightforward Sampling

Region No.	Source Energy Group, Mev					Total	Total Source** Spectrum 0.01-10 Mev
	0.01-0.5*	0.5-1.0*	1.0-2.0*	2.0-4.0*	4.0-7.0*		
1	34.47	46.99	53.61	43.15	13.94	192.16	205.19
2	51.05	73.39	80.66	62.39	18.63	286.12	298.56
3	63.46	85.27	91.01	71.92	22.48	334.14	368.95
4	56.67	75.87	89.17	70.51	21.17	313.39	317.36
5	38.80	55.38	55.51	45.24	14.98	209.91	214.14
6	53.42	72.83	80.25	65.99	20.67	293.16	295.68
7	75.04	102.96	118.89	92.09	28.10	417.08	424.01
8	95.87	126.19	133.78	115.01	31.62	502.47	495.87
9	83.98	116.79	130.06	103.52	30.55	464.90	474.39
10	54.61	79.98	88.21	66.17	20.59	309.56	307.77
11	54.28	77.38	78.32	69.38	19.70	299.06	300.80
12	83.84	113.24	114.16	91.87	27.44	430.55	442.56
13	99.38	133.61	147.04	114.89	32.71	527.63	517.62
14	93.68	123.12	127.87	101.38	31.62	477.67	484.47
15	61.17	82.73	90.85	71.22	21.23	327.20	343.68
17	5.92	17.96	31.96	31.33	10.88	98.05	93.28
18	25.03	82.19	130.46	129.97	38.81	406.46	394.03
19	5.53	19.67	28.59	28.79	8.40	90.98	103.23
20	7.69	21.49	31.05	34.65	12.50	107.38	101.59
21	0.352	1.39	3.28	5.72	2.10	12.84	13.21
22	71.81	222.05	358.48	335.10	108.41	1095.85	1114.56
23	16.42	57.76	113.49	131.40	50.28	369.35	369.41
24	0.559	6.49	14.76	23.51	10.26	55.58	47.40
25	0.304	2.17	7.84	12.05	5.44	27.80	27.75
26	0.184	3.16	16.85	28.44	13.89	62.52	58.71
27	0.424	1.19	2.99	4.02	1.65	10.27	15.51
28	0.489	1.69	3.74	4.42	2.38	12.72	14.95
32	0.128	0.546	0.99	0.686	0.40	2.75	1.96
35	0.808	2.67	7.54	5.58	3.17	19.77	20.84
39	0.306	0.999	1.66	1.46	0.715	5.14	5.71
40	0.076	0.106	0.32	0.337	0.16	0.999	0.702
42	0.058	0.286	0.584	0.587	0.21	1.725	2.11
44	0.078	0.197	0.309	0.275	0.112	0.971	1.15
46	0.018	0.348	0.772	1.38	0.42	2.94	1.81
51	0.493	1.85	3.21	2.86	1.18	9.59	5.69
52	0.429	1.85	4.26	4.65	1.42	12.61	17.05
53	0.494	3.40	6.89	9.31	2.56	22.65	21.48
54	0.275	1.09	3.06	3.63	1.23	9.29	10.74
55	0.0376	0.342	1.49	1.87	0.51	4.25	5.39
57	0.0885	0.490	0.812	1.99	0.68	4.06	4.33
59	0.108	0.599	0.956	1.06	0.31	3.03	3.73
60	0.0216	0.301	0.587	0.288	0.174	1.37	1.22
63	0.666	2.49	5.37	6.11	2.62	17.26	17.77
68	0	0.0218	0.211	0.261	0.165	0.659	0.955
70	0.029	0.961	2.59	4.74	1.78	10.10	8.63
71	0.101	0.327	1.17	1.63	0.57	3.79	2.29
72	0.261	1.82	4.38	7.16	3.08	16.70	12.32
73	0.006	0.351	2.23	3.42	1.27	7.28	9.11
74	0.114	0.688	4.39	6.23	1.87	13.29	17.48
75	0.0001	0.0259	0.153	0.269	0.091	0.539	0.603
76	0.102	0.232	1.24	1.71	0.49	3.77	3.38
77	0.0148	0.0142	0.14	0.152	0.046	0.467	0.254
78	0.109	0.353	1.045	2.29	0.65	4.45	6.39
79	0.005	0.104	0.554	0.288	0.37	1.32	1.79
80	0.0039	0.0287	0.309	0.371	0.155	0.868	0.536
82	0.00022	0.0499	0.716	1.29	0.375	2.43	2.46
83	0.046	0.164	0.842	0.545	0.48	2.08	3.17
84	0.0062	0.145	0.715	1.26	0.465	2.59	2.78
85	0	0.0253	0.343	0.097	0.0295	0.495	0.273
86	0	0	0	0.111	0.0272	0.138	0.205
89	0.0082	0.0033	0.00735	0.0048	0.01278	0.0364	0.213

* Average of two straightforward calculations from Table 12

** Average of the six runs from Table 11

[redacted]

[redacted]

TABLE 14

GAMMA RAY PARTICLE WEIGHTS FOR REAR PLUG REGIONS

Splitting Scheme No. 1

All region weights equal 1 except the following:

Region No.	W_γ
74 thru 80	.5
82 thru 86	.25
89	.25

Splitting Scheme No. 2

All region weights equal 1 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
43	.5	57	.5	78	.25
44	.5	58	.5	79	.25
45	.5	59	.5	80	.25
46	.5	60	.5	81	.125
47	.5	54	.25	82	.125
48	.5	55	.25	83	.125
49	.5	61	.25	84	.125
50	.5	61	.25	85	.125
51	.5	74	.25	86	.125
52	.5	75	.25	87	.125
53	.5	76	.25	88	.0625
56	.5	77	.25	89	.0625

Splitting Scheme No. 3

All region weights equal 1 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
29	.5	46	.5	74	.25
30	.5	47	.5	75	.25
31	.5	48	.5	76	.25
32	.5	49	.5	77	.25
33	.5	50	.5	78	.25
34	.5	51	.5	79	.25
35	.5	52	.5	80	.25
36	.5	53	.5	81	,125
37	.5	56	.5	82	.125
38	.5	57	.5	83	.125
39	.5	58	.5	84	.125
40	.5	59	.5	85	.125
41	.5	60	.5	86	.125
42	.5	54	.25	87	.125
43	.5	55	.25	88	.0625
44	.5	61	.25	89	.0625
45	.5	69	.25		

Splitting Scheme No. 4

Identical to Scheme No. 3 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
1	2	7	2	13	2
2	2	8	2	14	2
3	2	9	2	15	2
4	2	10	2	20	.5
5	2	11	2	21	.5
6	2	12	2		

[redacted]

TABLE 15

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS, MEV

Number of Histories per Run: 10,000
Source Energy Spectrum: 2-4 Mev
Technique: Particle splitting on location at region boundaries

Region No.	Average of Run #1 and Run #2*	Run No. 3 Splitting Scheme #1	Average	Run No. 4 Splitting Scheme #1	Average	Run No. 5 Splitting Scheme #1	Average	Run No. 6 Splitting Scheme #2	Average
1	43.15	45.99	44.05	45.32	44.40	44.68	44.46	46.38	44.78
2	62.39	63.78	62.79	65.55	63.53	61.94	63.21	63.24	63.22
3	71.92	76.82	73.48	82.28	75.74	80.09	76.61	72.03	75.84
4	70.51	69.81	70.28	70.05	70.22	70.79	70.33	68.14	69.97
5	45.24	47.04	45.83	49.90	46.85	43.96	46.27	52.59	47.33
6	65.99	67.60	66.52	60.98	65.14	62.53	64.62	63.36	64.24
7	92.09	94.79	92.98	94.67	93.41	88.65	92.46	85.17	91.24
8	115.01	109.22	113.07	98.95	109.55	108.09	109.26	107.39	108.95
9	103.52	104.69	103.89	105.98	104.43	99.21	103.38	102.28	103.20
10	66.17	70.51	67.61	69.68	68.13	69.43	68.39	68.69	68.44
11	69.38	70.77	69.84	65.90	68.86	66.85	68.46	64.16	67.74
12	91.87	96.88	93.53	89.17	92.45	98.26	93.61	97.15	94.20
13	114.89	107.27	112.34	119.89	114.24	110.50	113.49	113.23	113.45
14	101.38	103.84	102.19	100.68	101.82	104.22	102.29	106.34	102.97
15	71.22	69.45	70.62	69.66	70.39	66.90	69.69	74.26	70.45
17	31.33	29.73	30.79	25.84	29.56	26.86	29.02	30.42	29.25
18	129.97	122.59	127.49	118.80	125.33	126.79	125.62	125.77	125.65
19	28.79	28.35	28.64	28.08	28.50	25.85	27.97	32.02	28.65
20	34.65	33.78	34.36	30.26	33.34	32.38	33.14	32.29	33.00
21	5.72	4.12	5.18	5.13	5.17	5.14	5.16	3.99	4.97
22	335.10	334.85	334.98	330.11	333.79	341.45	335.32	333.82	335.08
23	131.40	128.26	130.34	133.45	131.13	135.48	131.99	127.85	131.31
24	23.51	21.89	22.97	23.45	23.09	20.37	22.55	18.42	21.86
25	12.05	12.61	12.24	12.57	12.32	11.37	12.13	13.02	12.28
26	28.44	26.58	27.82	31.46	28.73	29.57	28.89	32.29	29.46
27	4.02	4.36	4.14	3.91	4.08	6.50	4.57	5.20	4.67
28	4.42	5.19	4.67	4.97	4.75	5.99	4.99	5.85	5.14
32	0.686	0.887	0.753	1.31	0.893	0.614	0.837	1.77	0.992
35	5.58	6.69	5.95	9.31	6.79	10.41	7.51	7.39	7.49
39	1.46	2.68	1.86	2.41	2.00	1.21	1.84	1.73	1.82

* Average of two straightforward runs for this source energy group from Table 12

TABLE 15 (Contd.)

Region No.	Average of Run #1 and Run #2*	Run No. 3 Splitting Scheme #1	Average	Run No. 4 Splitting Scheme #1	Average	Run No. 5 Splitting Scheme #1	Average	Run No. 6 Splitting Scheme #2	Average
40	0.337	0.226	0.30	0.239	0.285	0.050	0.238	0.211	0.233
42	0.587	0.328	0.50	0.857	0.589	0.459	0.563	0.749	0.594
44	0.275	0.508	0.353	0.171	0.307	0.161	0.278	0.318	0.285
46	1.38	0.458	1.07	1.32	1.13	1.12	1.13	1.08	1.12
51	2.86	3.07	2.93	2.19	2.74	2.17	2.63	2.91	2.68
52	4.65	5.89	5.06	4.44	4.91	4.33	4.79	4.67	4.77
53	9.31	8.15	8.92	7.01	8.45	9.21	8.60	8.38	8.56
54	3.63	3.49	3.58	3.12	3.47	4.36	3.65	4.23	3.74
55	1.87	1.36	1.70	2.82	1.98	2.04	1.99	2.53	2.08
57	1.99	2.04	2.01	2.10	2.03	1.41	1.91	1.92	1.908
59	1.057	1.17	1.09	1.29	1.14	0.637	1.04	0.906	1.019
60	0.288	0.329	0.301	0.817	0.430	0.192	0.383	0.354	0.378
63	6.11	6.16	6.13	6.43	6.20	4.34	5.83	6.57	5.95
68	0.261	0.451	0.324	0.463	0.359	0.383	0.364	0.698	0.419
70	4.74	4.37	4.61	4.61	4.61	4.57	4.61	4.95	4.66
71	1.625	1.24	1.49	2.59	1.77	1.96	1.81	2.09	1.86
72	7.16	6.08	6.80	6.48	6.72	6.67	6.71	5.48	6.50
73	3.42	2.04	2.96	2.44	2.83	2.29	2.72	2.81	2.74
74	6.23	4.37	5.61	5.67	5.63	5.27	5.55	6.09	5.64
75	0.269	0.168	0.235	0.285	0.248	0.175	0.233	0.222	0.231
76	1.71	1.13	1.52	1.76	1.58	1.36	1.53	1.36	1.50
77	0.152	0.067	0.124	0.171	0.136	0.0965	0.128	0.208	0.141
78	2.29	1.85	2.14	1.88	2.08	1.99	2.06	2.48	2.13
79	0.288	0.434	0.337	0.443	0.363	0.609	0.412	0.579	0.440
80	0.371	0.92	0.554	0.466	0.532	0.388	0.503	0.699	0.536
82	1.29	0.93	1.17	0.986	1.12	0.495	0.996	0.875	0.976
83	0.545	1.07	0.719	1.19	0.837	1.48	0.966	1.64	1.078
84	1.26	0.79	1.10	1.36	1.17	0.783	1.09	1.95	1.23
85	0.097	0.152	0.116	0.224	0.143	0.456	0.205	0.408	0.239
86	0.046	0.045	0.0457	0.0657	0.0507	0.0049	0.0415	0.0332	0.0401
89	0.0645	0.0969	0.0753	0.138	0.0910	0.129	0.0986	0.241	0.122

* Average of two straightforward runs for this source energy group from Table 12.

TABLE 16

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS, MEV

Number of Histories per Run: 10,000

Source Energy Spectrum: 2-4 Mev

Technique: Particle splitting on location at region boundaries

Region No.	Run No. 7 Splitting Scheme #3	Run No. 8 Splitting Scheme #4	Average	Run No. 9 Splitting Scheme #4	Average	Run No. 10 Splitting Scheme #4	Average
1	43.30	42.08	42.69	47.89	44.42	46.60	44.97
2	67.54	62.35	64.95	57.60	62.49	63.35	62.71
3	73.52	71.45	72.49	73.18	72.71	78.54	74.17
4	71.34	67.56	69.45	65.96	68.28	69.59	68.61
5	47.86	48.14	48.00	47.67	47.89	46.69	47.59
6	60.24	62.58	61.41	69.45	64.08	68.29	65.14
7	97.57	95.69	96.63	90.02	94.42	90.09	93.34
8	105.06	112.74	108.90	102.36	106.71	106.87	106.76
9	97.82	97.45	97.64	107.61	100.95	100.99	100.97
10	67.97	68.01	67.99	72.90	69.62	66.70	68.89
11	67.60	73.27	70.44	72.06	70.97	66.48	69.85
12	95.29	98.96	97.13	95.77	96.66	101.51	97.88
13	110.08	112.02	111.05	105.95	109.34	107.21	108.82
14	109.09	106.67	107.88	95.54	103.76	104.98	104.07
15	73.07	71.12	72.10	73.81	72.66	69.70	71.93
17	29.91	28.32	29.12	32.30	30.17	31.22	30.44
18	125.99	121.37	123.68	126.03	124.45	128.15	125.39
19	31.47	28.48	29.98	30.30	30.08	26.55	29.20
20	32.72	32.22	32.47	33.39	32.77	30.89	32.31
21	4.13	4.38	4.26	4.34	4.28	4.43	4.32
22	334.62	336.27	335.45	338.85	336.55	333.37	335.78
23	137.87	131.75	134.81	134.44	134.67	135.41	134.87
24	18.47	23.38	20.93	22.15	21.33	22.12	21.53
25	12.50	11.73	12.12	12.92	12.38	12.36	12.38
26	25.69	28.49	27.09	27.95	27.37	29.09	278.05
27	4.31	5.76	5.04	3.99	4.69	5.23	4.82
28	2.29	5.62	3.96	4.63	4.18	4.23	4.19
32	1.14	0.997	1.07	1.57	1.24	0.896	4.60
35	7.78	8.73	8.26	9.01	8.51	8.06	8.39
39	1.75	1.64	1.70	1.42	1.60	1.42	1.56

TABLE 16 (Contd.)

Region No.	Run No. 7 Splitting Scheme #3	Run No. 8 Splitting Scheme #4	Average	Run No. 9 Splitting Scheme #4	Average	Run No. 10 Splitting Scheme #4	Average
40	0.318	0.318	0.318	0.506	0.381	0.408	0.388
42	0.216	0.869	0.543	0.665	0.583	0.689	0.609
44	0.326	0.498	0.412	0.362	0.395	0.437	0.406
46	1.16	1.06	1.11	1.17	1.13	0.999	1.09
51	3.06	2.69	2.88	2.58	2.78	2.13	2.62
52	3.98	4.23	4.11	4.34	4.18	4.56	4.28
53	8.86	7.77	8.32	8.11	8.25	7.27	8.00
54	3.35	3.57	3.46	3.79	3.57	3.71	3.61
55	2.11	1.52	1.82	2.05	1.89	1.72	1.85
57	1.49	1.74	1.62	1.97	1.73	2.33	1.88
59	0.620	0.615	0.618	0.752	0.662	1.09	0.769
60	0.582	0.422	0.502	0.708	0.571	0.575	0.572
63	4.94	5.54	5.24	6.11	5.53	5.39	5.49
68	0.987	0.234	0.611	0.383	0.535	0.360	0.491
70	4.52	4.25	4.39	4.94	4.57	4.48	4.55
71	1.66	2.26	1.96	1.91	1.94	2.07	1.98
72	7.07	5.08	6.08	5.93	6.03	6.08	6.04
73	3.12	2.36	2.74	3.18	2.89	1.899	2.64
74	6.20	5.78	5.99	5.98	5.99	4.69	5.66
75	0.435	0.205	0.320	0.307	0.316	0.243	0.298
76	1.32	1.23	1.28	0.997	1.18	1.24	1.19
77	0.175	0.123	0.149	0.140	0.146	0.109	0.137
78	2.21	1.69	1.95	2.26	2.05	2.10	2.07
79	0.382	0.406	0.394	0.635	0.474	0.593	0.504
80	0.609	0.394	0.502	0.579	0.527	0.469	0.513
82	0.715	0.589	0.652	0.685	0.663	0.615	0.651
83	1.21	1.24	1.23	1.13	1.19	1.51	1.27
84	1.31	1.33	1.32	1.59	1.41	1.12	1.34
85	0.092	0.212	0.152	0.176	0.160	0.516	0.249
86	0.0060	0.149	0.0775	0.0044	0.0531	0.194	0.0884
89	0.106	0.126	0.116	0.160	0.131	0.161	0.138

[redacted]

TABLE 17

EFFECT OF REGION SPLITTING ON GAMMA RAY PARTICLE CURRENT IN REAR PLUG ASSEMBLY

Number of Histories per Run: 10,000
Source Energy Spectrum: 2-4 Mev

Boundary No.	Straight-forward	Splitting Scheme #4
1	245	200
2	320	309
3	288	327
4	680	1383
5	570	2261
6	48	227
7	112	510
8	513	2020
9	418	1605
10	414	1658
11	37	144
12	27	113
13	19	89
14	15	78
15	31	106
16	13	53
17	32	118
18	8	18
19	15	71
20	8	39
21	291	1148
22	246	971
23	250	964
24	210	869
25	178	1455
26	23	284
27	132	1025
28	70	272
29	17	48
30	236	1808
31	54	390
32	36	254
33	23	138
34	8	46
35	5	72
36	4	61
37	19	72
38	2	4
39	23	446
40	3	56
41	13	132
42	0	8
43	2	27
44	2	2
45	0	2
46	12	78
47	31	113
48	59	268
49	150	283
50	69	134
51	6	19
52	7	16
53	90	152
54	58	108
55	61	127
56	34	77
57	21	65
58	4	6
59	38	618
60	33	567
61	4	129
62	5	122
63	43	58
64	18	36
65	37	87
66	42	71
67	31	134
68	3	57
69	27	56
70	2	101
71	0	31

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TABLE 18

GAMMA RAY ENERGY DEPOSITION IN REAR PLUG REGIONS, MEV

Number of Histories per Run: 10,000
Source Energy Spectrum: 2-4 Mev
Technique: Particle splitting on location at region boundaries

Region No.	Average Value of Runs #7 thru #10	Run #11 Lithium Hydride Removed Splitting Scheme #4	Run #12 One-half Active Core Splitting Scheme #4
1	44.97	40.95	28.79
2	62.71	67.35	10.10
3	74.17	73.76	41.68
4	68.61	72.60	51.84
5	47.59	49.29	52.34
6	65.14	63.17	5.59
7	93.34	92.96	15.54
8	106.76	111.61	56.96
9	100.97	100.65	92.50
10	68.89	71.26	66.33
11	69.85	61.57	65.63
12	97.88	91.10	16.19
13	108.82	110.60	62.12
14	104.07	103.73	91.69
15	71.93	70.66	63.85
17	30.44	28.78	14.53
18	125.39	125.19	66.29
19	29.20	27.78	26.46
20	32.31	32.53	27.98
21	4.32	4.27	3.96
22	335.78	340.89	178.14
23	134.87	128.46	67.39
24	21.53	21.95	13.47
25	12.38	10.64	5.74
26	278.05	---	16.42
27	4.82	5.64	4.80
28	4.19	7.14	4.80
32	1.15	1.21	1.53
35	8.39	7.74	6.60
39	1.56	1.87	1.48
40	0.388	0.370	0.462
42	0.609	0.941	0.544
44	0.406	0.344	0.239
46	1.09	1.16	1.27
51	2.62	2.53	2.35
52	4.28	3.92	3.89
53	8.00	7.76	6.53
54	3.61	2.88	3.08
55	1.85	1.50	1.48
57	1.88	1.44	1.58
59	0.769	1.24	0.604
60	0.572	0.498	0.347
63	5.49	4.36	6.31
68	0.491	0.125	0.641
70	4.55	---	4.09
71	1.98	---	1.71
72	6.04	---	6.33
73	2.64	---	2.95
74	5.66	5.03	4.64
75	0.298	0.253	0.280
76	1.19	1.21	1.09
77	0.137	0.102	0.092
78	2.07	2.43	1.51
79	0.504	0.472	0.385
80	0.513	0.372	0.338
82	0.651	0.555	0.445
83	1.27	1.12	0.904
84	1.34	1.07	1.00
85	0.249	0.132	0.133
86	0.0884	0.027	0.0318
89	0.138	0.132	0.0750

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5. FRONT PLUG ASSEMBLY

Presented in Figure 8 is the geometrical configuration which describes the XNJ140E-1 front plug and side shield. The encircled numbers refer to region numbers; and other integers refer to current count boundaries.

One hundred twenty-eight convex quadrilaterals rotated about the reactor axis were used to describe the shield. A new Program 18-0 assembly was used in which memory had been reallocated for additional region input data. The side shield, pressure vessel, and the shaft stuffing and cladding were described in more detail.

Table 19 contains the material volume fractions for this configuration. For convenience, Table 20 contains the composition applicable to each shield region. Gamma ray cross section data were approximated by twenty-five energy groups between 0.01 and 10 Mev. A listing of the actual input data is given in Appendix C.

One run for each of the five gamma ray source energy spectrum groups was made with the straightforward method. Results are given in Table 21. (In the 2 to 4 Mev group, four runs were made; the average of these runs is entered in the table.) The straightforward runs for each source group were made to (1) illustrate the relative importance of each group in each region, and (2) establish the gamma ray current counts at various boundary positions. The current count data are listed in Table 22. Computer times ranged from 0.51 hours for the 0.01 to 0.5 Mev group to 1.38 hours for the 4 to 7 Mev source energy group.

For the source group between 2 and 4 Mev, four straightforward runs were made to illustrate the severe statistical fluctuations in many of the front plug regions. Data from these four runs are presented in Table 23. Note, for example, energy deposition data in regions #41, #60, #65, and #70.

Region splitting in the front plug was investigated. The region weights (W_γ) applicable to the gamma ray particles for the various splitting schemes are given in Table 24. Again, region splitting was used in a "directional" sense.

However, to demonstrate the versatility of this option, the front plug splitting differed somewhat from that used in the rear plug. First of all, the source regions were given a weight of one. Both in the regions which

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describe the shaft stuffing and cladding, and in those which describe the shield directly above the front plug beyond the pressure vessel, the program was directed to play Russian roulette with the particles. This is done by specifying a larger weight for the region entered than for the region the particle left. For example: for region #70, $W_\gamma = 1/4$, but as the particles entered region #122, they encounter $W_\gamma = 1$. In Program 18-0, if $W(R) < W(R')$, Russian roulette is performed. A random number, ξ, is selected and tested against $\frac{W(R)}{W(R')}$. If $\xi \leq \frac{W(R)}{W(R')}$, the particle history is continued; otherwise, it is terminated.

When region splitting is employed, caution must be exercised in specifying region weights because of a memory limitation on the number of allowable latent particles. If a particle with $W_\gamma = 1$ enters a region with $W_\gamma = 1/16$, 16 latent particles are generated. If this occurs frequently, the latent particle memory locations can be overloaded, and the program stops. A good "rule-of-thumb" to follow is not to permit weights for any two adjacent regions to differ by more than a factor of four.

For the source energy group between 2 and 4 Mev, two runs were made with splitting scheme #1 (1.6 hours per run). Monte Carlo results are given in Table 25. Sufficient statistical fluctuations existed in some of the data so that splitting scheme #2 was applied. In this scheme, an attempt was made to split throughout regions describing the shaft stuffing and cladding. Thus run #3 was not averaged with runs #1 and #2 for certain regions as shown in Table 25. Computer time for run #3 was 1.78 hours. The shaft region weights were readjusted in splitting scheme #3, and one run was made in 1.81 hours. Results were acceptable except in regions #82, #86, #91, and #96. This is not surprising since all of these except #96 are very small regions. To improve statistics in region #96, additional splitting boundaries are necessary. This problem requires further investigation in more detail.

Table 26 is presented to show the increase in the number of gamma ray particles at various current count boundaries due to splitting scheme #3 as compared to straightforward calculations.

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Scale 1/5

Figure 8

○ Region Numbers

FRONT PLUG ASSEMBLY

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TABLE 19

MATERIAL VOLUME FRACTIONS USED IN FRONT PLUG ASSEMBLY

Composition No.	Material									
	Void	Inconel-X	Al_2O_3	BeO	Hastelloy	SS304	Be	LiH	UO_2	SS301
1	0.4527			0.5327					0.0146	
2	1.0									
3	0.8486	0.1514								
4	0.12		0.88							
5	0.4245			0.5755						
6	0.456						0.544			
7	0.2422						0.7578			
8	0.2078			0.7922						
9	0.04			0.96						
10	0.0853						0.9147			
11		1.0								
12	0.20	0.06					0.74			
13	0.7725	0.1315			0.106					
14								1.0		
15	0.89									0.11
16							1.0			
17						1.0				

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TABLE 20

FRONT PLUG REGION-COMPOSITION TABLE

Region No.	Composition No.	Region No.	Composition No.
1-15	1	79	16
16	2	80-81	2
17	3	82-83	13
18	4	84-85	2
19	6	86	16
20	7	87-88	2
21	10	89-92	11
22	8	93-96	16
23	9	97-98	2
24	13	99	17
25	2	100-101	2
26	5	102	17
27	11	103	2
28	2	104	11
29-31	14	105-106	2
32	17	107	11
33	10	108-110	2
34-38	2	111	14
39	16	112	2
40-41	3	113	15
42-43	16	114	2
44-45	17	115-116	14
46-56	16	117-118	2
57-60	12	119-120	11
61-68	16	121	16
69	17	122	11
70	16	123-126	14
71-75	2	127	2
76-77	16	128	17
78	12		

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TABLE 21

GAMMA RAY ENERGY DEPOSITION IN FRONT PLUG REGIONS FROM VARIOUS SOURCE SPECTRUM ENERGY GROUPS, MEV

Number of Particles per Run: 10,000
Technique: Straightforward Sampling

Region No.	Source Spectral Energy Group, Mev					Total
	.01 - .5	.5 - 1	1 - 2	2 - 4*	4 - 7	
1	36.05	50.38	54.59	45.45	15.21	201.68
2	49.85	65.16	81.37	63.25	19.55	279.18
3	64.71	89.39	94.42	72.82	21.51	342.85
4	60.76	81.78	87.11	70.15	19.37	319.17
5	39.27	52.14	55.93	45.96	13.56	206.86
6	58.24	76.63	83.06	66.99	18.88	303.80
7	73.19	111.04	117.36	92.64	27.22	421.45
8	95.39	125.73	149.17	109.18	31.98	511.45
9	81.64	108.53	136.36	99.92	28.58	455.03
10	53.25	79.06	93.26	66.13	20.97	312.67
11	58.15	78.46	85.78	67.81	18.85	309.05
12	79.55	109.54	119.47	95.07	26.92	430.55
13	98.70	136.36	142.84	109.52	33.09	520.51
14	93.98	122.87	135.41	103.70	29.31	485.27
15	60.92	76.09	86.82	71.02	22.45	317.36
17	5.86	19.72	27.15	30.83	10.95	94.51
18	23.96	86.38	122.75	123.78	41.76	398.63
19	5.46	13.42	23.28	22.85	6.54	71.55
20	0.811	3.14	5.85	7.08	1.97	18.85
21	0.117	1.66	2.63	3.73	1.43	9.57
22	74.29	220.99	351.06	339.30	107.93	1093.57
23	15.24	58.56	115.63	152.99	57.69	400.11
24	0.551	2.46	8.05	15.59	8.45	35.10
26	7.85	20.44	31.50	32.29	8.71	100.79
27	0.237	0.907	4.17	5.55	3.39	14.25
29	0	0.175	0.398	0.900	0.789	2.26
30	0	0.314	1.89	3.49	2.39	8.08
31	0	0.625	2.55	6.17	2.45	11.80
32	0.692	2.72	6.98	10.87	5.52	26.78
33	0.127	0.633	1.87	2.78	1.14	6.55
39	0.105	1.91	1.57	2.22	0.694	6.50
40	0.284	0.453	0.306	0.369	0.106	1.52
41	0.0302	0.473	0.757	0.534	0.227	2.02
42	0.456	1.49	3.67	3.47	0.986	10.07
43	0.242	1.93	2.57	2.14	1.06	7.94
44	1.81	9.19	15.55	16.45	6.97	49.97
45	1.17	4.78	9.31	7.97	3.37	26.60
46	0.0173	0.564	1.48	2.66	0.882	5.60
47	0.0214	0.179	1.09	1.17	0.474	2.93
48	0.0349	0.489	1.37	2.81	0.633	5.34
49	0.0412	0.161	0.719	1.29	0.304	2.52
50	0	0.709	1.74	1.85	1.16	5.46
51	0	0.176	0.573	1.24	0.926	2.92
52	0	0.326	0.876	1.91	0.725	3.84
53	0	0.122	0.513	1.11	0.334	2.08

* Average of four runs from Table 23

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TABLE 21 (Contd.)

Region No.	Source Spectral Energy Group, Mev					Total
	.01 - .5	.5 - 1	1 - 2	2 - 4*	4 - 7	
54	0	0.258	0.242	0.928	0.405	1.83
55	0	0.339	0.232	0.422	0.189	1.18
56	0	0.00067	0.0767	0.288	0.302	0.667
57	0.092	0.304	1.41	1.25	0.528	3.58
58	0.246	1.41	1.89	2.44	1.75	7.74
59	0.111	0.542	1.17	1.17	0.469	3.46
60	0	0.203	0.0204	0.271	0.347	0.841
61	0.166	0.688	1.01	1.54	0.526	3.93
62	0.318	0.746	1.49	2.05	0.599	5.20
63	0.150	0.529	2.04	3.19	1.05	6.96
64	0	0.0091	0.102	0.325	0.323	0.759
65	0.0492	0.525	1.25	1.08	0.796	3.70
66	0.149	0.579	0.868	2.49	0.839	4.93
67	0.0589	0.783	1.08	1.76	0.818	4.49
68	0.0105	0.345	0.217	0.670	0.211	1.45
69	0	0.347	2.07	1.46	0.652	4.53
70	0.00083	0.101	0.0717	0.0605	0.111	0.345
76	0	0.061	0.00463	0.0749	0.0032	0.144
77	0.0074	0	0.0253	0.106	0.0803	0.219
78	0	0	0.154	0.0856	0.0626	0.302
79	0	0	0.0397	0.445	0.248	0.732
82	0	0	0	0.00473	0	0.00473
83	0.198	0.163	0.711	0.535	0.343	1.95
86	0	0	0	0.00228	0	0.00228
89	0.281	1.34	1.18	2.18	0.914	5.90
90	0	0	0	0.158	0.0033	0.161
91	0	0	0	0.00778	0.0936	0.101
92	0	0	0	0.0335	0.0989	0.132
93	0	0.315	0.823	1.09	0.629	2.86
94	0.0294	0.0756	0.223	0.729	0.632	1.69
95	0	0	0	0.00575	0.0054	0.0112
96	0	0	0	0	0	0
99	0	0	0	0.00558	0.0602	0.0658
102	0	0	0	0.123	0	0.123
104	0	0	0.00441	0.0736	0.0068	0.0848
107	0	0	0.0652	0.180	0.177	0.422
111	0	0.0015	0	0.0644	0.0058	0.0717
113	0	0.0169	0.0176	0.212	0.0960	0.343
115	0	0	0	0.111	0.0216	0.133
116	0	0	0.243	0.152	0.179	0.574
119	0	0.0289	0.0242	0.178	0.0706	0.302
120	0.204	0.846	1.65	1.76	0.932	5.39
121	0	0	0.0177	0.208	0.101	0.327
122	0.146	1.18	3.07	3.35	2.04	9.79
123	0.0488	0.858	0.671	1.91	1.01	4.50
124	0	0.352	1.21	1.76	1.16	4.48
125	0	0.0816	1.24	3.24	1.33	5.89
126	0	0.862	3.94	10.34	5.13	20.27
128	0.0219	0	0.024	0.193	0.0807	0.320

* Average of four runs from Table 23

[redacted]

[redacted]

TABLE 22

GAMMA RAY PARTICLE CURRENT IN FRONT PLUG

Number of Particles per Run: 10,000
Technique: Straightforward Sampling

Boundary No.	Source Spectral Energy Group, Mev				
	.01 - .5	.5 - 1	1 - 2	2 - 4	4 - 7
1	41	119	178	221	237
2	67	207	259	326	355
3	70	190	273	359	378
4	141	414	603	770	848
5	4	11	28	32	35
6	3	10	30	46	45
7	1	8	11	21	31
8	1	6	7	20	19
9	23	70	106	163	210
10	3	12	50	76	97
11	5	37	52	95	112
12	11	50	81	117	177
13	85	308	446	593	683
14	101	394	581	815	978
15	101	390	570	796	950
16	90	336	490	660	762
17	8	54	66	123	168
18	4	22	32	52	65
19	4	12	21	30	31
20	0	2	5	9	10
21	2	24	51	108	180
22	78	276	421	574	641
23	7	43	63	65	98
24	2	7	7	11	12
25	29	122	192	225	280
26	13	39	53	77	111
27	34	126	197	282	319
28	12	75	110	146	186
29	2	25	53	97	118
30	1	9	27	42	81
31	2	23	47	71	107
32	1	12	22	46	81
33	2	7	14	21	28
34	0	22	39	62	91
35	0	11	18	51	77
36	4	22	30	50	78
37	12	27	42	56	83
38	8	24	38	57	63
39	10	41	71	97	111
40	1	1	11	17	6
41	0	10	23	41	71
42	0	6	10	36	50
43	0	1	0	3	11
44	0	8	7	29	41
45	0	4	4	14	20

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[redacted]

TABLE 22 (Contd.)

Boundary No.	Source Spectral Energy Group, Mev				
	.01 - .5	.5 - 1	1 - 2	2 - 4	4 - 7
46	0	0	3	14	20
47	0	2	4	5	4
48	0	0	0	3	2
49	0	2	1	7	16
50	0	0	3	7	10
51	0	0	2	6	16
52	0	1	0	5	8
53	0	0	1	3	5
54	1	1	3	6	4
55	0	0	0	0	0
56	0	0	0	0	0
57	1	4	1	7	24
58	0	0	0	0	2
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	2
62	0	0	0	0	0
63	0	0	0	0	1
64	0	0	0	0	1
65	0	0	0	0	0
66	0	0	0	0	0
67	294	1010	1637	2364	2776
68	24	115	399	808	1135
69	6	53	194	508	825
70	2	31	131	381	659
71	3	32	134	380	653
72	1	40	141	417	747
73	0	6	48	111	241
74	0	14	47	158	269
75	2	23	53	106	183
76	0	5	18	47	79
77	0	5	23	37	76
78	0	1	4	13	16
79	6	21	47	63	78
80	0	1	4	10	25
81	5	45	73	129	179
82	0	0	2	6	13
83	0	0	1	1	1

[redacted]

[redacted]

TABLE 23

GAMMA RAY ENERGY DEPOSITION IN FRONT PLUG REGIONS, MEV

Number of Particles per Run: 10,000
Source Energy Spectrum: 2-4 Mev
Technique: Straightforward Sampling

Region No.	Run #1	Run #2	Average	Run #3	Average	Run #4	Average
1	44.71	43.12	43.92	47.35	45.06	46.63	45.45
2	60.60	63.04	61.82	65.83	63.15	63.52	63.25
3	73.41	77.85	75.63	66.83	72.69	73.17	72.82
4	68.59	74.03	71.31	67.42	70.01	70.54	70.15
5	44.52	45.77	45.15	48.92	46.39	44.61	45.96
6	68.15	64.73	66.44	68.89	67.19	66.21	66.99
7	88.81	96.33	92.57	86.24	90.45	99.16	92.64
8	104.44	106.12	105.28	114.61	108.38	111.54	109.18
9	95.67	97.77	96.72	100.45	97.95	105.80	99.92
10	64.97	63.02	63.91	69.93	65.97	66.59	66.13
11	68.24	68.95	68.60	62.35	66.51	71.70	67.81
12	99.89	95.89	97.89	96.04	97.26	88.47	95.07
13	109.96	112.92	111.44	109.21	110.69	105.97	109.52
14	102.35	106.35	104.35	104.08	104.25	102.02	103.70
15	65.97	75.11	70.54	71.07	70.71	71.92	71.02
17	30.71	30.87	30.79	32.22	31.26	29.51	30.83
18	122.15	125.41	123.78	120.54	122.69	127.02	123.78
19	23.00	18.68	20.84	24.79	22.15	24.92	22.85
20	7.15	7.82	7.49	6.51	7.15	6.84	7.08
21	4.24	2.86	3.55	4.08	3.73	3.75	3.73
22	355.60	340.34	347.97	337.10	344.31	324.17	339.30
23	153.61	150.13	151.87	158.66	154.12	149.54	152.99
24	16.12	14.93	15.53	15.87	15.64	15.42	15.59
26	37.25	29.84	33.55	32.23	33.10	29.87	32.29
27	6.64	4.88	5.76	4.11	5.21	6.55	5.55
29	1.23	0.925	1.08	0.478	0.877	0.967	0.900
30	3.36	3.49	3.43	3.48	3.44	3.65	3.49
31	6.87	6.95	6.91	5.88	6.57	4.97	6.17
32	11.42	10.38	10.90	10.59	10.79	11.07	10.87
33	3.02	3.06	3.04	2.86	2.98	2.19	2.78
39	2.40	2.56	2.48	1.84	2.27	2.06	2.22
40	0.279	0.241	0.260	0.547	0.356	0.411	0.369
41	0.655	0.610	0.633	0.592	0.619	0.278	0.534
42	3.09	3.61	3.35	4.44	3.71	2.75	3.47
43	2.74	1.79	2.27	1.80	2.11	2.21	2.14
44	16.46	16.15	16.31	16.94	16.52	16.25	16.45
45	6.81	8.81	7.81	8.13	7.92	8.12	7.97
46	2.43	3.56	2.99	1.97	2.65	2.69	2.66
47	1.09	1.19	1.14	1.22	1.17	1.19	1.17
48	2.59	2.85	2.72	3.51	2.98	2.29	2.81
49	0.729	1.61	1.17	1.31	1.22	1.53	1.29
50	1.92	1.87	1.90	2.03	1.94	1.57	1.85
51	1.02	1.39	1.20	1.26	1.22	1.28	1.24
52	1.62	1.67	1.65	2.03	1.77	2.30	1.91
53	1.77	0.963	1.37	0.396	1.04	1.32	1.11

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TABLE 23 (Contd.)

Region No.	Run #1	Run #2	Average	Run #3	Average	Run #4	Average
54	1.38	0.434	0.907	1.07	0.961	0.827	0.928
55	0.557	0.206	0.382	0.582	0.448	0.341	0.422
56	0.285	0.229	0.257	0.193	0.236	0.443	0.288
57	1.52	0.861	1.19	1.19	1.19	1.45	1.25
58	3.26	1.25	2.26	3.19	2.57	2.05	2.44
59	1.67	0.866	1.27	1.39	1.31	0.772	1.17
60	0.084	0.182	0.133	0.287	0.184	0.530	0.271
61	1.33	0.985	1.16	1.84	1.38	2.01	1.54
62	1.71	2.38	2.05	2.22	2.10	1.88	2.05
63	2.28	3.54	2.91	3.30	3.04	3.67	3.19
64	0.439	0.137	0.288	0.461	0.346	0.263	0.325
65	1.43	0.967	1.19	0.739	1.05	1.18	1.08
66	2.76	2.01	2.39	2.09	2.29	3.08	2.49
67	2.51	1.97	2.24	1.01	1.83	1.54	1.76
68	0.489	0.515	0.502	1.13	0.711	0.547	0.670
69	1.51	1.86	1.69	1.51	1.63	0.972	1.46
70	0.0056	0.150	0.0778	0.0677	0.0744	0.0186	0.0605
76	0.0209	0.0681	0.0445	0.210	0.0997	0.00069	0.0749
77	0.0499	0.0521	0.0510	0.0632	0.0551	0.259	0.106
78	0.271	0.0123	0.142	0.0565	0.113	0.0027	0.0856
79	0.987	0.383	0.685	0.149	0.506	0.262	0.445
82	0	0.0054	0.0027	0	0.0018	0.0135	0.00473
83	0.216	0.338	0.277	0.496	0.349	1.09	0.535
86	0.0060	0	0.0030	0.0031	0.00303	0	0.00228
89	2.14	1.71	1.93	2.26	2.04	2.59	2.18
90	0.0209	0.329	0.175	0.248	0.199	0.0336	0.158
91	0.0153	0	0.0077	0.0158	0.0129	0	0.00778
92	0	0	0	0	0	0.134	0.0335
93	1.01	1.04	1.025	0.801	0.950	1.53	1.09
94	1.28	0.467	0.874	0.631	0.793	0.539	0.729
95	0	0.023	0.0115	0	0.0077	0	0.00575
96	0	0	0	0	0	0	0
99	0.0223	0	0.0112	0	0.0074	0	0.00558
102	0.0141	0	0.0070	0.452	0.155	0.0269	0.123
104	0.139	0.0043	0.0717	0.142	0.0951	0.00905	0.0736
107	0.336	0.0199	0.178	0.231	0.196	0.134	0.180
111	0.00031	0.254	0.127	0	0.0848	0.00311	0.0644
113	0.0673	0.389	0.178	0.0179	0.125	0.472	0.212
115	0.0183	0.413	0.216	0	0.144	0.0109	0.111
116	0.171	0	0.085	0.353	0.175	0.0855	0.152
119	0.0226	0.274	0.148	0.0206	0.106	0.397	0.178
120	1.72	1.43	1.58	1.85	1.67	2.05	1.76
121	0.311	0.404	0.358	0.0376	0.251	0.0798	0.208
122	2.88	3.27	3.08	4.19	3.45	3.06	3.35
123	1.66	2.03	1.85	1.52	1.74	2.43	1.91
124	1.43	3.11	2.27	1.45	1.99	1.03	1.76
125	3.17	3.00	3.08	2.32	2.83	4.48	3.24
126	12.49	9.30	10.90	9.98	10.59	9.58	10.34
128	0.0418	0.0384	0.0401	0.638	0.239	0.0532	0.193

[redacted]

[redacted]

TABLE 24

GAMMA RAY PARTICLE WEIGHTS FOR FRONT PLUG ASSEMBLY

Splitting Scheme No. 1

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
1-18	1.0	60	.0625	78	.25
19-21	.5	61-62	.25	79-81	.0625
22-25	1.0	63	.125	82-83	.25
26	.5	64	.0625	84-87	.5
27-33	1.0	65	.5	88-98	1.0
34-40	.5	66-67	.25	99	.25
41	.25	68-69	.5	100-101	1.0
42-49	.25	70-73	.25	102	.25
50-53	.125	74	.125	103-106	1.0
54-56	.0625	75	.0625	107	.25
57-58	.25	76	.125	108-127	1.0
59	.125	77	.0625	128	.25

Splitting Scheme No. 2

Same as Scheme No. 1 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
16-18	.5	85	.125	93	.5
33	.5	86-88	.0625	94	.25
82	.0625	89	.25	95	.125
83	.125	90	.125	96-99	.0625
84	.25	91-92	.0625	100	.25

Splitting Scheme No. 3

Same as Scheme No. 2 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
33	.25	85	.0625	93	.125
82	.03125	86-88	.03125	94-96	.03125
83	.0625	89-90	.0625	98	.03125
84	.125	91-92	.03125		

[redacted]

[redacted]

TABLE 25

GAMMA RAY ENERGY DEPOSITION IN FRONT PLUG REGIONS, MEV

Number of Particles per Run: 10,000

Source Energy Spectrum: 2-4 Mev

Technique: Particle splitting on location at region boundaries

Region No.	Run No. 1 Splitting Scheme #1	Run No. 2 Splitting Scheme #1	Average	Run No. 3 Splitting Scheme #2	Average	Run No. 4 Splitting Scheme #3	Average
1	41.23	47.34	44.29	43.09	43.88	49.13	45.19
2	61.09	62.55	61.82	62.26	61.96	66.51	63.10
3	76.39	72.76	74.53	71.52	73.55	66.23	71.73
4	66.89	71.39	68.14	69.92	69.39	66.26	68.62
5	49.96	47.33	48.65	50.55	49.28	45.57	48.35
6	72.75	66.69	69.72	62.07	67.16	66.65	67.04
7	93.50	92.34	92.92	93.37	93.06	83.34	90.64
8	105.59	111.44	108.52	113.65	110.22	113.39	111.02
9	105.49	101.37	103.43	98.38	101.74	103.71	102.24
10	71.83	73.72	72.78	69.79	71.77	69.79	71.28
11	65.67	67.48	66.53	69.61	67.58	67.85	67.65
12	91.10	97.88	94.49	90.66	93.20	88.89	92.13
13	109.22	107.04	108.13	108.39	108.21	112.22	109.22
14	91.94	105.79	98.87	101.79	99.83	95.66	98.80
15	72.28	64.94	68.51	67.95	68.38	68.14	68.33
17	28.81	28.82	28.82	29.76	29.13	31.67	29.77
18	123.55	120.55	122.05	127.69	123.92	133.53	126.33
19	25.15	22.29	23.72	23.03	23.49	23.78	23.56
20	7.72	6.77	7.25	6.75	7.07	7.23	7.12
21	5.28	6.51	5.89	4.17	5.32	4.62	5.15
22	341.21	342.93	342.07	345.04	343.03	350.41	344.89
23	148.22	149.87	149.04	148.23	148.76	151.27	149.39
24	13.23	13.51	13.37	15.69	14.14	16.39	14.71
26	33.05	29.48	31.26	30.29	30.94	31.00	30.96
27	6.28	6.87	6.57	7.48	6.88	5.69	6.58
29	1.06	0.73	0.895	0.711	0.834	0.363	0.716
30	3.82	3.93	3.87	4.08	3.94	3.43	3.82
31	4.31	5.28	4.79	5.42	5.00	3.70	4.68
32	12.57	11.09	11.83	11.68	11.78	12.13	11.87
33	2.89	3.27	3.08	3.18	3.11	2.85	3.05
39	2.55	2.36	2.45	2.61	2.51	2.92	2.61
40	0.647	0.395	0.521	0.113	0.385	0.198	0.338
41	0.976	0.432	0.704	0.479	0.629	0.595	0.621
42	3.15	3.25	3.20	3.05	3.15	3.76	3.30
43	3.55	2.62	3.08	2.40	2.86	2.49	2.77
44	16.53	17.15	16.84	14.96	16.21	16.67	16.33
45	10.78	7.94	9.36	10.71	9.81	9.27	9.68
46	2.17	2.31	2.24	2.88	2.45	2.69	2.51
47	1.62	1.16	1.39	2.14	1.64	1.27	1.55
48	1.93	2.36	2.15	2.36	2.22	2.48	2.28
49	1.24	1.06	1.15	1.49	1.26	0.982	1.19
50	1.99	2.09	2.04	2.45	2.18	2.21	2.19
51	1.41	1.10	1.25	1.25	1.25	1.07	1.21
52	1.69	1.71	1.70	1.72	1.71	1.84	1.74
53	1.01	1.00	1.005	0.732	0.914	1.04	0.946

[redacted]

TABLE 25 (Contd.)

Region No.	Run No. 1 Splitting Scheme #1	Run No. 2 Splitting Scheme #1	Average	Run No. 3 Splitting Scheme #2	Average	Run No. 4 Splitting Scheme #3	Average
54	0.907	0.661	0.784	0.879	0.816	0.958	0.851
55	0.489	0.326	0.407	0.457	0.424	0.368	0.410
56	0.437	0.323	0.380	0.401	0.387	0.407	0.392
57	1.72	1.42	1.57	1.29	1.48	1.41	1.46
58	2.63	2.09	2.36	2.57	2.43	2.32	2.40
59	1.65	1.60	1.63	1.39	1.55	1.36	1.50
60	0.620	0.445	0.532	0.296	0.455	0.340	0.425
61	1.52	1.74	1.63	1.66	1.64	1.61	1.63
62	1.66	1.61	1.64	2.07	1.78	1.68	1.76
63	3.23	2.93	3.08	2.86	3.01	2.79	2.95
64	0.418	0.279	0.348	0.373	0.357	0.235	0.326
65	1.41	2.05	1.73	1.61	1.69	1.00	1.52
66	1.66	2.16	1.91	2.59	2.14	1.57	1.99
67	1.32	1.29	1.31	1.55	1.39	1.59	1.44
68	0.694	1.17	0.932	0.643	0.836	0.744	0.813
69	1.66	1.42	1.54	2.49	1.86	1.05	1.66
70	0.0937	0.127	0.110	0.132	0.118	0.100	0.113
76	0.157	0.102	0.129	0.136	0.132	0.0640	0.115
77	0.179	0.125	0.152	0.179	0.161	0.0890	0.143
78	0.0378	0.0472	0.0425	0.137	0.0739	0.0165	0.0596
79	0.261	0.285	0.273	0.258	0.268	0.299	0.276
82	0	0.00866	0.00422	0.0035	---	0.0103	0.0069
83	0.816	0.474	0.645	0.419	---	0.496	0.458
86	0.0068	0.0378	0.0223	0.0040	---	0.0159	0.0099
89	2.48	1.57	2.02	1.63	---	1.91	1.77
90	0.0021	0.113	0.0575	0.0422	---	0.0283	0.0353
91	0.0322	0	0.0162	0.0042	---	0.0384	0.0213
92	0.00846	0	0.00432	0.0158	---	0.0286	0.0222
93	1.94	0.765	1.35	1.17	---	1.15	1.16
94	1.15	0.509	0.829	0.706	---	0.593	0.649
95	0.0747	0	0.0373	0.0745	---	0.0322	0.0534
96	0.0696	0	0.0348	0	---	0.0133	0.00665
99	0.0527	0	0.0263	0.0301	---	0.00272	0.0164
102	0.0053	0.0054	0.0054	0.0047	0.0051	0.0105	0.00648
104	0.0053	0.0278	0.0165	0	0.0110	0.0109	0.0110
107	0.249	0.0766	0.162	0.188	0.171	0.0386	0.138
111	0.0142	0.0049	0.0095	0.116	0.0449	0.241	0.0941
113	0.461	0.143	0.302	0.345	0.316	0.438	0.347
115	0.0776	0	0.0288	0.0354	0.0377	0	0.0283
116	0.205	0.744	0.474	0.565	0.505	0.371	0.471
119	0.0317	0.0559	0.0438	0.271	0.119	0.0233	0.0955
120	1.40	2.26	1.83	1.27	1.64	1.82	1.69
121	0.146	0.072	0.109	0.562	0.259	0.861	0.410
122	3.36	4.83	4.09	3.67	3.95	3.31	3.79
123	1.38	3.53	2.45	1.37	2.09	2.06	2.09
124	1.69	2.61	2.15	1.31	1.87	1.52	1.78
125	2.09	2.76	2.42	2.41	2.42	3.49	2.69
126	8.89	10.62	9.75	8.63	9.38	9.29	9.36
128	0.198	0.163	0.181	0.120	0.160	0.108	0.147

[redacted]

TABLE 26

EFFECT OF REGION SPLITTING ON GAMMA RAY PARTICLE CURRENT IN FRONT PLUG ASSEMBLY

Number of Particles per Run: 10,000

Source Energy Spectrum: 2-4 Mev

Boundary No.	Straight Forward	Splitting Scheme #3
1	221	220
2	326	352
3	359	302
4	770	1528
5	32	80
6	46	78
7	21	99
8	20	31
9	163	166
10	76	87
11	95	171
12	117	265
13	593	1181
14	815	1625
15	796	1596
16	660	1327
17	123	222
18	52	171
19	30	166
20	9	15
21	108	101
22	574	1148
23	65	149
24	11	48
25	225	495
26	77	190
27	282	1110
28	146	608
29	97	399
30	42	219
31	71	402
32	46	207
33	21	70
34	62	339
35	51	173
36	50	225
37	56	252
38	57	177
39	97	394
40	17	67
41	41	439
42	36	247
43	3	37
44	29	219
45	14	99
46	14	78
47	5	41
48	3	12
49	7	170
50	7	72
51	6	98
52	5	69
53	3	50
54	6	32
55	0	6
56	0	5
57	7	80
58	0	46
59	0	8
60	0	2
61	0	13
62	0	6
63	0	1
64	0	1
65	0	4
66	0	3
67	2364	2368
68	808	727
69	508	455
70	381	331
71	380	330
72	417	368
73	111	90
74	158	138
75	106	104
76	47	42
77	37	43
78	13	9
79	63	205
80	10	167
81	129	249
82	6	93
83	1	33

[redacted]

6. ENTIRE REACTOR-SHIELD ASSEMBLY

The entire reactor-shield assembly was described for several reasons:

1. to determine the effect on computer time,
2. to study the feasibility of obtaining energy-angle bin distribution data, and
3. to investigate the "escape" tape option recently incorporated in the code.

When the "escape" tape option is used, the spatial coordinates of the escape point on the surface of the assembly, together with the energy and direction cosines at escape, are written on tape for each escaping particle. Program 18-0 is able to accept such a tape as input and continue the history of each particle listed provided that the new region description does not affect the region number or weight of the escape particle.

Presented in Figure 9 is the geometrical configuration which describes the entire XNJ140E-1 reactor-shield assembly. Two hundred and one convex quadrilaterals rotated about the reactor axis were used. The front plug and side shield descriptions were the same as described in Section 5 except for a change in the beryllium volume fraction in the shaft stuffing. Several changes were made in the rear plug configuration as follows:

1. the shielding in front of the bearing (Regions #178, #179, and #180) was changed from beryllium to stainless steel,
2. a design change was inserted as Region #168,
3. the shaft stuffing and cladding were described in more detail with a decrease in the beryllium volume fraction, and
4. the beryllium volume fraction in several rear plug regions farthest from the source was changed due to a memory limitation for the allowable number of compositions.

Table 27 contains the material volume fractions for this configuration. Table 28 contains the composition applicable to each region. A listing of the actual input data is given in Appendix D.

To verify the geometry input data and to determine computer times, one straightforward run was made consisting of 10,000 source particles in the source spectrum energy range of 2 to 4 Mev. This run required 1.58 hours as compared to 1.3 hours for the front plug, and one hour for the rear plug assembly. It is certainly more feasible to describe the entire shield in

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one problem, provided of course, the program user feels that the region description is adequate. Results from this run, presented in Table 29, compare favorably with similar data for the separate front and rear plug assemblies. Certain anticipated variations in the Monte Carlo results occurred due to the shield changes previously described.

The use of region splitting not only in a "directional" sense, but also to increase the number of particles escaping the entire reactor-shield assembly was investigated. The region weights applicable to the gamma ray particles for various splitting schemes are given in Table 30.

Approximately 1000 source particles between source energies 2 and 4 Mev were run with splitting scheme #1. Computer times estimates for 10,000 histories based on this run were prohibitive. The region weights throughout the lithium hydride were reduced, and another run was made for 1000 source particles with splitting scheme #2. Again, time estimates were very high. Apparently, a great deal of time is required to follow the histories in the lithium hydride because of the number of scatterings needed to reduce the particle's energy sufficiently for termination by absorption or by some cut-off value.

Splitting scheme #3 was then used in which the weights for the side shielding were again decreased. Two runs were made consisting of 10,000 gamma ray particles with source energies between 2 and 4 Mev. Computer time was 3.91 hours per run. Energy deposition data for these two runs (#2 and #3), given in Table 29, show excellent statistical agreement.

Since a large part of the computation time involves following histories through the inner shield assembly described in Section 2, the advantage of using the "escape" tape option was investigated. Regions #1 through #34 inclusive (Figure 9) were described as a separate problem. One run (Run #4) for 10,000 gamma ray particles between source energies of 2 and 4 Mev with splitting scheme #3 was made in 1.62 hours. Parameters for those particles leaving the assembly were placed on a tape. This tape was used as a source tape to Program 18-0 for a problem in which the entire reactor-shield assembly was described. One such run was made in 2.61 hours. Results are given in Table 29. It is interesting to note that back-scattering into the inner shield regions was not an important contributor to the total energy deposition in those regions.

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The "escape" tape option is a powerful tool in applying the Monte Carlo method to complex shield analysis. In the case of gamma ray histories, acceptable statistics can easily be obtained in the inner shield. Once the inner shield energy deposition data and escaping particles are established, the escape tape can be applied as many times as desired to the remainder of the shield where design changes are generally required.

Once adequate heating rates are obtained in the inner shield system, the regions can be homogenized in such a way as to make more regions available for the outer shield assembly. For example, in Figure 9, regions 1 through 15 describing the core could have been homogenized into one region. Thus an additional 14 regions could be used in the lithium hydride or elsewhere in the shield.

Table 31 is presented to illustrate the increase in the number of gamma ray particles at various current count boundaries due to splitting scheme #3 as compared to straightforward calculations.

Although application of splitting scheme #3 resulted in reliable energy deposition data, it was also interesting to see if the same scheme could produce reliable energy-angle bin distribution data. For runs #2, #3, and #4, energy-angle bin output data were obtained for nineteen unequally spaced energy bins between 0.01 and 4 Mev, and for twelve equally spaced angle bins between 0 and 180 degrees. The angle refers to a point source equivalent to the reactor-shield assembly where zero degrees refers to the rear of the shield. Results for each run for all bins, as well as the average, are given in Table 32 in units of the number of gamma ray particles in an angle bin, $\Delta\theta$, and energy bin, ΔE. Statistical fluctuations indicate that additional region splitting boundaries are required in the side shielding which will effect a substantial increase in computer time.

In Table 33 the energy-angle bin data were coalesced into four energy bins. The last column in this table is the average number of gamma ray particles per unit solid angle in a given $\Delta\theta$ bin in energy bin ΔE. These data are quantitatively more meaningful than those given in Table 32 as they show the relative importance of each angle bin. This quantity was obtained by dividing the number of particles in each $\Delta\theta$ bin by $\overline{\sin\theta}$, the sine of the average angle, θ, for the particular bin. Division by $\Delta\theta$ was not necessary because $\Delta\theta$, in this case, is a constant value. Also, it was only desired to examine the relative shape of the particle distribution. In Table 34, the data were coalesced into one energy bin to illustrate more clearly the significance of each angle bin.

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Program 18-0 computes the energy-angle distribution by adding the weight of a particle leaking from the assembly to a tally for the appropriate energy-angle bin. If three particles escape at an angle of 20° anywhere in the shield surface, each having a weight of .25, then a total of .75 particles would be tallied in the angle bin of 15° to 30°.

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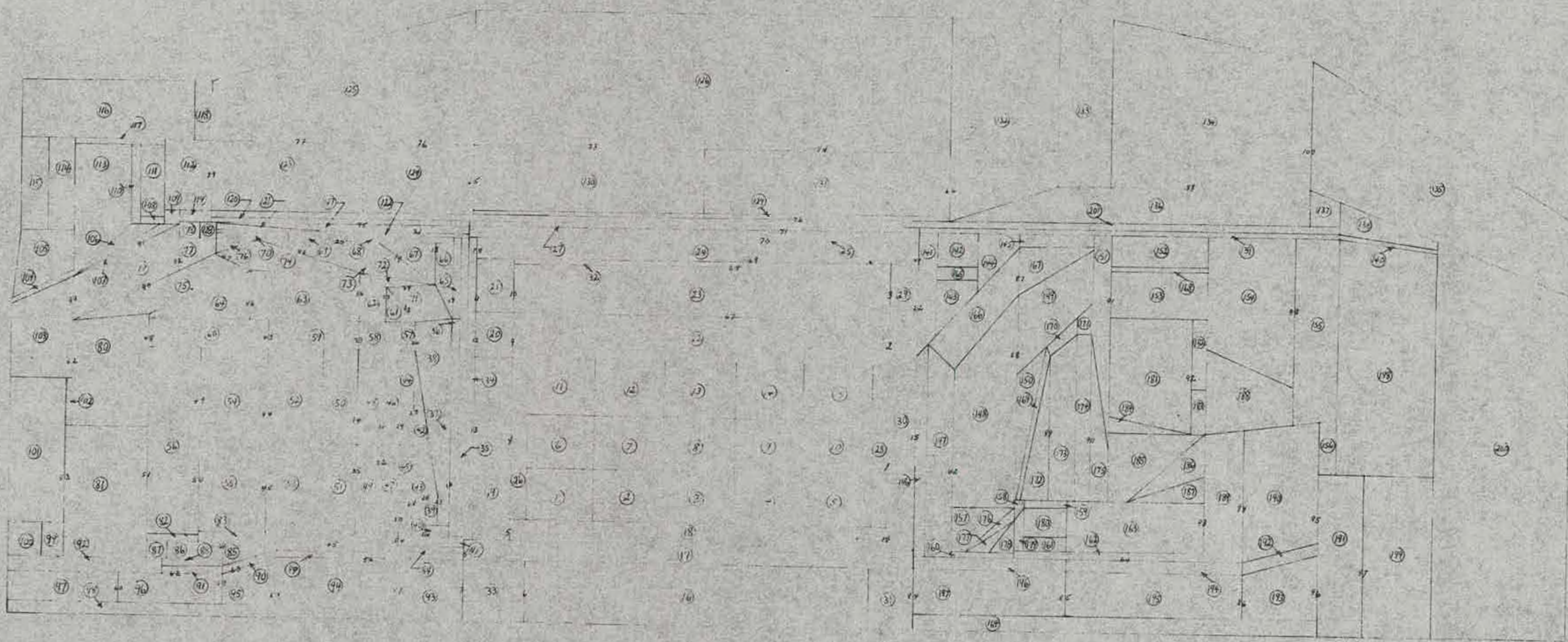

Scale 1/5

Figure 9

Entire Reactor Shield Assembly

○ Region Numbers

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TABLE 27

MATERIAL VOLUME FRACTIONS FOR ENTIRE REACTOR-SHIELD ASSEMBLY

Composition No.	Material									
	Void	Inconel-X	Al_2O_3	BeO	Hastelloy	SS304	Be	LiH	UO_2	SS301
1	0.4527			0.5327					0.0146	
2	1.0									
3	0.8486	0.1514								
4	0.12		0.88							
5	0.4255			0.5755						
6	0.456						0.544			
7	0.2422						0.7578			
8	0.2078			0.7922						
9	0.04			0.96						
10	0.0853						0.9147			
11		1.0								
12	0.20	0.06					0.74			
13	0.7725	0.1315			0.106					
14								1.0		
15	0.89									0.11
16							1.0			
17						1.0				
18	0.843	0.033			0.124					
19	0.7804				0.2196					
20	0.50	0.50								

[redacted]

TABLE 28

ENTIRE REACTOR-SHIELD ASSEMBLY REGION-COMPOSITION TABLE

Region No.	Composition No.	Region No.	Composition No.
1-15	1	102	17
16	2	103	2
17	3	104	11
18	4	105-106	2
19	6	107	11
20	7	108-110	2
21	10	111	14
22	8	112	2
23	9	113	15
24	13	114	2
25	2	115-116	14
26	5	117-118	2
27	11	119-120	11
28	5	121	16
29	19	122	11
30	18	123-126	14
31	7	127	2
32	17	128	11
33	7	129-135	14
34-38	2	136-164	2
39	16	165-167	16
40-41	3	168	17
42-43	16	169-171	3
44-45	17	172-175	16
46-56	16	176	20
57-60	12	177	3
61-68	16	178-180	17
69	17	181	16
70	16	182	7
71-75	2	183	3
76-77	16	184	20
78	12	185	16
79	16	186	3
80-81	2	187	16
82	11	188-189	10
83	20	190	16
84-85	2	191	6
86	16	192	20
87-88	2	193	7
89-92	11	194	20
94-96	7	195	7
97-98	2	196	20
99	17	197	7
100-101	2	198-201	2

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TABLE 29

GAMMA RAY ENERGY DEPOSITION IN ENTIRE REACTOR-SHIELD ASSEMBLY REGIONS, MEV

Number of Histories per Run: 10,000
Source Energy Spectrum: 2-4 Mev
Technique: Straightforward Sampling and
Particle Splitting on Location at Region Boundaries

Region No.	Run #1 Straight Forward	Run #2 Splitting Scheme #3	Run #3 Splitting Scheme #3	Average *	Run #4 Splitting Scheme #3	Run #4 From Escape Tape	Average
1	50.01	43.83	47.36	45.59	45.88	--	45.64
2	64.54	65.03	60.56	62.79	65.31	--	63.57
3	73.10	71.05	76.67	73.86	72.37	--	73.29
4	73.75	72.41	72.78	72.59	73.96	--	72.98
5	48.40	51.13	43.98	47.56	47.07	--	47.35
6	70.89	73.96	62.13	68.05	71.46	--	69.11
7	90.51	87.58	91.02	89.30	89.95	--	89.43
8	108.71	114.10	113.24	113.67	104.59	--	110.53
9	110.48	94.99	101.57	98.28	104.84	--	100.37
10	68.02	68.65	69.82	69.24	72.08	--	70.11
11	66.25	71.87	70.15	71.01	66.12	--	69.31
12	80.60	90.65	90.65	90.65	91.78	--	90.94
13	103.10	115.66	110.98	113.32	107.91	--	111.41
14	104.90	92.54	104.35	98.45	95.28	--	97.29
15	68.20	68.65	72.41	70.53	72.73	--	71.19
17	28.61	32.91	33.11	33.01	29.56	0.20	31.89
18	121.90	125.70	134.55	130.13	123.28	--	127.88
19	25.81	23.59	24.76	24.18	21.79	0.34	23.47
20	8.02	7.38	7.63	7.51	6.11	0.16	7.09
21	3.52	4.02	4.42	4.22	4.54	0.16	4.38
22	360.00	345.43	349.63	347.53	335.77	0.15	343.32
23	157.21	157.88	148.99	153.44	158.52	0.23	155.05
24	15.15	16.86	16.14	16.50	16.45	0.58	16.66
26	29.70	30.17	28.59	29.38	30.76	0.13	29.85
27	5.85	7.48	6.88	7.18	5.63	0.25	6.74
28	30.00	28.39	27.26	27.83	30.15	--	28.57
29	3.69	4.63	4.27	4.45	3.31	0.24	4.15
30	32.43	34.57	31.92	33.25	34.76	0.67	33.94
31	1.87	2.36	2.12	2.24	2.42	--	2.29
32	11.65	11.80	10.58	11.19	12.12	--	11.49
33	2.85	2.98	2.08	2.53	2.28	--	2.44
39	2.42	3.21	2.49	2.85	--	2.09	2.59
40	0.189	0.320	0.342	0.331	--	0.374	0.345
41	0.331	0.756	0.939	0.848	--	0.973	0.888
42	2.19	2.67	3.22	2.95	--	3.06	2.98
43	2.58	2.35	2.59	2.47	--	2.47	2.47
44	14.35	16.78	17.13	16.96	--	16.92	16.93
45	9.16	7.78	10.54	9.16	--	8.70	8.99
46	1.76	2.37	2.10	2.24	--	2.77	2.41
47	1.09	1.23	1.33	1.28	--	1.05	1.20
48	2.18	2.16	2.43	2.29	--	2.74	2.44
49	1.89	1.20	1.51	1.36	--	1.32	1.34
50	2.26	2.19	2.12	2.16	--	2.26	2.19
51	1.60	1.25	1.38	1.32	--	0.925	1.18
52	1.67	1.64	1.64	1.64	--	1.86	1.71
53	1.21	0.887	1.02	0.954	--	0.845	0.916
54	0.949	0.788	0.892	0.840	--	0.911	0.863
55	0.585	0.466	0.617	0.542	--	0.431	0.504
56	0.823	0.464	0.359	0.412	--	0.369	0.397
57	1.38	1.57	1.44	1.50	--	1.29	1.43
58	2.97	2.31	2.47	2.39	--	2.34	2.37
59	1.65	1.61	1.54	1.58	--	1.57	1.57
60	0.436	0.358	0.495	0.427	--	0.461	0.438
61	1.58	1.54	1.56	1.55	--	1.45	1.52
62	2.04	1.33	1.47	1.40	--	1.38	1.39
63	3.23	2.59	2.95	2.77	--	2.81	2.78
64	0.0444	0.257	0.294	0.276	--	0.279	0.276
65	2.27	1.31	1.11	1.21	--	1.39	1.27
66	1.71	1.95	2.27	2.11	--	2.49	2.23
67	0.685	1.68	1.97	1.83	--	2.27	1.97
68	0.758	0.763	0.672	0.718	--	0.947	0.793
69	1.99	1.55	1.51	1.53	--	1.36	1.47
70	0.0242	0.135	0.0767	0.106	--	0.0902	0.101
76	0.0086	0.0726	0.0529	0.0628	--	0.0713	0.0656
77	0.0152	0.139	0.139	0.139	--	0.132	0.137
78	0.0184	0.0598	0.0214	0.0406	--	0.0264	0.0358
79	0.435	0.268	0.287	0.277	--	0.227	0.259
82	0	0.033	0.0376	0.0353	--	0.0109	0.0271
83	0.785	1.19	0.977	1.08	--	0.812	0.992
86	0.142	0.0104	0.0362	0.0233	--	0.0199	0.0221

* Average of Runs #2 and #3

[redacted]

[redacted]

TABLE 29 (Contd.)

Region No.	Run #1 Straight Forward	Run #2 Splitting Scheme #3	Run #3 Splitting Scheme #3	Average*	Run #4 Splitting Scheme #3	Run #4 From Escape Tape	Average
89	2.24	2.86	2.79	2.83	--	2.70	2.78
90	0.0785	0.086	0.0865	0.0863	--	0.0504	0.0742
91	0.00712	0.0545	0.0332	0.0439	--	0.0266	0.0381
92	0.298	0.033	0.0253	0.0292	--	0.0144	0.0242
93	1.01	1.33	1.17	1.25	--	1.27	1.26
94	1.07	0.666	0.859	0.763	--	0.708	0.744
95	0.0545	0.0667	0.0409	0.0538	--	0.0472	0.0515
96	0	0.0185	0.0107	0.0146	--	0.0157	0.0149
99	0	0.0122	0.0064	0.0093	--	0.0192	0.0125
102	0	0.0213	0.0209	0.0211	--	0.0206	0.0209
104	0.0154	0.0431	0.0537	0.0484	--	0.0407	0.0458
107	0.051	0.153	0.175	0.164	--	0.166	0.165
111	0.0362	0.0569	0.0590	0.0579	--	0.0508	0.0555
113	0.0322	0.173	0.134	0.154	--	0.113	0.140
115	0.162	0.0149	0.041	0.0279	--	0.0259	0.0272
116	0.412	0.371	0.337	0.354	--	0.369	0.359
119	0.295	0.0832	0.0697	0.0765	--	0.0923	0.0817
120	2.32	1.82	2.24	2.03	--	2.64	2.23
121	0.322	0.109	0.0775	0.0933	--	0.118	0.101
122	2.78	3.43	3.63	3.53	--	3.25	3.43
123	2.21	1.99	1.87	1.93	--	2.07	1.97
124	1.89	1.49	2.29	1.89	--	2.03	1.93
125	2.93	2.98	3.11	3.04	--	3.15	3.08
126	9.34	11.51	10.68	11.09	--	11.18	11.11
128	0.0705	0.215	0.142	0.179	--	0.191	0.182
129	1.58	1.22	1.04	1.13	--	1.28	1.18
130	5.45	5.54	4.37	4.96	--	5.33	5.07
131	5.64	5.44	5.01	5.23	--	5.30	5.25
132	4.92	5.10	3.76	4.42	--	4.72	4.52
133	1.11	2.32	1.35	1.84	--	1.98	1.88
134	7.18	6.29	5.61	5.95	--	6.85	6.24
135	2.51	2.07	2.25	2.16	--	2.96	2.42
139	5.51	5.75	4.97	5.36	--	6.47	5.72
140	0.338	0.359	0.342	0.342	--	0.572	0.418
165	0.835	1.05	1.69	1.37	--	1.05	1.26
166	10.35	9.63	8.54	9.09	--	9.02	9.05
167	1.57	2.13	1.38	1.76	--	1.69	1.73
168	1.86	1.87	1.77	1.82	--	1.69	1.77
169	3.29	2.92	3.1[illegible]	3.02	--	3.03	3.02
170	1.54	0.899	1.26	1.08	--	1.30	1.15
171	0.416	0.494	0.525	0.509	--	0.619	0.545
172	4.59	4.19	4.75	4.47	--	4.65	4.53
173	8.55	8.50	6.72	7.61	--	8.53	7.91
174	3.71	3.81	3.22	3.52	--	3.87	3.63
175	1.42	1.65	1.18	1.42	--	2.21	1.68
176	1.83	1.07	1.38	1.23	--	1.08	1.18
177	0.584	0.503	0.552	0.528	--	0.463	0.505
178	2.24	1.94	3.31	2.63	--	2.28	2.51
179	1.29	0.909	1.48	1.19	--	1.63	1.34
180	3.14	2.73	2.61	2.67	--	2.79	2.71
181	3.45	5.55	5.44	5.50	--	7.40	6.12
182	0.405	0.174	0.164	0.169	--	0.201	0.179
183	0.0719	0.105	0.115	0.110	--	0.152	0.124
184	1.39	1.25	1.29	1.27	--	1.16	1.23
185	1.74	2.05	1.73	1.89	--	2.11	1.96
186	0.0805	0.437	0.381	0.409	--	0.418	0.412
187	0.134	0.422	0.418	0.420	--	0.369	0.403
188	0.872	1.00	0.728	0.864	--	0.662	0.796
189	0.475	0.615	0.709	0.662	--	0.834	0.719
190	0.695	0.927	0.834	0.881	--	0.927	0.895
191	0.0322	0.0894	0.0701	0.0798	--	0.139	0.0994
192	0.114	0.0722	0.0599	0.0661	--	0.241	0.124
193	0.515	0.0414	0.0476	0.0445	--	0.0799	0.0562
194	0.425	0.544	0.577	0.561	--	0.991	0.703
195	0.0155	0.237	0.209	0.223	--	0.293	0.246
196	2.95	2.99	3.93	3.46	--	4.44	3.78
197	1.28	1.67	2.15	1.91	--	2.09	1.97

* Average of Runs #2 and #3

[redacted]

TABLE 30

GAMMA RAY PARTICLE WEIGHTS FOR ENTIRE REACTOR-SHIELD ASSEMBLY

Splitting Scheme No. 1

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
1-15	2	71	.5	139	.25
16-17	.5	72-73	.25	140	.0625
18	1	74	.125	141-150	.5
19-21	.5	75	.0625	151-153	.25
22	1	76-78	.125	154-155	.125
23	.5	79-81	.0625	156	.0625
24-25	.25	82	.03125	157-161	.5
26	1	83-84	.125	162-164	.25
27	.25	85	.0625	165-167	.5
28	1	86-88	.03125	168	.25
29-40	.5	89	.125	169-170	.5
41-49	.25	90	.0625	171	.25
50-53	.125	91-92	.03125	172-173	.5
54-56	.0625	93-95	.0625	174-175	.25
57-58	.25	96-97	.03125	176-180	.5
59	.125	98-119	.0625	181-187	.25
60	.0625	120-122	.25	188-190	.125
61-62	.25	123-126	.0625	191	.0625
63	.125	127	.25	192-193	.125
64	.0625	128-129	.125	194-195	.25
65	.5	130-135	.0625	196-197	.5
66-69	.25	136-137	.125	198-200	.0625
70	.125	138	.0625	201	.125

Splitting Scheme No. 2

Same as Scheme No. 1 except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
24-25	.5	118-119	.125	136-137	.25
27	.5	123-126	.125	138	.125
109	.125	129	.25	140	.125
112	.125	130-135	.125	201	.25

Splitting Scheme No. 3

Same as previous scheme except the following:

Region No.	W_γ	Region No.	W_γ	Region No.	W_γ
16-17	1	27	.5	123-126	.25
18	2	32	1	130-135	.25
22	2	108	.125	138	.25
23	1	112	.125	140	.25
24-25	.5	118	.125		

[redacted]

TABLE 31

EFFECT OF REGION SPLITTING ON GAMMA RAY PARTICLE CURRENT IN ENTIRE REACTOR-SHIELD ASSEMBLY

Number of Histories per Run: 10,000
Source Energy Spectrum: 2-4 Mev

Boundary No.	Straight Forward	Splitting Scheme #3	Boundary No.	Straight Forward	Splitting Scheme #3
1	723	1428	51	6	214
2	156	163	52	3	154
3	70	159	53	3	85
4	777	1488	54	7	48
5	33	38	55	15	122
6	31	84	56	26	333
7	22	124	57	15	391
8	12	35	58	1	72
9	186	156	59	1	26
10	84	151	60	0	3
11	81	347	61	3	16
12	144	552	62	0	10
13	584	2261	63	1	16
14	35	45	64	19	104
15	601	2358	65	30	203
16	654	2555	66	28	251
17	122	481	67	2499	2408
18	47	386	68	757	1554
19	43	310	69	489	971
20	93	743	70	392	1491
21	87	855	71	395	1510
22	39	238	72	638	5129
23	76	292	73	158	1286
24	18	48	74	160	1294
25	242	872	75	90	851
26	91	356	76	43	381
27	248	2104	77	40	364
28	166	1124	78	7	39
29	88	776	79	7	96
30	75	410	80	14	424
31	88	727	81	9	173
32	74	385	82	4	64
33	29	180	83	2	50
34	72	612	84	24	93
35	62	323	85	1	21
36	65	376	86	2	3
37	59	485	87	32	162
38	59	202	88	421	1706
39	98	393	89	227	1015
40	13	156	90	173	1558
41	14	37	91	232	1869
42	425	1647	92	27	291
43	2	71	93	10	76
44	22	378	94	22	269
45	19	243	95	5	103
46	8	155	96	2	9
47	5	86	97	5	71
48	2	31	98	29	621
49	9	299	99	129	942
50	5	186	100	54	285

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[redacted]

TABLE 32

ENERGY-ANGLE BIN DISTRIBUTION DATA

Number of Gamma Ray Source Particles: 10,000 per Run
Source Energy: 2 to 4 Mev
Technique: Particle Splitting on Location at Region Boundaries
Units: Number of Gamma Ray Particles

Angle Bin, degrees	Energy Bin: .01 to .02 Mev				Energy Bin: .02 to .03 Mev				Energy Bin: .03 to .04 Mev				Energy Bin: .04 to .06 Mev			
	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average
165°-180°	0	0	0	0	0.25	0	0	0.0833	0.0625	0.1875	0.0625	0.1041	0.375	0.4063	0.25	0.3434
150°-165°	0.50	1.0625	0.3125	0.6244	1.125	0.75	1.625	1.1655	1.75	0.9375	0.875	1.1863	1.75	1.125	1.6875	1.5193
135°-150°	1.0	0.6875	[illegible]	0.6452	2.625	2.625	1.9375	2.3934	2.625	2.0	1.5625	2.0604	3.375	3.25	4.0625	3.5589
120°-135°	1.5625	1.75	0.25	1.1863	3.4375	4.3125	4.5625	4.1001	5.0	3.5625	4.9375	4.4955	4.8125	5.375	4.625	4.9326
105°-120°	1.75	2.25	1.75	1.9148	6.625	4.75	5.8125	5.7234	5.5625	4.6875	5.25	5.1615	5.75	9.3125	9.875	8.3042
90°-105°	2.75	2.25	2.25	2.4143	3.75	5.75	5.0	4.8285	6.25	9.5625	5.50	7.0971	7.8125	7.875	8.0	7.8879
75°-90°	2.25	1.3125	1.50	1.6858	6.375	5.8125	5.75	5.9732	6.75	4.50	5.50	5.5778	8.375	7.25	10.0625	8.5539
60°-75°	2.50	0.75	1.50	1.5818	6.5625	3.50	5.0	5.0158	5.5625	3.50	3.8125	4.2874	5.875	6.25	10.0625	7.3884
45°-60°	1.50	1.8125	1.25	1.5193	3.6875	3.875	5.8125	4.4539	3.50	3.50	2.3125	3.1011	6.125	3.6875	4.375	4.7244
30°-45°	1.00	0.50	0.25	0.5828	2.8125	1.1875	2.3125	2.1021	2.625	3.1875	2.0625	2.6224	2.1875	1.75	3.6875	2.5391
15°-30°	0.25	0.4375	1.0	0.5619	0.875	0	0.75	0.5411	1.625	1.25	1.75	1.5401	1.4375	1.4375	1.5625	1.4777
0°-15°	0	0	[illegible]	0.0833	0.25	0.4375	0.5625	0.4163	0	0.25	0.9375	0.3954	0	0.625	0.50	0.3746

Angle Bin, degrees	Energy Bin: .06 to .08 Mev				Energy Bin: .08 to .10 Mev				Energy Bin: .1 to .2 Mev				Energy Bin: .2 to .3 Mev			
	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average
165°-180°	0.3125	0.3125	0.25	0.2914	0	0.0625	0.0625	0.0416	0.1875	0.5625	0.3125	0.3538	0.125	0.0625	0.4375	0.2081
150°-165°	0.25	1.0	0.75	0.6667	0.9375	1.4688	0.0875	1.0927	[illegible]1875	2.375	1.50	2.0188	0.6875	0.4375	0.75	0.6244
135°-150°	[illegible]	3.3125	2.0625	2.2061	2.1875	1.375	3.125	2.2269	5.5625	3.5938	5.0	4.7140	1.4375	2.875	2.50	2.2686
120°-135°	4.6875	[illegible]125	4.0	3.6006	3.0625	2.8438	3.375	3.0906	6.8125	7.375	9.8125	8.0000	5.9375	3.5625	7.125	5.5361
105°-120°	5.9375	3.5625	5.9375	5.1407	3.8125	2.625	3.9375	3.4549	7.00	11.6875	13.0635	10.57[illegible]8	3.8125	4.4375	6.375	4.8701
90°-105°	7.1875	6.0	6.375	6.5143	4.75	4.25	5.50	4.8285	10.125	12.8125	11.125	11.2406	7.0625	5.375	4.8125	5.7443
75°-90°	5.125	3.5625	6.5625	5.0783	5.1875	3.6875	3.0625	3.9752	9.8125	13.5625	14.5625	12.6332	7.9375	7.0625	5.5625	6.8473
60°-75°	3.125	4.125	5.125	4.1209	4.50	3.9375	4.50	4.3082	13.75	8.6875	11.1875	11.1971	4.875	5.50	4.9375	5.0991
45°-60°	2.625	3.125	4.8125	3.5173	2.9375	3.25	2.50	2.8929	8.75	6.5	9.9375	8.3874	6.00	4.6875	6.5875	5.7859
30°-45°	3.6875	[illegible]3125	1.8125	[illegible].6016	1.1875	2.375	2.625	2.0604	7.375	5.25	3.875	5.4945	[illegible].625	2.25	3.6875	2.8513
15°-30°	1.1875	3.25	2.0	[illegible].1437	0.875	1.75	1.125	1.2488	2.75	4.375	3.625	3.5798	2.625	2.875	[illegible].1875	2.5599
0°-15°	0.375	0.50	0.625	0.5000	0.4375	0.1875	0.125	0.2500	0.875	1.0625	1.0	0.978[illegible]	1.125	1.50	1.50	1.3736

Angle Bin, degrees	Energy Bin: .3 to .4 Mev				Energy Bin: .4 to .6 Mev				Energy Bin: .6 to .8 Mev				Energy Bin: .8 to 1 Mev			
	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average
165°-180°	0.0625	0.125	0.25	0.1457	0.125	0.4688	0.1875	0.2602	0.125	0.375	0.375	0.2914	0.125	0.4375	0.1875	0.2500
150°-165°	0.5625	1.3125	0.9375	0.9366	1.125	1.4375	1.125	1.2279	0.9375	1.0625	1.1875	1.0614	1.25	0.6875	0.3125	0.3746
135°-150°	1.3125	[illegible].0625	[illegible]	2.0000	3.4375	3.375	4.0	3.6003	0.8125	2.125	1.9375	1.6234	2.25	2.25	2.1875	2.2269
120°-135°	3.5625	3.3125	2.75	3.2051	6.9375	5.0	4.5625	5.[illegible]945	5.375	2.6875	3.5625	3.8711	2.1875	1.5625	3.5625	2.4351
105°-120°	[illegible]	3.625	4.875	4.0168	7.75	7.375	7.50	7.5341	4.625	5.1875	5.50	5.0991	3.6875	1.4375	3.125	3.7463
90°-105°	3.75	5.375	6.1875	5.0991	10.0	7.8125	10.25	9.3448	6.0625	6.0	5.0625	5.7026	6.0	6.375	6.625	6.3270
75°-90°	5.6125	4.75	4.4375	5.0000	11.9375	7.625	7.0625	8.8661	7.5	6.75	5.75	6.6667	6.0	2.50	4.25	4.2458
60°-75°	2.3125	4.0625	4.8125	3.7254	8.5625	9.3125	11.875	9.3068	5.75	5.5625	5.25	5.5153	5.75	5.5	5.0	5.4113
45°-60°	4.4375	3.[illegible]375	4.5625	[illegible].1417	4.875	7.25	7.875	6.6667	[illegible].75	4.875	7.0625	5.5569	4.0	4.25	3.25	3.8295
30°-45°	3.625	2.3125	3.9375	3.2884	3.50	3.0625	3.75	3.4341	3.875	2.875	4.4375	3.6919	1.5625	4.125	4.1875	3.2884
15°-30°	1.625	1.75	1.5625	1.6441	3.75	2.8125	3.375	3.3092	2.125	3.0	3.9375	3.0178	2.9375	1.0	3.125	2.3518
0°-15°	0.5625	0.25	0.375	0.3954	0.6875	0.75	1.125	0.8533	2.00	0.375	4.125	2.1645	0.5625	0.375	0.3125	0.4163

Angle Bin, degrees	Energy Bin: 1 to 1.25 Mev				Energy Bin: 1.25 to 1.5 Mev				Energy Bin: 1.5 to 1.75 Mev				Energy Bin: 1.75 to 2 Mev			
	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average
165°-180°	0.375	0.50	0.5625	0.4787	0.1875	0.4375	0.25	0.[illegible]914	0.3125	0.1875	0.1875	0.2289	0.3125	0.125	0.3125	0.2498
150°-165°	0.875	1.0625	0.25	0.7284	0.1875	0.75	0.375	0.4371	0.75	0.6875	0.4375	0.6244	0.4375	0.625	0.50	0.4870
135°-150°	1.375	0.875	1.1875	1.1447	1.5	1.375	0.75	1.2071	1.125	1.375	1.125	1.2071	1.375	1.125	0.75	1.0823
120°-135°	3.875	2.625	2.0	2.8305	1.4375	1.4375	3.3125	2.0604	2.5625	2.0	3.8125	2.7889	1.4375	2.625	1.50	1.8523
105°-120°	4.0	4.25	4.1875	4.1417	4.0	2.5625	2.8125	3.1219	1.5	3.5625	1.8125	2.2894	3.0	2.50	2.0	2.4975
90°-105°	5.3125	6.9375	2.8125	5.0158	2.5	3.25	5.75	3.8295	1.75	4.8125	3.75	4.4331	2.75	4.0	2.5	3.0803
75°-90°	7.5	6.75	5.75	6.6667	6.0	2.50	4.25	4.2458	4.75	3.50	2.75	3.6630	6.25	3.5	3.75	4.4955
60°-75°	5.75	5.0	6.0	5.5828	3.5	5.75	4.0	4.4123	5.0	4.50	5.0	4.8295	3.25	3.25	3.5	3.3333
45°-60°	5.0625	4.5	4.375	4.6412	5.25	4.75	3.3125	4.4331	4.3125	5.25	4.25	4.5996	5.0	3.5	4.8125	4.4331
30°-45°	2.75	3.625	3.125	3.1635	5.5625	1.5625	2.8125	3.3092	2.1875	4.0	5.375	3.8503	2.125	2.25	2.6875	2.3518
15°-30°	1.25	2.3125	2.375	1.9772	2.4375	1.25	2.8125	2.1645	1.0	1.0625	3.0625	2.3726	1.375	2.6875	2.125	2.0604
0°-15°	1.375	2.0	0.625	1.3333	0.875	0.375	1.875	1.0406	0.8125	0	0.50	0.4371	0.25	1.1875	1.375	0.9366

Angle Bin, degrees	Energy Bin: 2 to 2.5 Mev				Energy Bin: 2.5 to 3 Mev				Energy Bin: 3 to 4 Mev			
	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average	Run #2	Run #3	Run #4	Average
165°-180°	0.4375	0.3125	0.375	0.3746	0.375	0.3125	0.50	0.3954	0.4375	0.4375	0.75	0.5411
150°-165°	0.875	1.125	1.0	1.0000	1.125	0.4375	0.3125	0.6244	0.4375	0.3125	0.6875	0.4787
135°-150°	2.0	1.625	2.0	1.8731	1.5	1.25	1.25	1.3333	3.375	1.6875	3.8125	2.9554
120°-135°	6.5	5.125	7.375	6.3270	4.8125	3.25	4.5625	4.2041	4.25	3.9375	7.0	5.0574
105°-120°	6.8125	6.0	8.0	6.9306	4.75	4.50	7.0	5.4113	4.25	8.5	4.25	5.6610
90°-105°	7.5	6.0	8.25	7.2428	8.0	7.75	8.25	8.0000	11.0	5.25	4.75	7.0000
75°-90°	8.25	7.0	7.0	7.4093	7.0	5.25	3.5	5.2500	5.75	6.0	5.50	5.7443
60°-75°	9.0	7.25	10.25	8.8245	6.0	3.25	6.5	5.2500	9.25	6.25	6.50	7.3260
45°-60°	10.5	12.5	12.50	11.8215	7.0	8.50	8.0	7.8255	8.25	6.5	9.50	8.0753
30°-45°	8.25	4.0	7.3125	6.5143	4.75	6.375	6.3125	5.8067	8.0	5.25	9.75	7.6590
15°-30°	5.375	3.75	6.9375	5.3488	3.0	3.3125	2.125	2.8097	3.4375	2.5	5.375	3.7670
0°-15°	3.125	2.8125	2.50	2.8097	1.5	2.375	1.4375	1.7691	2.0	1.25	2.0	1.7483

[redacted]

[redacted]

TABLE 33

COALESCED ENERGY-ANGLE BIN DISTRIBUTION DATA

Units: See footnote

Angle Bin, degrees	Coalesced Energy Bin: .01 to .1 Mev						Total*	Total** sin θ
	Original Energy Bin, Mev							
	.01-.02	.02-.03	.03-.04	.04-.06	.06-.08	.08-.10		
165°-180°	0	0.0833	0.1041	0.3434	0.2914	0.0416	0.8638	6.618
150°-165°	0.6244	1.1655	1.1863	1.5193	0.6667	1.0927	6.2549	16.345
135°-150°	0.6452	2.3934	2.0604	3.5589	2.2061	2.2269	13.0909	21.503
120°-135°	1.1863	4.1001	4.4955	4.9326	3.6006	3.0906	21.4057	26.979
105°-120°	1.9148	5.7234	5.1615	8.3042	5.1407	3.4549	29.6995	32.165
90°-105°	2.4143	4.8285	7.0971	7.8879	6.5143	4.8285	33.5706	33.859
75°-90°	1.6858	5.9732	5.5778	8.5539	5.0783	3.9752	30.8443	31.109
60°-75°	1.5818	5.0158	4.2874	7.3884	4.1209	4.3082	26.7025	28.919
45°-60°	1.5193	4.4539	3.1011	4.7244	3.5173	2.8929	20.2089	25.471
30°-45°	0.5828	2.1021	2.6224	2.5391	2.6016	2.0604	12.5084	20.546
15°-30°	0.5619	0.5411	1.5401	1.4777	2.1437	1.2488	7.5133	19.632
0°-15°	0.0833	0.4163	0.3954	0.3746	0.5000	0.2500	2.0196	15.472

Angle Bin, degrees	Coalesced Energy Bin: .1 to .6 Mev				Total*	Total** sin θ
	Original Energy Bin, Mev					
	.1-.2	.2-.3	.3-.4	.4-.6		
165°-180°	0.3538	0.2081	0.1457	0.2602	0.9678	7.414
150°-165°	2.0188	0.6244	0.9366	1.2279	4.8077	12.563
135°-150°	4.7140	2.2686	2.0000	3.6006	12.5832	20.669
120°-135°	8.0000	5.5361	3.2051	5.4945	22.2357	28.026
105°-120°	10.5728	4.8701	4.0168	7.5341	26.9938	29.234
90°-105°	11.2406	5.7443	5.0991	9.3448	31.4288	31.699
75°-90°	12.6332	6.8473	5.0000	8.8661	33.3466	33.633
60°-75°	11.1971	5.0991	3.7254	9.9068	29.9284	32.412
4 °-60°	8.3874	5.7859	4.1417	6.6667	24.9817	31.487
30°-45°	5.4945	2.8513	3.2884	3.4341	15.0683	24.751
15°-30°	3.5798	2.5599	1.6441	3.3092	11.0930	28.986
0°-15°	0.9782	1.3736	0.3954	0.8533	3.6005	27.583

Angle Bin, degrees	Coalesced Energy Bin: .6 to 2 Mev						Total*	Total** sin θ
	Original Energy Bin, Mev							
	.6-.8	.8-1	1-1.25	1.25-1.5	1.5-1.75	1.75-2		
165°-180°	0.2914	0.2500	0.4787	0.2914	0.2289	0.2498	1.7902	13.715
150°-165°	1.0614	0.3746	0.7284	0.4371	0.6244	0.4870	3.7129	9.702
135°-150°	1.6234	2.2269	1.1447	1.2071	1.2071	1.0823	8.4915	13.948
120°-135°	3.8711	2.4351	2.8305	2.0604	2.7889	1.8523	15.8383	19.963
105°-120°	5.0991	3.746	4.1417	3.1219	2.2894	2.4975	20.8959	22.630
90°-105°	5.7026	6.3270	5.0158	3.8295	4.4331	3.0803	28.3883	28.632
75°-90°	8.3874	4.5788	6.6667	4.2458	3.6630	4.4955	32.0372	32.313
60°-75°	5.5153	5.4113	5.5828	5.5828	4.4123	3.3333	29.0835	31.497
45°-60°	5.5569	3.8295	4.6412	4.4331	4.5996	4.4331	27.4934	34.642
30°-45°	3.6919	3.2884	3.1635	3.3092	3.8503	2.3518	19.3851	31.830
15°-30°	3.0718	2.3518	1.9772	2.1645	2.3726	2.0604	13.9443	36.436
0°-15°	2.1645	0.4163	1.3333	1.0406	0.4371	0.9366	6.3284	48.482

Angle Bin, degrees	Coalesced Energy Bin: 2 to 4 Mev			Total*	Total** sin θ
	Original Energy Bin, Mev				
	2-2.5	2.5-3	3-4		
165°-180°	0.3746	0.3954	0.5411	1.3111	10.044
150°-165°	1.0000	0.6244	0.4787	2.1031	5.496
135°-150°	1.8731	1.3333	2.9554	6.1618	10.118
120°-135°	6.3270	4.2041	5.0574	15.5885	19.642
105°-120°	6.9306	5.4113	5.6610	18.0029	19.497
90°-105°	7.2428	8.0000	7.0000	22.2428	22.421
75°-90°	7.4093	5.2500	5.7443	18.4036	18.562
60°-75°	8.8245	5.2500	7.3260	21.4005	23.177
45°-60°	11.8215	7.8255	8.0753	27.7223	34.941
30°-45°	6.5143	5.8067	7.6590	19.9800	32.819
15°-30°	5.3488	2.8097	3.7670	11.9255	31.161
0°-15°	2.8097	1.7691	1.7483	6.3271	48.472

Units: * Number of gamma ray particles in a $\Delta\theta$ ΔE bin.

** Average number of gamma ray particles per unit solid angle in a $\Delta\theta$ ΔE bin.

[redacted]

TABLE 34

ANGLE BIN DISTRIBUTION DATA

Units: See footnote

Angle Bin, degrees	Coalesced Energy Bin: .01 to 4 Mev — Original Energy Bin, Mev				Total*	$\frac{\text{Total**}}{\sin\theta}$
	.01-.1	.1-.6	.6-2	2-4		
165°-180°	0.8638	0.9678	1.7902	1.3111	4.9329	37.791
150°-165°	6.2549	4.8077	3.7129	2.1031	16.8786	44.099
135°-150°	13.0909	12.5832	8.4915	6.1618	40.3274	66.218
120°-135°	21.4057	22.2357	15.8383	15.5885	75.0682	94.616
105°-120°	29.6995	26.9938	20.8959	18.0029	95.5921	103.526
90°-105°	33.5706	31.4288	28.3883	22.2428	115.6305	116.625
75°-90°	30.8443	33.3466	32.0372	18.4036	114.6317	115.548
60°-75°	26.7025	29.9284	29.0835	21.4005	107.1149	116.005
45°-60°	20.2089	24.9817	27.4934	27.7223	100.4063	126.552
30°-45°	12.5084	15.0683	19.3851	19.9800	66.9418	109.959
15°-30°	7.5133	11.0930	13.9443	11.9255	44.4761	116.216
0°-15°	2.0196	3.6005	6.3284	6.3271	18.2756	140.009

Units:

* Number of gamma ray particles in a $\Delta\theta$ ΔE bin.

** Average number of gamma ray particles per unit solid angle in a $\Delta\theta$ ΔE bin.

[redacted]

7. COMPARISON OF MONTE CARLO AND POINT KERNEL CORE GAMMA HEATING IN THE XNJ140E-1 REACTOR-SHIELD

Mr. E. P. Jacobs performed calculations necessary for a comparison of Monte Carlo gamma ray heating rates with those obtained with Shielding Computer Program 14-0 at various positions in the XNJ140E-1 reactor-shield.

Program 14-0 employs the point kernel method to calculate gamma heating at point detector locations. Those presented here are for core gamma heating only; no heating due to secondary gammas is included. To obtain comparable heating rates, it was necessary to integrate the heating rate curve from the point kernel method over a region or regions of interest, and to apply appropriate conversion factors.

Point kernel calculations throughout the entire reactor-shield assembly were not available for comparison. In Table 35 are presented results for regions in the front and rear plugs and in the side shield where axial and radial traverses were made using the kernel method. Agreement at all positions is excellent. The total heating rate comparisons are amazingly good considering that two entirely different methods were applied.

[redacted]

TABLE 35

COMPARISON OF GAMMA RAY ENERGY DEPOSITION DUE TO CORE GAMMA RAYS USING MONTE CARLO AND POINT KERNEL METHODS

Front Plug

Region No.*	Gamma Ray Energy Deposition Watts/MW		Monte Carlo / Point Kernel
	Point Kernel	Monte Carlo	
39, 42, 43	2.09×10^{2}	2.07×10^{2}	0.991
44, 45	5.83×10^{2}	6.29×10^{2}	1.078
46, 47	8.20×10^{1}	6.91×10^{1}	0.843
48, 49	7.27×10^{1}	5.83×10^{1}	0.802
50, 51	6.53×10^{1}	6.83×10^{1}	1.046
52, 53	4.97×10^{1}	5.24×10^{1}	1.054
54, 55	2.40×10^{1}	3.00×10^{1}	1.250
56	6.65×10^{0}	6.66×10^{1}	1.002
65	3.41×10^{1}	3.33×10^{1}	0.997
66	5.29×10^{1}	4.33×10^{1}	0.819
67	4.85×10^{1}	4.33×10^{1}	0.893
69	3.71×10^{1}	3.83×10^{1}	1.032
TOTAL	1.265×10^{3}	1.279×10^{3}	1.011

Rear Plug

Region No.**	Gamma Ray Energy Deposition Watts/MW		Monte Carlo / Point Kernel
	Point Kernel	Monte Carlo	
52, 53, 54	4.39×10^{2}	3.70×10^{2}	0.843
35	2.00×10^{2}	1.65×10^{2}	0.825
57	4.10×10^{1}	3.38×10^{1}	0.824
TOTAL	6.80×10^{2}	5.688×10^{2}	0.836

Side Shield

Region No.*	Gamma Ray Energy Deposition Watts/MW		Monte Carlo / Point Kernel
	Point Kernel	Monte Carlo	
29	1.74×10^{1}	2.16×10^{1}	1.242
30	7.04×10^{1}	6.62×10^{1}	0.941
31	7.81×10^{1}	1.04×10^{2}	1.332
126	1.61×10^{2}	1.87×10^{2}	1.161
TOTAL	3.269×10^{2}	3.788×10^{2}	1.159

Shaft Stuffing

Region No.*	Gamma Ray Energy Deposition Watts/MW		Monte Carlo / Point Kernel
	Point Kernel	Monte Carlo	
93	2.16×10^{1}	2.33×10^{1}	1.080

* Region numbers refer to those in Figure 8.

** Region numbers refer to those in Figure 7.

[redacted]

8. CONCLUSIONS

This study yielded valuable information regarding utilization of the Specialized Monte Carlo code in obtaining gamma ray energy deposition data in an actual reactor-shield assembly due to core gamma rays. The knowledge gained can be summarized as follows:

1. It is feasible to describe the entire reactor-shield assembly in one problem.
2. The use of the "escape" tape option decreases the amount of computer time required for analysis of the reactor-shield.
3. The gamma ray fission spectrum should be handled in several energy groups.
4. Region splitting must be applied judiciously to obtain adequate energy-angle bin distribution data.
5. Particle current counts are a valuable guide in determining region weights.

Acceptable energy deposition data due to core gamma rays for the entire reactor-shield assembly for the five source energy groups described here using region splitting can be obtained in about 47 hours on the IBM-704 digital computer. This time estimate does not include time necessary to obtain reliable energy-angle bin distribution data. To obtain such data, computer time should be increased by a factor of two or three. This estimate is based on 10,000 source particles in each run. A study should be made to determine the adequacy of 5000 source particles.

Recommendations made in this report for use of Program 18-0 do not imply optimum use of the code. They do, however, offer a means of obtaining reliable data in a reasonable amount of time, thus demonstrating the feasibility, in the case of core gamma rays, of the Monte Carlo approach. Additional detailed studies should be made in the future to determine optimum use of the code.

9. APPENDICES

A. Source Generator Input Data Listing for Shielding Computer Program 20-0

B. Input Data Listing for Rear Plug Assembly for Specialized Reactor-Shield Monte Carlo Program 18-0

C. Input Data Listing for Front Plug Assembly

D. Input Data Listing for Entire Reactor-Shield Assembly

NOTE: The geometry input data in these listings do not conform to the input format specified in the report describing Program 18-0. The Program 18-0 report implies the use of Shield Region Data Converter Program 20-7 which was not available at the time this study was made.

APPENDIX A. SOURCE GENERATOR INPUT DATA FOR PROGRAM 20-0

```
KNAME,3,M A CAPO
KDATE,3,JULY 20 1960
KKIND,6,D140 CORE GAMMA SPECTRUM
MCLPT,35,0,
MNE,35,77,1,
LPOFE,13.2871,18.2871,12.2871,28.2871,10.2871,9.2871,
 9.2871,10.0871,10.4871,11.2871,13.2871,16.2871,18.2871,
 13.2871,15.7871,18.2871,14.5302,12.8233,11.8733,10.9733,
 10.3233,9.5833,9.0333,8.5333,8.0433,7.5733,6.50528,
 5.48725,4.864795,4.22234,3.98234,3.67234,2.87689,2.46689,
 2.26689,2.17689,1.93282,1.71974,1.504135,1.27353,1.13515,
 1.00377,.92177,.85977,.76385,.67093,.62993,.59493,
 .52667,.44141,.39141,.35741,.25052,.15362,.13062,
 .11162,.067489,.04236,.04136,.036361,.0501625,.058692,
 .055692,.054692,.0302325,.006773,.004773,.001773,.001839,
 .001905,.001905,.001905,.00119985,4.947/-4,4.947/-4,4.947/-4,
 4.947/-4,
LUORES,.01,.015,.02,.03,.04,.05,
 .06,.07,.08,.09,.1,.15,.2,
 .25,.3,.35,.4,.45,.5,.55,
 .6,.65,.7,.75,.8,.85,.9,
 .95,1,1.1,1.2,1.3,1.4,1.5,
 1.6,1.7,1.8,1.9,2.0,2.1,2.2,
 2.3,2.4,2.5,2.6,2.7,2.8,2.9,
 3,3.25,3.5,3.75,4,4.25,4.5,
 4.75,5,5.25,5.5,5.75,6,6.25,
 6.5,6.75,7,7.25,7.5,7.75,8,
 8.25,8.5,8.75,9,9.25,9.5,9.75,
 10,
LEW,10,
MN,35,10000,200,1,0,
LWE,1,
MMC,35,1,49,1,28,1,
MNTYT,35,1001,
LPOFT,1,
LPOFZ,.805,.79,.78,.758,.736,.721,
 .698,.71,.723,.748,.775,.805,.843,
 .891,.95,.995,1.04,1.08,1.12,1.16,
 1.19,1.23,1.26,1.28,1.292,1.3,1.302,
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[redacted]

[redacted]

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 .9458,.9537,.9646,.98,1.00175,1.0323,1.102,
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MRNOS,35,1,1,1,1,1,1,1,1,1,6,6,6,6,6,6,6,6,6,11,11,
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[redacted]

[redacted]


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*TAPEN,35,7,
8
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APPENDIX

B. PROGRAM 18-0 INPUT DATA FOR REAR PLUG ASSEMBLY

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MVCR,35,0,2,0,0,1,0,0,0,
MVNORD,35,92,16,71,12,0,25,
LVREDS,1,21.872,-38.1,21.872,-22.5,33.872,-22.5,33.872,-38.1,      REDS1A
 0,1147.312384,0,1147.312384,1,1,1,2,0,0,0,0,                      REDS1B
 18,2,6,0,                                                         REDS1E
 2,3,0,0,                                                          REDS1G
 1,21.872, 22.5,21.872,-7.5,33.872,-7.5,33.872,-22.5,              REDS2A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                      REDS2B
 18,3,7,1,                                                         REDS2E
 2,3,0,1,                                                          REDS2G
 1,21.872, 7.5,21.872,7.5,33.872,7.5,33.872,-7.5,                  REDS3A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                      REDS3B
 18,4,8,2,                                                         REDS3E
 2,3,0,1,                                                          REDS3G
 1,21.872,7.5,21.872,22.5,33.872,22.5,33.872,7.5,                  REDS4A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                      REDS4B
 18,5,9,3,                                                         REDS4E
 2,3,0,1,                                                          REDS4G
 1,21.872,22.5,21.872,38.1,33.872,38.1,33.872,22.5,                REDS5A
 0,1147.312384,0,1147.312384,1,4,1,1,0,0,0,0,                      REDS5B
 18,19,10,4,                                                       REDS5E
 2,3,0,1,                                                          REDS5G
 1,33.872, 38.1,33.872,-22.5,45.872,-22.5,45.872,-38.1,            REDS6A
 0,2104.2404,0,2104.2404,1,1,1,2,0,0,0,0,                          REDS6B
 1,7,11,0,                                                         REDS6F
 2,3,0,0,                                                          REDS6G
 1,33.872, 22.5,33.872,-7.5,45.872,-7.5,45.872,-22.5,              REDS7A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                          REDS7B
 2,8,12,6,                                                         REDS7E
 2,3,0,1,                                                          REDS7G
 1,33.872, 7.5,33.872,7.5,45.872,7.5,45.872,-7.5,                  REDS8A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                          REDS8B
 3,9,13,7,                                                         REDS8E
 2,3,0,1,                                                          REDS8G
 1,33.872,7.5,33.872,22.5,45.872,22.5,45.872,7.5,                  REDS9A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                          REDS9B
 4,10,14,8,                                                        REDS9E
 2,3,0,1,                                                          REDS9G
 1,33.872,22.5,33.872,38.1,45.872,38.1,45.872,22.5,                REDS10A
 0,2104.2404,0,2104.2404,1,5,1,1,0,0,0,0,                          REDS10B
 5,19,15,9,                                                        REDS10E
 2,3,0,1,                                                          REDS10G
 1,45.872, 38.1,45.872,-22.5,57.15,-22.5,57.15,-38.1,              REDS11A
 0,3266.1225,0,3266.1225,1,1,1,2,0,0,0,0,                          REDS11B
 6,12,22,0,                                                        REDS11E
 2,3,0,0,                                                          REDS11G
 1,45.872, 22.5,45.872,-7.5,57.15,-7.5,57.15,-22.5,                REDS12A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                          REDS12B
 7,13,22,11,                                                       REDS12E
 2,3,0,1,                                                          REDS12G
 1,45.872, 7.5,45.872,7.5,57.15,7.5,57.15,-7.5,                    REDS13A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                          REDS13B
 8,14,22,12,                                                       REDS13E
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2,3,0,1,                                                          REDS13G
1,45.872,7.5,45.872,22.5,57.15,22.5,57.15,7.5,                    REDS14A
0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0;                          REDS14B
9,15,22,13,                                                       REDS14E
2,3,0,1,                                                          REDS14G
1,45.872,22.5,45.872,38.1,57.15,38.1,57.15,22.5,                  REDS15A
0,3266.1225,0,3266.1225,1,6,1,1,0,0,0,0,                          REDS15B
10,19,22,14,                                                      REDS15F
2,3,0,1,                                                          REDS15G
2,0,-38.1,0,38.1,13.0175,38.1,13.0175,-38.1,                      REDS16A
0,169.45531,0,169.45531,0,68,1,2,0,0,0,0,                         REDS16B
0,27,17,0,                                                        REDS16E
0,3,0,0,                                                          REDS16G
3,13.0175,-38.1,13.0175,48.26,17.323,48.26,17.323,-38.1,          REDS17A
0,300.08633,0,300.08633,1,67,1,2,1,1,1,0,                         REDS17B
38.1,252.1744,41.91,                                              REDS17C
16,27,28,29,18,20,0,                                              REDS17E
2,2,3,3,0,0,0,                                                    REDS17G
4,17.323, 38.1,17.323,41.91,21.872,41.91,21.872,-38.1,            REDS18A
0,478.38438,0,478.38438,1,66,1,2,0,0,5,0,                         REDS18B
 22.5,-7.5,7.5,22.5,38.1,                                         REDS18C
17,20,1,2,3,4,5,19,0,                                             REDS18F
2,3,0,0,0,0,0,0,0,
5,21.872,38.1,21.872,41.91,57.15,41.91,57.15,38.1,                REDS19A
0,3266.1225,0,3266.1225,1,7,1,1,0,0,0,2,                          REDS19B
1147.3128,210-.2404,                                              REDS19C
18,20,22,5,10,15,                                                 REDS19F
2,3,0,1,1,1,                                                      REDS19G
6,17.323,41.91,17.323,48.26,67.31,48.26,67.31,41.91,              REDS20A
0,4530.6361,0,4530.6361,1,8,1,1,0,1,0,2,                          REDS20B
3456.0994,478.38438,3266.1225,                                    REDS20C
17,29,30,21,18,19,22,                                             REDS20E
2,3,3,0,1,1,1,                                                    REDS20G
7,67.31,41.91,67.31,48.26,79.68,48.26,79.68,41.91,                REDS21A
0,6348.9024,0,6348.9024,1,9,1,1,0,0,0,0,                          REDS21B
20,30,24,23,                                                      REDS21E
2,3,0,1,                                                          REDS21G
8,57.15,-38.1,57.15,41.91,67.31,41.91,67.31,-38.1,                REDS22A
0,4530.6361,0,4530.6361,1,52,1,2,5,0,0,0,                         REDS22B
 22.5,-7.5,7.5,22.5,38.1,                                         REDS22C
11,12,13,14,15,19,20,23,0,                                        REDS22E
2,2,2,2,2,2,3,0,0,                                                REDS22G
9,67.31,-38.1,67.31,41.91,79.68,41.91,79.68,-38.1,                REDS23A
0,6348.9024,0,6348.9024,1,53,1,2,0,0,0,0,                         REDS23B
22,21,24,0,                                                       REDS23F
2,3,0,0,                                                          REDS23G
13,79.68, 38.1,79.68,48.26,83.82,48.26,83.82,-38.1,               REDS24A
0,7025.7924,0,7025.7924,1,54,1,2,1,0,0,0,                         REDS24B
41.91,                                                            REDS24C
23,21,30,25,0,                                                    REDS24E
2,2,3,0,0,                                                        REDS24G
3,83.82,-38.1,83.82,48.26,88.65,48.26,88.65,-38.1,                REDS25A
0,7858.8225,0,7858.8225,1,55,1,2,0,2,0,0,                         REDS25B
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7475.3316,7569,                                                      REDS25C
24,30,63,62,26,0,                                                    REDS25E
2,3,3,3,0,0,                                                         REDS25G
14,88.65, 38.1,88.65,54.61,133.12,54.61,133.12,-38.1,                REDS26A
0,17720.934,0,17720.934,1,56,2,2,1,0,0,0,                            REDS26B
48.26,                                                               REDS26C
25,62,70,0,0,                                                        REDS26E
2,2,3,0,0,                                                           REDS26G
12,0,38.1,0,120.4,13.0175,120.4,13.0175,38.1,                        REDS27A
0,169.45531,0,169.45531,0,47,1,1,0,0,1,0,                            REDS27B
48.26,                                                               REDS27C
0,86,17,28,16,                                                       REDS27E
0,3,0,0,1,                                                           REDS27G
15,13.0175,48.26,13.0175,120.4,15.88,120.4,15.88,48.26,              REDS28A
0,252.1744,0,252.1744,72,48,1,1,0,0,4,0,                             REDS28B
50.8,56.64,70.36,111.96,                                             REDS28C
27,85,29,36,41,48,83,17,                                             REDS28E
2,3,0,0,0,0,0,1,                                                     REDS28G
2,15.88,48.26,15.88,50.8,61.6,50.8,58.788599,48.26,                  REDS29A
0,3794.56,1.1068507,3456.0994,1,11,1,1,0,0,0,1,                      REDS29B
300.08633,                                                           REDS29C
28,36,30,17,20,                                                      REDS29E
2,3,0,1,1,                                                           REDS29G
2,58.788599,48.26,62.728988,51.82,86.46,51.82,86.46,48.26,           REDS30A
1.1068507,7475.3316,0,7475.3316,1,10,1,1,1,2,0,3,                    REDS30B
50.8,5768.4025,6280.5625,4530.6361,6348.9024,7025.7924,              REDS30C
29,35,31,32,33,63,20,21,24,25,                                       REDS30E
2,2,3,3,3,0,1,1,1,1,                                                 REDS30G
2,62.728988,51.82,72.889878,61,75.95,61,75.95,51.82,                 REDS31A
1.1068507,5768.4025,0,5768.4025,1,17,1,1,0,0,0,0,                    REDS31B
35,34,32,30,                                                         REDS31E
2,3,0,1,                                                             REDS31G
16,75.95,51.82,75.95,61,79.25,61,79.25,51.82,                        REDS32A
0,6280.5625,0,6280.5625,1,16,1,1,0,0,0,0,                            REDS32B
31,34,33,30,                                                         REDS32E
2,3,0,1,                                                             REDS32G
2,79.25,51.82,79.25,61,86.46,61,86.46,51.82,                         REDS33A
0,7475.3316,0,7475.3316,1,15,1,1,0,0,0,0,                            REDS33B
32,34,63,30,                                                         REDS33E
2,3,0,1,                                                             REDS33G
2,72.889877,61,83.25,70.36,86.46,70.36,86.46,61,                     REDS34A
1.1068507,7475.3316,0,7475.3316,1,49,1,1,0,0,0,2,                    REDS34B
5768.4025,6280.5625,                                                 REDS34C
35,58,63,31,32,33,                                                   REDS34E
2,3,0,1,1,1,                                                         REDS34G
16,56.69,56.64,73.66,70.36,83.25,70.36,61.6,50.8,                    REDS35A
1.2368805,6930.5625,1.1068507,-.84075342,1,14,1,1,0,0,2,0,           REDS35B
51.82,61,                                                            REDS35C
37,57,30,31,34,36,                                                   REDS35E
2,3,0,0,0,2,                                                         REDS35G
2,15.88,50.8,15.88,56.64,56.69,56.64,61.6,50.8,                      REDS36A
0,3213.7561,-.84075342,3794.56,1,12,1,1,0,2,0,0,                     REDS36B
280.8976,713.9584,                                                   REDS36C
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28,41,38,37,35,29,                                                    REDS36E
2,3,3,3,3,1,                                                          REDS36G
2,26.72,56.64,26.72,70.36,73.66,70.36,56.69,56.64,                    REDS37A
0,5425.7955,1.2368805,3213.7561,1,13,1,1,0,2,0,0,                     REDS37B
802.0224,3296.1097,                                                   REDS37C
38,43,50,56,35,36,                                                    REDS37E
2,3,3,3,0,1,                                                          REDS37G
2,16.76,56.64,16.76,58.5,26.72,70.36,26.72,56.64,                     REDS38A
0,.83979764,0,713.9584,1,1,1,1,0,0,0,0,                               REDS38B
41,39,37,36,                                                          REDS38E
2,2,0,1,                                                              REDS38G
15,16.76,58.5,24.2,70.36,26.72,70.36,16.76,58.5,                      REDS39A
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40,43,38,0,                                                           REDS39E
2,3,1,0,                                                              REDS39G
3,16.76,58.5,16.76,63,24.2,70.36,16.76,58.5,                          REDS40A
0,1.0108696,.62731872,0,1,1,1,1,0,0,0,0,                              REDS40B
41,42,39,0,                                                           REDS40E
2,2,0,0,                                                              REDS40G
2,15.88,56.64,15.88,70.36,16.76,70.36,16.76,56.64,                    REDS41A
0,280.8976,0,280.8976,1,1,1,1,0,0,2,0,                                REDS41B
58.5,63,                                                              REDS41C
28,48,38,40,42,36,                                                    REDS41E
2,3,0,0,0,1,                                                          REDS41G
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293.7796,
41,48,44,40,0,                                                        REDS42E
2,3,3,1,0,                                                            REDS42G
2,24.2,70.36,26.72,72.39,28.32,72.39,28.32,70.36,                     REDS43A
1.2413793,802.0224,0,802.0224,1,19,1,1,0,0,1,1,                       REDS43B
71.76,585.64,                                                         REDS43C
44,45,51,52,39,37,                                                    REDS43E
2,3,0,0,1,1,                                                          REDS43G
16,17.14,70.36,17.14,72.39,26.72,72.39,24.2,70.36,                    REDS44A
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423.1249,                                                             REDS44C
48,47,46,43,42,                                                       REDS44E
2,3,3,0,1,                                                            REDS44G
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77.6,                                                                 REDS45C
46,49,52,53,43,                                                       REDS45E
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47,49,45,44,                                                          REDS46E
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48,49,46,44,                                                          REDS47E
2,3,0,1,                                                              REDS47G
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51,0,56,37,                                                             REDS50E
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43,52,59,50,                                                            REDS51E
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81.4,                                                                   REDS53C
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49,78,61,54,                                                            REDS55E
2,3,0,1,                                                                REDS55G
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57,61,63,34,                                                            REDS58E
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2,3,0,2,                                                                REDS59G
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54.61,                                                                      REDS62C
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25,                                                                         REDS63F
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68,92,73,66,                                                                REDS67E
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90,92,67,63,                                                                REDS68E
2,3,0,1,                                                                    REDS68G
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108.92,                                                                     REDS69C
74,75,81,63,61,                                                             REDS69E
2,2,3,0,1,                                                                  REDS69G
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64,71,0,26,                                                                 REDS70E
2,3,0,1,                                                                    REDS70G
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65,72,0,70,                                                                 REDS71E
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65,73,0,71,                                                           REDS72E
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139.57,161.67,                                                        REDS73C
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2845.1556,                                                            REDS74C
76,77,75,69,61,                                                       REDS74E
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3794.56,                                                              REDS75C
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78,82,75,74,                                                          REDS77E
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120.4,2845.1556,                                                      REDS82C
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.96593,1,                                                         VWZ11
KVNAME,3,M A CAPO                                                 NAME
KVDATE,3,OCT 3 1960                                               DATE
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0,0,0,0,0,                                                          1P2
246.52,36.26,11.5,4.94,1.58,.779,.475,.178,.134,.115,               1P3
.0948,.0823,.0739,.0658,.0603,.0559,.0526,.0481,.0451,.0413,        1P3
.0394,.0383,.0377,.0374,.0374,                                      1P3
56.67,7.17,2.45,1.28,.748,.607,.544,.423,.366,.327,                 1P4
.276,.243,.218,.195,.178,.165,.153,.136,.124,.108,                  1P4
.0976,.0903,.085,.0812,.0783,                                       1P4
6.46,.952,.473,.349,.289,.265,.249,.204,.177,.158,                  1P5
.134,.118,.106,.0944,.086,.0798,.0739,.0653,.0593,.0508,            1P5
.0452,.0412,.0382,.036,.0343,                                       1P5
237.2,41.38,13.25,5.74,1.85,.957,.575,.196,.143,.121,               1P6
.0993,.0861,.0773,.0687,.0629,.0584,.0549,.0503,.0472,.0433,        1P6
.0413,.0403,.0397,.0394,.0394,                                      1P6
325.3,59.5,19.09,8.29,2.68,1.39,.837,.279,.202,.171,                1P7
.14,.121,.108,.0964,.0883,.0819,.0772,.0706,.0662,.0609,            1P7
.058,.0567,.0559,.0555,.0555,                                       1P7
8.89,1.31,.651,.479,.398,.365,.343,.28,.244,.218,                   1P8
.184,.162,.146,.129,.118,.109,.102,.0898,.0816,.0699,               1P8
.0622,.0567,.0525,.0496,.0472,                                      1P8
120.2,16.8,5.48,2.51,.967,.585,.439,.269,.225,.199,                 1P9
.167,.147,.132,.118,.107,.0997,.0927,.0827,.0757,.0662,             1P9
.0601,.056,.0529,.0509,.0493,                                       1P9
.524,.201,.169,.159,.147,.139,.133,.109,.0952,.0853,                1P10
.072,.0633,.0569,.0508,.0462,.0427,.0396,.0353,.0315,.0264,         1P10
.0235,.0213,.0195,.0182,.0171,                                      1P10
1628,239.4,75.98,32.66,10.44,5.15,3.14,1.17,.884,.758,              1P11
.626,.544,.489,.435,.398,.369,.348,.317,.297,.273,                  1P11
.259,.253,.249,.247,.247,                                           1P11
.882,.337,.285,.267,.248,.234,.223,.184,.16,.143,                   1P12
.121,.106,.0956,.0853,.0778,.0718,.0667,.0594,.053,.0444,           1P12
.0395,.0358,.0328,.0306,.0288,                                      1P12
371.1,60.1,19.18,8.29,2.66,1.35,.815,.289,.214,.182,                1P13
.15,.13,.117,.104,.0949,.088,.0829,.0758,.0711,.0652,               1P13
.0621,.0606,.0597,.0592,.0592,                                      1P13
 219,.147,.138,.132,.124,.117,.112,.0923,.0805,.072,                1P14
 0609,.0531,.048,.0427,.0389,.036,.0334,.0293,.0262,.0226,          1P14
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[redacted]


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.0195,.0174,.0159,.0148,.0139,                                    1P14
814.5,119.9,38.15,16.48,5.36,2.7,1.69,.686,.53,.458,             1P15
.38,.331,.298,.264,.242,.224,.211,.191,.178,.161,                 1P15
.151,.146,.143,.14,.139,                                          1P15
.968,.37,.313,.293,.272,.257,.245,.202,.176,.157,                 1P16
.133,.117,.105,.0937,.0854,.0788,.0732,.0653,.0582,.0493,         1P16
.0434,.0393,.036,.0336,.0316,                                     1P16
LVSIG2,6.2,7.46,3.72,1.43,.763,.487,.274,.159,.122,.0919,         2P1
.0773,.0681,.0599,.0545,.0504,.0469,.0418,.0385,.0338,.0308,      2P1
.0288,.0273,.0263,.0256,.025,                                     2P1
0,0,0,0,0,0,0,0,0,0,                                              2P2
0,0,0,0,0,0,0,0,0,0,                                              2P2
0,0,0,0,0,                                                        2P2
36.26,11.5,4.94,1.58,.779,.475,.178,.134,.115,.0948,              2P3
.0823,.074,.0658,.0603,.0559,.0526,.0481,.0451,.0413,.0393,       2P3
.0383,.0377,.0374,.0374,.0373,                                    2P3
7.17,2.45,1.28,.748,.607,.544,.423,.366,.327,.276,                2P4
.243,.218,.195,.178,.165,.153,.136,.124,.108,.0976,               2P4
.0903,.085,.0812,.0783,.0761,                                     2P4
.952,.473,.349,.289,.265,.249,.204,.177,.158,.134,                2P5
.118,.106,.0944,.086,.0798,.0739,.0653,.0593,.0508,.0452,         2P5
.0412,.0382,.036,.0343,.0329,                                     2P5
41.38,13.25,5.74,1.85,.957,.575,.196,.143,.121,.0993,             2P6
.0861,.0773,.0687,.0629,.0584,.0549,.0503,.0472,.0433,.0413,      2P6
.0403,.0397,.0394,.0394,.0394,                                    2P6
59.51,19.1,8.29,2.68,1.39,.837,.279,.202,.171,.14,                2P7
.121,.108,.0964,.0883,.0819,.0772,.0706,.0662,.0609,.058,         2P7
.0567,.0559,.0555,.0555,.0555,                                    2P7
1.31,.651,.479,.399,.365,.343,.28,.244,.218,.184,                 2P8
.162,.146,.129,.118,.109,.102,.0898,.0816,.0699,.0622,            2P8
.0567,.0525,.0496,.0472,.0452,                                    2P8
16.84,5.48,2.-1,.967,.585,.439,.269,.225,.199,.167,               2P9
.147,.132,.118,.107,.0997,.0927,.0827,.0757,.0662,.0601,          2P9
.0561,.0529,.0509,.0493,.048,                                     2P9
.201,.169,.159,.147,.139,.133,.109,.0952,.0853,.072,              2P10
.0633,.0569,.0508,.0462,.0427,.0396,.0353,.0315,.0264,.0235,      2P10
.0213,.0193,.0182,.0171,.0162,                                    2P10
239.4,75.98,32.66,10.44,5.15,3.14,1.17,.884,.758,.626,            2P11
.544,.489,.435,.398,.369,.348,.317,.297,.273,.259,                2P11
.253,.249,.247,.247,.247,                                         2P11
.337,.285,.267,.248,.234,.223,.184,.16,.143,.121,                 2P12
.106,.0956,.0853,.0778,.0717,.0667,.0594,.053,.0444,.0395,        2P12
.0358,.0328,.0306,.0288,.0273,                                    2P12
60.13,19.18,8.29,2.66,1.35,.815,.289,.214,.182,.15,               2P13
.13,.117,.104,.0949,.088,.0829,.0758,.0711,.0652,.0621,           2P13
.0606,.0597,.0592,.0592,.0592,                                    2P13
.147,.138,.132,.124,.117,.112,.0923,.0805,.072,.0609,             2P14
.0531,.048,.0427,.0389,.036,.0334,.0293,.0262,.0226,.0195,        2P14
.0174,.0159,.0148,.0139,.0131,                                    2P14
119.9,38.15,16.48,5.36,2.7,1.69,.686,.53,.458,.38,                2P15
.331,.298,.264,.242,.224,.211,.191,.178,.161,.151,                2P15
.146,.143,.14,.139,.138,                                          2P15
.37,.313,.293,.272,.257,.245,.202,.176,.157,.133,                 2P16
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.117,.105,.0937,.0854,.0788,.0732,.0653,.0582,.0493,.0434,          2P16
.0393,.036,.0336,.0316,.0299,                                        2P16
LVGSP1,5.28/-3,.0303,.0244,.0474,.116,.207,.308,.451,.676,.788,      3P1
.888,.927,.945,.959,.96,.955,.951,.935,.912,.866,                    3P1
.819,.776,.732,.694,.655,                                            3P1
0,0,0,0,0,0,0,0,0,0,                                                 3P2
0,0,0,0,0,0,0,0,0,0,                                                 3P2
0,0,0,0,0,                                                           3P2
.00091,.0059,.018,.0407,.1195,.2303,.3612,.7936,.9174,.9583,         3P3
.9827,.9902,.9942,.994,.9887,.9786,.9637,.9315,.8898,.809,           3P3
.7311,.6647,.604,.5556,.5071,                                        3P3
.0116,.089,.252,.466,.753,.878,.934,.991,.998,1,                     3P4
1,1,1,1,.997,.991,.987,.973,.956,.916,                               3P4
.876,.837,.797,.76,.722,                                             3P4
.0496,.325,.633,.828,.942,.976,.989,.997,1,1,                        3P5
1,1,1,1,1,.993,.992,.982,.972,.945,                                  3P5
.918,.889,.861,.832,.803,                                            3P5
9.8/-4,.0054,.0163,.0365,.106,.195,.311,.748,.894,.945,              3P6
.977,.986,.992,.993,.987,.977,.962,.928,.886,.803,                   3P6
.725,.658,.598,.549,.502,                                            3P6
.0052,.0159,.0355,.103,.188,.299,.737,.888,.941,.975,                3P7
.986,.991,.993,.987,.977,.961,.927,.885,.802,.723,                   3P7
.657,.596,.548,.5,.465,                                              3P7
.0496,.325,.633,.828,.942,.976,.989,.997,1,1,                        3P8
1,1,1,1,1,.993,.992,.982,.972,.945,                                  3P8
.918,.889,.861,.832,.803,                                            3P8
3.32/-3,.0228,.0679,.143,.352,.551,.699,.941,.979,.989,              3P9
.996,.998,.999,.999,.996,.99,.985,.969,.948,.904,                    3P9
.858,.815,.772,.734,.695,                                            3P9
.329,.829,.948,.979,.995,1,1,1,1,1,                                  3P10
1,1,1,1,.999,.997,.995,.99,.983,.979,                                3P10
.948,.927,.907,.889,.866,                                            3P10
9.1/-4,.0059,.018,.0407,.1195,.23,.361,.794,.917,.958,               3P11
.983,.99,.994,.994,.989,.979,.964,.932,.889,.809,                    3P11
.731,.665,.604,.556,.507,                                            3P11
.329,.829,.948,.979,.995,1,1,1,1,1,                                  3P12
1,1,1,1,.999,.997,.995,.99,.983,.979,                                3P12
.948,.927,.907,.889,.866,                                            3P12
.0017,.0056,.017,.038,.112,.208,.331,.767,.892,.95,                  3P13
.979,.988,.993,.993,.988,.978,.963,.929,.887,.806,                   3P13
.728,.661,.6,.552,.504,                                              3P13
.658,.95,.986,.994,1,1,1,1,1,1,                                      3P14
1,1,1,1,.999,.998,.997,.993,.989,.979,                               3P14
.966,.954,.94,.926,.908,                                             3P14
.00105,.00678,.0207,.0465,.135,.256,.394,.816,.927,.963,             3P15
.985,.992,.996,.995,.989,.981,.967,.939,.901,.827,                   3P15
.754,.69,.632,.584,.536,                                             3P15
.329,.829,.948,.978,.995,1,1,1,1,1,                                  3P16
1,1,1,1,.999,.997,.995,.983,.983,.967,                               3P16
.948,.927,.907,.889,.866,                                            3P16
LVGSP2,.0303,.0244,.0474,.116,.207,.308,.451,.676,.788,.888,         4P1
.927,.945,.959,.96,.955,.951,.935,.912,.866,.819,                    4P1
776,.732,.694,.655,.621,                                             4P1
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0,0,0,0,0,0,0,0,0,0,                                      4P2
0,0,0,0,0,0,0,0,0,0,                                      4P2
0,0,0,0,                                                  4P2
.0059,.018,.0407,.1195,.2303,.3612,.7936,.9174,.9583,.9827, 4P3
.9902,.9942,.994,.9887,.9786,.9637,.9315,.8898,.809,.7311, 4P3
.6647,.604,.5556,.5071,.4731,                             4P3
.089,.252,.46=,.753,.878,.934,.991,.998,1,1,              4P4
1,1,1,.997,.991,.987,.973,.956,.916,.876,                 4P4
.837,.797,.76,.722,.691,                                  4P4
.325,.633,.828,.942,.976,.989,.997,1,1,1,                 4P5
1,1,1,1,.993,.992,.982,.972,.945,,918,                    4P5
.889,.861,.832,.803,.775,                                 4P5
.0054,.0163,.0365,.106,.195,.311,.748,.894,.945,.977,     4P6
.986,.992,.993,.987,.977,.962,.928,.886,.803,.725,        4P6
.658,.598,.549,.502,.467,                                 4P6
1/-3,.0052,.0159,.0355,.103,.188,.299,.737,.888,.941,     4P7
.975,.986,.991,.993,.987,.977,.961,.927,.885,.802,        4P7
.723,.657,.596,.548,.5,                                   4P7
.325,.633,.828,.942,.976,.989,.997,1,1,1,                 4P8
1,1,1,1,.993,.992,.982,.972,.945,.918,                    4P8
.889,.861,.832,.803,.775,                                 4P8
.0228,.0673,.143,.352,.551,.699,.941,.979,.989,.996,      4P9
.998,.999,.999,.996,.99,.985,.969,.948,.904,.858,         4P9
.815,.772,.734,.695,.662,                                 4P9
.829,.948,.979,.995,1,1,1,1,1,1,                          4P10
1,1,1,.999,.997,.995,.99,.983,.979,.948,                  4P10
.927,.907,.889,.866,.846,                                 4P10
.0059,.018,.0407,.1195,.23,.361,.794,.917,.958,.983,      4P11
.99,.994,.994,.989,.979,.964,.932,.889,.809,.731,         4P11
.665,.604,.556,.507,.473,                                 4P11
.829,.948,.979,.995,1,1,1,1,1,1,                          4P12
1,1,1,.999,.997,.995,.99,.983,.979,.948,                  4P12
.927,.907,.889,.866,.846,                                 4P12
.0056,.017,.038,.112,.208,.331,.767,.892,.95,.979,        4P13
.988,.993,.993,.988,.978,.963,.929,.887,.806,.728,        4P13
.661,.6,.552,.504,.469,                                   4P13
.95,.986,.994,1,1,1,1,1,1,1,                              4P14
1,1,1,.999,.998,.997,.993,.989,.979,.966,                 4P14
.954,.94,.926,.908,.895,                                  4P14
.0068,.0207,.0465,.135,.256,.394,.816,.927,.963,.985,     4P15
.992,.996,.995,.989,.981,.967,.939,.901,.827,.754,        4P15
.69,.632,.584,.536,.502,                                  4P15
.829,.948,.978,.995,1,1,1,1,1,1,                          4P16
1,1,1,.999,.997,.995,.983,.983,.967,.948,                 4P16
.927,.907,.889,.866,.847,                                 4P16
LVGEGB,.01,.02,.03,.04,.06,.08,.1,.2,.3,.4,
.6,.8,1,1.25,1.5,1.75,2,2.5,3,4,5,6,7,8,9,
10,
MVNU,35,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
*VJG,35,25,                                               VJG
8                                                         END CARD
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[redacted]

APPENDIX C. PROGRAM 18-0 INPUT DATA FOR FRONT PLUG ASSEMBLY

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LVREDS,1,21.872,-38.1,21.872,-22.5,33.872,-22.5,33.872,-38.1,        REDS1A
 0,1147.312384,0,1147.312384,1,1,1,4,0,0,0,0,                         REDS1B
 18,2,6,26,                                                           REDS1E
 2,3,0,1,                                                             REDS1G
 1,21.872, 22.5,21.872,-7.5,33.872,-7.5,33.872,-22.5,                 REDS2A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS2B
 18,3,7,1,                                                            REDS2E
 2,3,0,1,                                                             REDS2G
 1,21.872, 7.5,21.872,7.5,33.872,7.5,33.872,-7.5,                     REDS3A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS3B
 18,4,8,2,                                                            REDS3E
 2,3,0,1,                                                             REDS3G
 1,21.872,7.5,21.872,22.5,33.872,22.5,33.872,7.5,                     REDS4A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS4B
 18,5,9,3,                                                            REDS4E
 2,3,0,1,                                                             REDS4G
 1,21.872,22.5,21.872,38.1,33.872,38.1,33.872,22.5,                   REDS5A
 0,1147.312384,0,1147.312384,1,2,1,1,0,0,0,0,                         REDS5B
 18,0,10,4,                                                           REDS5E
 2,3,0,1,                                                             REDS5G
 1,33.872, 38.1,33.872,-22.5,45.872,-22.5,45.872,-38.1,               REDS6A
 0,2104.2404,0,2104.2404,1,1,1,5,0,0,0,0,                             REDS6B
 1,7,11,26,                                                           REDS6E
 2,3,0,1,                                                             REDS6G
 1,33.872, 22.5,33.872,-7.5,45.872,-7.5,45.872,-22.5,                 REDS7A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS7B
 2,8,12,6,                                                            REDS7E
 2,3,0,1,                                                             REDS7G
 1,33.872, 7.5,33.872,7.5,45.872,7.5,45.872,-7.5,                     REDS8A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS8B
 3,9,13,7,                                                            REDS8E
 2,3,0,1,                                                             REDS8G
 1,33.872,7.5,33.872,22.5,45.872,22.5,45.872,7.5,                     REDS9A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS9B
 4,10,14,8,                                                           REDS9E
 2,3,0,1,                                                             REDS9G
 1,33.872,22.5,33.872,38.1,45.872,38.1,45.872,22.5,                   REDS10A
 0,2104.2404,0,2104.2404,1,2,1,1,0,0,0,0,                             REDS10B
 5,0,15,9,                                                            REDS10E
 2,3,0,1,                                                             REDS10G
 1,45.872, 38.1,45.872,-22.5,57.15,-22.5,57.15,-38.1,                 REDS11A
 0,3266.1225,0,3266.1225,1,1,1,6,0,0,0,0,                             REDS11B
 6,12,22,26,                                                          REDS11E
 2,3,0,1,                                                             REDS11G
 1,45.872, 22.5,45.872,-7.5,57.15,-7.5,57.15,-22.5,                   REDS12A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                             REDS12B
 7,13,22,11,                                                          REDS12E
 2,3,0,1,                                                             REDS12G
 1,45.872, 7.5,45.872,7.5,57.15,7.5,57.15,-7.5,                       REDS13A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                             REDS13B
 3,14,22,12,                                                          REDS13E
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2,3,0,1,                                                          REDS13G
1,45.872,7.5,45.872,22.5,57.15,22.5,57.15,7.5,                    REDS14A
0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                          REDS14B
9,15,22,13,                                                       REDS14E
2,3,0,1,                                                          REDS14G
1,45.872,22.5,45.872,38.1,57.15,38.1,57.15,22.5,                  REDS15A
0,3266.1225,0,3266.1225,1,2,1,1,0,0,0,0,                          REDS15B
10,0,22,14,                                                       REDS15E
2,3,0,1,                                                          REDS15G
2,0,-38.1,0,38.1,13.0175,38.1,13.0175,-38.1,                      REDS16A
0,169.45531,0,169.45531,0,2,1,9,0,0,0,0,                          REDS16B
0,0,17,33,                                                        REDS16E
0,0,0,1,                                                          REDS16G
3,13.0175,-51.94,13.0175,38.1,17.323,38.1,17.323, 51.94,          REDS17A
0,300.08633,0,300.08633,1,2,1,11,1,0,2,2,                         REDS17B
 38.1,-50.67,-41.91,204.2041,252.1744,                            REDS17C
33,16,0,34,19,18,89,84,41,                                        REDS17E
2,2,0,0,0,0,1,1,1,                                                REDS17G
4,17.323, 41.91,17.323,38.1,21.872,38.1,21.872,-41.91,            REDS18A
0,478.38438,0,478.38438,1,2,1,8,0,0,5,0,                          REDS18B
 38.1,-22.5,-7.5,7.5,22.5,                                        REDS18C
17,0,26,1,2,3,4,5,19,                                             REDS18E
2,0,0,0,0,0,0,0,1,                                                REDS18G
6,17.323, 50.67,17.323,-41.91,57.15,-41.91,57.15, 50.67,          REDS19A
0,3266.1225,0,3266.1225,1,1,1,16,0,1,0,0,                         REDS19B
478.38438,                                                        REDS19C
17,18,26,20,34,                                                   REDS19E
2,3,3,0,1,                                                        REDS19G
7,57.15,-50.67,57.15,-41.91,67.31,-41.91,67.31,-50.67,            REDS20A
0,4530.6361,0,4530.6361,1,1,1,15,0,0,0,0,                         REDS20B
19,22,21,34,                                                      REDS20E
2,3,0,1,                                                          REDS20G
10,67.31, 50.67,67.31,-41.91,79.36,-41.91,79.36,-50.67,           REDS21A
0,6298.0096,0,6298.0096,1,1,1,14,0,1,0,0,                         REDS21B
6199.9876,                                                        REDS21C
20,23,32,24,34,                                                   REDS21E
2,3,3,0,1,                                                        REDS21G
8,57.15,-41.91,57.15,38.1,67.31,38.1,67.31,-41.91,                REDS22A
0,4530.6361,0,4530.6361,1,2,70,12,5,0,0,0,                        REDS22B
 38.1,-22.5,-7.5,7.5,22.5,                                        REDS22C
26,11,12,13,14,15,0,23,20,                                        REDS22E
2,2,2,2,2,2,0,0,1,                                                REDS22G
9,67.31,-41.91,67.31,38.1,78.74,38.1,78.74,-41.91,                REDS23A
0,6199.9876,0,6199.9876,1,2,71,13,0,0,0,0,                        REDS23B
22,0,32,21,                                                       REDS23E
2,0,0,1,                                                          REDS23G
13,79.36, 50.67,79.36,38.1,83.82,38.1,83.82,-50.67,               REDS24A
0,7Y25.7924,0,7025.7924,1,2,73,81,1,0,0,0,                        REDS24B
 41.91,                                                           REDS24C
21,32,0,25,34,                                                    REDS24E
2,2,0,0,1,                                                        REDS24G
2,83.82,-51.94,83.82,38.1,86.46,38.1,86.46,-51.94,                REDS25A
0,7475.3316,0,7475.3316,1,2,74,1,1,0,0,1,                         REDS25B
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50.67,7098.0625,                                                    REDS25C
34,24,0,27,122,127,                                                 REDS25F
2,2,0,0,1,1,                                                        REDS25G
5,21.872, 41.91,21.872,-38.1,57.15,-38.1,57.15,-41.91,              REDS26A
0,3266.1225,0,3266.1225,1,1,1,7,0,2,0,0,                            REDS26B
1147.312384,2104.2404,                                              REDS26C
18,1,6,11,22,19,                                                    REDS26E
2,3,3,3,0,1,                                                        REDS26G
11,86.46, 51.94,86.46,38.1,87,38.1,87,-51.94,                       REDS27A
0,7569,0,7369,1,2,1,1,0,0,0,0,                                      REDS27B
25,0,28,120,                                                        REDS27F
2,0,0,1,                                                            REDS27G
2,87,-108.16,87,38.1,88.65,38.1,88.65,-108.16,                      REDS28A
0,7858.8225,0,7858.8225,1,2,75,1,1,0,2,0,                           REDS28B
51.94,-75.51,-51.94,                                                REDS28C
120,27,0,123,124,29,119,                                            REDS28E
2,2,0,0,0,0,1,                                                      REDS28G
14,88.65, 51.94,88.65,38.1,89.92,38.1,89.92,-51.94,                 REDS29A
0,8085.6064,0,8085.6064,1,2,1,1,0,0,1,0,                            REDS29B
8.94,                                                               REDS29C
28,0,30,31,124,                                                     REDS29E
2,0,0,0,1,                                                          REDS29G
14,89.92, 51.94,89.92,-8.94,104.14,-8.94,104.14,-51.94,             REDS30A
0,10845.1396,0,10845.1396,1,1,76,1,0,0,0,0,                         REDS30B
29,31,126,124,                                                      REDS30E
2,3,0,1,                                                            REDS30G
14,89.92, 8.94,89.92,38.1,104.14,38.1,104.14,-8.94,                 REDS31A
0,10845.1396,0,10845.1396,1,2,77,1,0,0,0,0,                         REDS31B
29,0,126,30,                                                        REDS31E
2,0,0,1,                                                            REDS31G
17,78.74, 41.91,78.74,38.1,79.36,38.1,79.36,-41.91,                 REDS32A
0,6298.0096,0,6298.0096,1,2,72,1,0,0,0,0,                           REDS32B
23,0,24,21,                                                         REDS32E
2,0,0,1,                                                            REDS32G
10,0,-51.94,0,-38.1,13.0175,-38.1,13.0175,-51.94,                   REDS33A
0,169.45531,0,169.45531,0,1,1,10,0,0,0,0,                           REDS33B
0,16,17,93,                                                         REDS33E
0,3,0,1,                                                            REDS33G
2,17.323, 51.94,17.323,-50.67,83.82,-50.67,83.82, 51.94,            REDS34A
0,7025.7924,0,7025.7924,1,1,1,17,0,3,0,2,                           REDS34B
3266.1225,4530.6361,6298.0096,327.9721,6992.3044,                   REDS34C
17,19,20,21,24,25,41,35,122,                                        REDS34E
2,3,3,3,3,0,1,1,1,                                                  REDS34G
2,18.11,-53.85,18.11,-51.94,83.62,-51.94,83.62,-53.85,              REDS35A
0,6992.3044,0,6992.3044,1,1,1,18,0,0,0,2,                           REDS35B
4294.1809,6814.5025,                                                REDS35C
41,34,122,36,65,68,                                                 REDS35E
2,3,0,1,1,1,                                                        REDS35G
2,18.11,-55.5,18.11,-53.85,65.53,-53.85,65.53,-55.5,                REDS36A
0,4294.1809,0,4294.1809,1,1,1,19,0,0,0,1,                           REDS36B
423.1249,                                                           REDS36C
41,35,65,40,37,                                                     REDS36E
2,3,0,1,1,                                                          REDS36G
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2,20.57,-57.73,20.57,-55.5,65.53,-55.5,28.58,-57.73,                    REDS37A
0,4294.1809,16.569507,816.8164,1,1,25,26,0,0,0,0,                       REDS37B
40,36,38,39,                                                            REDS37E
2,3,1,1,                                                                REDS37G
2,58.25,-63.27,28.58,-57.73,65.53,-55.5,64.44,-63.27,                   REDS38A
 5.3555957,16.569507,.14028314,4152.5136,1,1,1,29,1,0,0,0,              REDS38B
 60.38,                                                                 REDS38C
42,39,37,71,57,                                                         REDS38E
2,2,2,0,1,                                                              REDS38G
16,20.57, 60.38,20.57,-57.73,28.58,-57.73,42.7723285,-60.38,            REDS39A
0,816.8164,-5.3555957,1829.4721,1,1,1,28,0,0,0,1,                       REDS39B
1422.0441,                                                              REDS39C
40,37,38,43,42,                                                         REDS39E
2,3,0,1,1,                                                              REDS39G
3,18.11,-60.38,18.11,-55.5,20.57,-55.5,20.57,-60.38,                    REDS40A
0,423.1249,0,423.1249,1,1,1,27,0,0,1,0,                                 REDS40B
 57.73,                                                                 REDS40C
41,36,39,37,43,                                                         REDS40E
2,3,0,0,1,                                                              REDS40G
3,15.88,-66.17,15.88,-51.94,18.11,-51.94,18.11,-66.17,                  REDS41A
0,327.9721,0,327.9721,1,1,1,57,0,1,4,0,                                 REDS41B
300.08633,-63.27,-60.38,-55.5,-53.85,                                   REDS41C
84,17,34,45,43,40,36,35,83,                                             REDS41E
2,3,3,0,0,0,0,0,1,                                                      REDS41G
16,37.71, 63.27,37.71,-60.38,42.7723285,-60.38,58.25,-63.27,            REDS42A
0,1829.4721,-5.3555957,3393.0625,1,1,1,30,0,0,0,0,                      REDS42B
43,39,38,44,                                                            REDS42E
2,3,0,1,                                                                REDS42G
16,18.11, 63.27,18.11,-60.38,37.71,-60.38,37.71,-63.27,                 REDS43A
0,1422.0441,0,1422.0441,1,1,1,31,0,1,0,0,                               REDS43B
423.1249,                                                               REDS43C
41,40,39,42,45,                                                         REDS43E
2,3,3,0,1,                                                              REDS43G
17,37.71, 66.17,37.71,-63.27,58.25,-63.27,58.25,-66.17,                 REDS44A
0,3393.0625,0,3393.0625,1,1,1,32,0,0,0,0,                               REDS44B
45,42,57,46,                                                            REDS44E
2,3,0,1,                                                                REDS44G
17,18.11, 66.17,18.11,-63.27,37.71,-63.27,37.71,-66.17,                 REDS45A
0,1422.0441,0,1422.0441,1,1,1,33,0,0,0,0,                               REDS45B
41,43,44,47,                                                            REDS45E
2,3,0,1,                                                                REDS45G
16,37.71, 70.23,37.71,-66.17,58.25,-66.17,58.25,-70.23,                 REDS46A
0,3393.0625,0,3393.0625,1,1,1,34,0,0,0,0,                               REDS46B
47,44,58,48,                                                            REDS46E
2,3,0,1,                                                                REDS46G
16,18.11, 70.23,18.11,-66.17,37.71,-66.17,37.71,-70.23,                 REDS47A
0,1422.0441,0,1422.0441,1,1,1,35,0,0,0,0,                               REDS47B
83,45,46,49,                                                            REDS47E
2,3,0,1,                                                                REDS47G
16,37.71, 75.51,37.71,-70.23,58.25,-70.23,58.25,-75.51,                 REDS48A
0,3393.0625,0,3393.0625,1,1,1,37,0,0,0,0,                               REDS48B
49,46,58,50,                                                            REDS48E
2,3,0,1,                                                                REDS48G
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16,18.11, 75.51,18.11,-70.23,37.71,-70.23,37.71,-75.51,              REDS49A
0,1422.0441,0,1422.0441,1,1,1,38,0,0,0,0,                             REDS49B
83,47,48,51,                                                          REDS49E
2,3,0,1,                                                              REDS49G
16,37.71, 83.34,37.71,-75.51,58.25,-75.51,58.25,-83.34,              REDS50A
0,3393.0625,0,3393.0625,1,1,1,44,0,0,0,0,                             REDS50B
51,48,59,52,                                                          REDS50E
2,3,0,1,                                                              REDS50G
16,18.11, 83.34,18.11,-75.51,37.71,-75.51,37.71,-83.34,              REDS51A
0,1422.0441,0,1422.0441,1,1,1,45,0,0,0,0,                             REDS51B
83,49,50,53,                                                          REDS51E
2,3,0,1,                                                              REDS51G
16,37.71, 95.34,37.71,-83.34,58.25,-83.34,58.25,-95.34,              REDS52A
0,3393.0625,0,3393.0625,1,1,1,47,0,0,0,0,                             REDS52B
53,50,59,54,                                                          REDS52E
2,3,0,1,                                                              REDS52G
16,18.11, 95.34,18.11,-83.34,37.71,-83.34,37.71,-95.34,              REDS53A
0,1422.0441,0,1422.0441,1,1,1,48,0,0,0,0,                             REDS53B
83,51,52,55,                                                          REDS53E
2,3,0,1,                                                              REDS53G
16,37.71, 110.26,37.71,-95.34,58.25,-95.34,58.25, 110.26,            REDS54A
0,3393.0625,0,3393.0625,1,1,1,52,0,0,0,0,                             REDS54B
55,52,60,56,                                                          REDS54E
2,3,0,1,                                                              REDS54G
16,18.11, 110.26,18.11,-95.34,37.71,-95.34,37.71, 110.26,            REDS55A
0,1422.0441,0,1422.0441,1,1,1,53,0,0,0,0,                             REDS55B
83,53,54,56,                                                          REDS55E
2,3,0,1,                                                              REDS55G
16,17.42, 120.93,17.42,-110.26,58.25,-110.26,58.25,-120.93,          REDS56A
0,3393.0625,0,3393.0625,1,1,1,54,0,1,0,1,                             REDS56B
1422.0441,1651.6096,                                                  REDS56C
82,55,54,60,81,80,                                                    REDS56E
2,3,3,0,1,1,                                                          REDS56G
12,58.25, 66.17,58.25,-63.27,64.44,-63.27,64.44,-66.17,              REDS57A
0,4152.5136,0,4152.5136,1,1,1,82,0,0,0,0,                             REDS57B
44,38,61,58,                                                          REDS57E
2,3,0,1,                                                              REDS57G
12,58.25, 75.51,58.25,-66.17,64.44,-66.17,64.44,-75.51,              REDS58A
0,4152.5136,0,4152.5136,1,1,1,36,1,0,1,0,                             REDS58B
 70.23,-70.23,                                                        REDS58C
48,46,57,62,61,59,                                                    REDS58E
2,2,3,0,0,1,                                                          REDS58G
12,58.25, 95.34,58.25,-75.51,64.44,-75.51,64.44,-95.34,              REDS59A
0,4152.5136,0,4152.5136,1,1,1,46,1,0,0,0,                             REDS59B
 83.34,                                                               REDS59C
52,50,58,63,60,                                                       REDS59E
2,2,3,0,1,                                                            REDS59G
12,58.25, 120.93,58.25,-95.34,64.44,-95.34,64.44, 120.93,            REDS60A
0,4152.5136,0,4152.5136,1,1,1,51,1,0,1,0,                             REDS60B
 110.26,-99.64,                                                       REDS60C
56,54,59,64,63,80,                                                    REDS60E
2,2,3,0,0,1,                                                          REDS60G
 6,64.44, 70.23,64.44,-63.27,64.44,-63.27,72.8,-70.23,               REDS61A
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0,0,-1.2011494,5299.84,1,1,1,40,1,0,0,0,                                  REDS61B
 66.17,                                                                   REDS61C
58,57,0,71,62,                                                            REDS61E
2,2,0,3,1,                                                                REDS61G
16,64.44, 75.51,64.44,-70.23,72.8,-70.23,75.44,-75.51,                    REDS62A
0,5299.84,-.5,5691.1936,1,1,1,39,0,0,0,0,                                 REDS62B
58,61,72,63,                                                              REDS62E
2,3,0,1,                                                                  REDS62G
16,64.44, 99.64,64.44,-75.51,75.44,-75.51,75.44,-99.64,                   REDS63A
0,5691.1936,0,5691.1936,1,1,1,49,1,0,0,0,                                 REDS63B
 95.34,                                                                   REDS63C
60,59,62,74,64,                                                           REDS63E
2,2,3,0,1,                                                                REDS63G
16,64.44, 120.93,64.44,-99.64,75.44,-99.64,65.66, 120.93,                 REDS64A
0,5691.1936,.45937059,4311.2356,1,1,83,1,0,0,0,0,                         REDS64B
60,63,75,80,                                                              REDS64E
2,3,1,1,                                                                  REDS64G
16,65.53, 55.5,65.53,-53.85,82.55,-53.85,82.55,-55.5,                     REDS65A
0,6814.5025,0,6814.5025,1,1,1,20,0,0,0,0,                                 REDS65B
36,35,68,66,                                                              REDS65E
2,3,0,1,                                                                  REDS65G
16,73.41, 59.87,65.53,-55.5,82.55,-55.5,82.55,-59.87,                     REDS66A
 1.8032037,6814.5025,0,6814.5025,1,1,1,21,0,0,0,0,                        REDS66B
71,65,68,67,                                                              REDS66E
1,3,0,1,                                                                  REDS66G
16,82.55, 72.17,73.41,-59.87,82.55,-59.87,82.55,-72.17,                   REDS67A
 .74308943,6814.5025,0,0,22,1,1,1,0,0,0,0,                                REDS67B
73,66,68,0,                                                               REDS67E
1,3,0,0,                                                                  REDS67G
16,82.55, 78.99,82.55,-53.85,83.62,-53.85,83.62,-78.99,                   REDS68A
0,6992.3044,0,6992.3044,1,1,84,23,3,0,0,0,                                REDS68B
 72.17,-59.87,-55.5,                                                      REDS68C
73,67,66,65,35,122,69,                                                    REDS68E
2,2,2,2,3,0,1,                                                            REDS68G
17,82.55, 91.97,82.55,-78.99,83.62,-78.99,83.62,-91.97,                   REDS69A
0,6992.3044,0,6992.3044,1,1,1,1,0,0,0,0,                                  REDS69B
73,68,122,70,                                                             REDS69E
2,3,0,1,                                                                  REDS69G
16,82.55, 107.72,82.55,-91.97,83.62,-91.97,83.62, 107.72,                 REDS70A
0,6992.3044,0,6992.3044,1,1,1,1,1,0,0,0,                                  REDS70B
 98.67,                                                                   REDS70C
76,73,69,122,128,                                                         REDS70E
2,2,3,0,1,                                                                REDS70G
2,64.44,-63.27,65.53,-55.5,73.41,-59.87,72.8,-70.23,                      REDS71A
.14028314,-1.8032037,.05888031,-1.2011494,1,1,42,41,0,0,0,0,              REDS71B
38,66,72,61,                                                              REDS71E
2,0,1,2,                                                                  REDS71G
2,75.44,-75.51,72.8,-70.23,73.41,-59.87,75.44,-75.51,                     REDS72A
 .5,.05888031,-.12979539,0,1,1,1,1,0,0,0,0,                               REDS72B
62,71,73,0,                                                               REDS72E
2,2,0,0,                                                                  REDS72G
2,75.44,-75.51,73.41,-59.87,82.55,-72.17,82.55,-98.67,                    REDS73A
 .12979539,-.74308943,0,-.30699482,1,1,1,43,0,0,2,0,                      REDS73B
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91.97,-78.99,                                                          REDS73C
72,67,70,69,68,74,                                                     REDS73E
2,0,0,0,0,1,                                                           REDS73G
  75.44,-99.64,75.44,-75.51,82.55,-98.67,79.2,-107.72,                 REDS74A
0,-.30699482,.37016575,-.46534653,1,1,1,50,0,0,0,0,                    REDS74B
63,73,76,75,                                                           REDS74E
2,3,0,2,                                                               REDS74G
2,63.75,-138.84,65.66,-120.93,75.44,-99.64,79.2,-107.72,               REDS75A
.10664433,.45937059,-.46534653,.49646529,1,1,1,1,0,0,0,1,              REDS75B
5677.9833,                                                             REDS75C
80,64,74,79,77,                                                        REDS75E
2,2,3,0,0,                                                             REDS75G
16,79.2,-107.72,82.55,-98.67,82.55,-98.67,82.55,-107.72,               REDS76A
.37016575,0,0,6814.5025,1,1,1,1,0,0,0,0,                               REDS76B
74,0,70,77,                                                            REDS76E
2,0,0,1,                                                               REDS76G
16,75.3523939,-115.47,79.2,-107.72,82.55,-107.72,82.55,-115.47,        REDS77A
.49646529,6814.5025,0,6814.5025,1,1,1,85,0,0,1,0,                      REDS77B
 111.22,                                                               REDS77C
75,76,78,128,79,                                                       REDS77E
3,3,0,0,1,                                                             REDS77G
12,82.55, 115.47,82.55,-111.22,86.46,-111.22,86.46,-115.47,            REDS78A
0,7475.3316,0,7475.3316,1,1,1,1,0,0,0,1,                               REDS78B
7240.3081,                                                             REDS78C
77,128,119,79,109,                                                     REDS78E
2,3,0,1,1,                                                             REDS78G
16,63.75, 138.84,75.3523939,-115.47,85.09,-115.47,73.41,-138.84,       REDS79A
.49646529,7240.3081,.49978605,5389.0281,1,1,1,86,0,1,0,0,              REDS79B
6814.5025,                                                             REDS79C
75,77,78,107,103,                                                      REDS79E
3,3,3,0,1,                                                             REDS79G
2,40.64,-138.84,40.64,-120.93,65.66,-120.93,63.75,-138.84,             REDS80A
0,4311.2356,.10664433,4064.0625,1,1,1,55,0,2,0,1,                      REDS80B
3393.0625,4152.5136,2619.3924,                                         REDS80C
81,56,60,64,75,102,103,                                                REDS80E
2,3,3,3,0,1,1,                                                         REDS80G
2,11.81,-139.6,11.81,-120.93,40.64,-120.93,40.64, 139.6,               REDS81A
0,1651.6096,0,1651.6096,1,1,1,56,0,2,1,1,                              REDS81B
252.1744,303.45=4,-138.84,326.8864,                                    REDS81C
92,87,82,56,102,80,99,101,                                             REDS81E
2,3,3,3,0,0,1,1,                                                       REDS81G
13,15.88, 120.93,15.88,-110.26,17.42,-110.26,17.42,-120.93,            REDS82A
0,303.4564,0,303.4564,1,1,1,59,1,0,0,0,                                REDS82B
 116.99,                                                               REDS82C
87,86,83,56,81,                                                        REDS82E
2,2,3,0,1,                                                             REDS82G
13,15.88, 110.26,15.88,-66.17,18.11,-66.17,18.11, 110.26,              REDS83A
0,327.9721,0,327.9721,1,1,1,58,2,0,4,1,                                REDS83B
 105.41,-93.47,-95.34,-83.34, 75.51,-70.23,303.4564,                   REDS83C
86,85,84,41,55,53,51,49,47,82,56,                                      REDS83E
2,2,2,3,0,0,0,0,0,1,1,                                                 REDS83G
2,14.29,-93.47,14.29,-51.94,15.88,-51.94,15.88,-93.47,                 REDS84A
0,252.1744,0,252.1744,1,1,1,68,0,0,1,0,                                REDS84B
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 66.17,                                                                  REDS84C
89,17,83,41,85,                                                          REDS84E
2,3,0,0,1,                                                               REDS84G
2,10.54,-105.41,14.29,-93.47,15.88,-93.47,15.88,-105.41,                 REDS85A
.31407035,252.1744,0,252.1744,1,1,1,64,0,0,0,1,                          REDS85B
139.4761,                                                                REDS85C
90,84,83,88,86,                                                          REDS85E
2,3,0,1,1,                                                               REDS85G
16,11.81, 116.99,11.81,-105.41,15.88,-105.41,15.88,-116.99,              REDS86A
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0,0,0,0,0,0,0,0,0,0,                                            2P2
0,0,0,0,0,                                                      2P2
36.26,11.5,4.94,1.58,.779,.475,.178,.134,.115,.0948,            2P3
.0823,.074,.0658,.0603,.0559,.0526,.0481,.0451,.0413,.0393,     2P3
.0383,.0377,.0374,.0374,.0373,                                  2P3
7.17,2.45,1.28,.748,.607,.544,.423,.366,.327,.276,              2P4
.243,.218,.195,.178,.165,.153,.136,.124,.108,.0976,             2P4
.0903,.085,.0812,.0783,.0761,                                   2P4
.952,.473,.349,.289,.265,.249,.204,.177,.158,.134,              2P5
.118,.106,.0944,.086,.0798,.0739,.0653,.0593,.0508,.0452,       2P5
.0412,.0382,.036,.0343,.0329,                                   2P5
.201,.169,.159,.147,.139,.133,.109,.0952,.0853,.072,            2P6
.0633,.0569,.0508,.0462,.0427,.0396,.0353,.0315,.0264,.0235,    2P6
.0213,.0195,.0182,.0171,.0162,                                  2P6
.279,.236,.221,.205,.194,.185,.152,.133,.119,.1,                2P7
.0881,.0792,.0707,.0644,.0595,.0552,.0492,.0439,.0368,.0327,    2P7
.0296,.0272,.Y253,.0238,.0226,                                  2P7
1.31,.651,.479,.399,.365,.343,.28,.244,.218,.184,               2P8
.162,.146,.129,.118,.109,.102,.0898,.0816,.0699,.0622,          2P8
.0567,.0525,.0496,.0472,.0452,                                  2P8
1.65,.822,.606,.504,.461,.433,.354,.3082,.275,.233,             2P9
.204,.184,.164,.149,.139,.128,.113,.103,.0884,.0785,            2P9
.0716,.0663,.0626,.0597,.0571,                                  2P9
.337,.285,.267,.249,.243,.223,.184,.16,.143,.121,               2P10
.106,.0956,.0853,.0778,.0718,.0667,.0594,.053,.0444,.0395,      2P10
.0358,.0323,.0306,.0288,.0273,                                  2P10
239.4,75.98,32.66,10.44,5.15,3.14,1.17,.884,.758,.326,          2P11
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[redacted]

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.544,.489,.435,.398,.369,.348,.317,.297,.273,.259,                  2P11
.253,.249,.247,.247,.247,                                          2P11
14.78,4.83,2.19,.831,.5,.369,.22,.183,.162,.136,                    2P12
.119,.107,.0955,.0871,.0805,.0751,.0674,.0609,.0529,.0478,          2P12
.0444,.417,.0398,.0383,.0371,                                       2P12
60.13,19.18,8.29,2.66,1.35,.815,.289,.214,.182,.15,                 2P13
.13,.117,.104,.0949,.088,.0829,.0758,.0711,.0652,.0621,             2P13
.0606,.0597,.0592,.0592,.0592,                                      2P13
.147,.138,.132,.124,.117,.112,.0923,.0805,.072,.0609,               2P14
.0531,.048,.0427,.0389,.036,.0334,.0293,.0262,.0226,.0195,          2P14
.0174,.0159,.0148,.0139,.0131,                                      2P14
21.3,6.73,2.94,.947,.468,.293,.119,.0917,.0795,.0659,               2P15
.0574,.0515,.0461,.0419,.0391,.0366,.0336,.0311,.0285,.0271,        2P15
.0263,.0257,.0255,.0254,.0254,                                      2P15
.37,.313,.293,.272,.257,.245,.202,.176,.157,.133,                   2P16
.117,.105,.0937,.0854,.0788,.0732,.0653,.0582,.0493,.0434,          2P16
.0393,.036,.0336,.0316,.0299,                                       2P16
195.3,61.83,26.94,8.69,4.29,2.68,1.09,.842,.729,.604,               2P17
.527,.473,.423,.384,.358,.337,.308,.286,.262,.248,                  2P17
.241,.236,.234,.233,.233,                                           2P17
LVGSP1,5.28/-3,.0303,.0244,.0474,.116,.207,.308,.451,.676,.788,    3P1
.888,.927,.945,.959,.96,.955,.951,.935,.912,.866,                   3P1
.819,.776,.732,.694,.655,                                           3P1
0,0,0,0,0,0,0,0,0,0,                                                3P2
0,0,0,0,0,0,0,0,0,0,                                                3P2
0,0,0,0,0,                                                          3P2
.00091,.0059,.018,.0407,.1195,.2303,.3612,.7936,.9174,.9583,        3P3
.9827,.9902,.9942,.994,.9887,.9786,.9637,.9315,.8898,.809,          3P3
.7311,.6647,.604,.5556,.5071,                                       3P3
.0116,.089,.2-2,.466,.753,.878,.934,.991,.998,1,                    3P4
1,1,1,1,.997,.991,.987,.973,.956,.916,                              3P4
.876,.837,.797,.76,.722,                                            3P4
.0496,.325,.633,.828,.942,.976,.989,.997,1,1,                       3P5
1,1,1,1,1,.993,.992,.982,.972,.945,                                 3P5
.918,.889,.861,.832,.803,                                           3P5
.329,.829,.948,.978,.995,1,1,1,1,1,                                 3P6
1,1,1,1,.999,.997,.995,.983,.983,.967,                              3P6
.948,.927,.907,.889,.866,                                           3P6
.329,.829,.948,.978,.995,1,1,1,1,1,                                 3P7
1,1,1,1,.999,.997,.995,.983,.983,.967,                              3P7
.948,.927,.907,.889,.866,                                           3P7
.0496,.325,.633,.828,.942,.976,.989,.997,1,1,                       3P8
1,1,1,1,1,.993,.992,.982,.972,.945,                                 3P8
.918,.889,.861,.832,.803,                                           3P8
.0496,.3247,.6326,.8284,.9424,.9761,.9885,.9971,1,1,                3P9
1,1,1,1,1,.9932,.9921,.9821,.9719,.945,                             3P9
.9178,.8897,.8612,.8322,.8032,                                      3P9
.329,.829,.948,.978,.995,1,1,1,1,1,                                 3P10
1,1,1,1,.999,.997,.995,.983,.983,.967,                              3P10
.948,.927,.907,.889,.866,                                           3P10
9.1/-4,.0059,.018,.0407,.1195,.23,.361,.794,.917,.958,              3P11
.983,.99,.994,.994,.989,.979,.964,.932,.889,.809,                   3P11
.731,.665,.604,.556,.507,                                           3P11
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[redacted]

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.003,.021,.0625,.133,.332,.523,.674,.934,.976,.988,               3P12
.995,.997,.998,.998,.996,.992,.986,.973,.955,.917,                3P12
.876,.835,.796,.762,.724,                                         3P12
,0017,.0056,.017,.038,.112,.208,.331,.767,.892,.95,               3P13
,979,.988,.993,.993,.988,.978,.963,.929,.887,.806,                3P13
.728,.661,.6,.552,.504,                                           3P13
.658,.95,.986,.994,1,1,1,1,1,1,                                   3P14
1,1,1,1,.999,.998,.997,.993,.989,.979,                            3P14
.966,.954,.94,.926,.908,                                          3P14
.001,.007,.0215,.0478,.139,.268,.409,.828,.934,.967,              3P15
.986,.992,.995,.999,.993,.983,.969,.934,.896,.818,                3P15
.742,.677,.618,.57,.525,                                          3P15
.329,.829,.948,.978,.995,1,1,1,1,1,                               3P16
1,1,1,1,.999,.997,.995,.983,.983,.967,                            3P16
.948,.927,.907,.889,.866,                                         3P16
.00119,.007,.0215,.0478,.1398,.268,.409,.828,.934,.967,           3P17
.986,.992,.996,.999,.992,.982,.969,.934,.896,.818,                3P17
.742,.677,.618,.57,.525,                                          3P17
LVGSP2,.0303,.0244,.0474,.116,.207,.308,.451,.676,.788,.888,      4P1
.927,.945,.959,.96,.955,.951,.935,.912,.866,.819,                 4P1
.776,.732,.694,.655,.621,                                         4P1
0,0,0,0,0,0,0,0,0,0,                                              4P2
0,0,0,0,0,0,0,0,0,0,                                              4P2
0,0,0,0,0,                                                        4P2
.0059,.018,.0407,.1195,.2303,.3612,.7936,.9174,.9583,.9827,       4P3
.9902,.9942,.994,.9887,.9786,.9637,.9315,.8898,.809,.7311,        4P3
.6647,.604,.5556,.5071,.4731,                                     4P3
.089,.252,.466,.753,.878,.934,.991,.998,1,1,                      4P4
1,1,1,.997,.991,.987,.973,.956,.916,.876,                         4P4
.837,.797,.76,.722,.691,                                          4P4
.325,.633,.828,.942,.976,.989,.997,1,1,1,                         4P5
1,1,1,1,.993,.992,.982,.972,.945,.918,                            4P5
.889,.861,.832,.803,.775,                                         4P5
.829,.948,.978,.995,1,1,1,1,1,1,                                  4P6
1,1,1,.999,.997,.995,.983,.983,.967,.948,                         4P6
.927,.907,.889,.866,.847,                                         4P6
.829,.948,.978,.995,1,1,1,1,1,1,                                  4P7
1,1,1,.999,.997,.995,.983,.983,.967,.948,                         4P7
.927,.907,.889,.866,.847,                                         4P7
.325,.633,.828,.942,.976,.989,.997,1,1,1,                         4P8
1,1,1,1,.993,.992,.982,.972,.945,.918,                            4P8
.889,.861,.832,.803,.775,                                         4P8
.3247,.6326,.8284,.9424,.9761,.9885,.9971,1,1,1,                  4P9
1,1,1,1,.9932,.9921,.9821,.9719,.945,.9178,                       4P9
.8897,.8612,.8322,.8032,.7754,                                    4P9
.829,.948,.978,.995,1,1,1,1,1,1,                                  4P10
1,1,1,.999,.997,.995,.983,.983,.967,.948,                         4P10
.927,.907,.889,.866,.847,                                         4P10
.0059,.018,.0407,.1195,.23,.361,.794,.917,.958,.983,              4P11
.99,.994,.994,.989,.979,.964,.932,.889,.809,.731,                 4P11
.665,.604,.556,.507,.473,                                         4P11
.021,.0625,.133,.332,.523,.674,.934,.976,.988,.995,               4P12
.997,.998,.998,.996,.992,.986,.973,.955,.917,.876,                4P12
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[redacted]

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.835,.796,.762,.724,.694,                                              4P12
.0056,.017,.038,.112,.208,.331,.767,.892,.95,.979,                     4P13
.988,.993,.993,.988,.978,.963,.929,.887,.806,.728,                     4P13
.661,.6,.552,.504,.469,                                                4P13
.95,.986,.994,1,1,1,1,1,1,1,                                           4P14
1,1,1,.999,.998,.997,.993,.989,.979,.966,                              4P14
.954,.94,.926,.908,.895,                                               4P14
.007,.0215,.0478,.139,.268,.409,.828,.934,.967,.986,                   4P15
.992,.995,.999,.993,.983,.969,.934,.896,.818,.742,                     4P15
.677,.618,.57,.525,.487,                                               4P15
.829,.948,.978,.995,1,1,1,1,1,1,                                       4P16
1,1,1,.999,.997,.995,.983,.983,.967,.948,                              4P16
.927,.907,.889,.866,.847,                                              4P16
.007,.0215,.0478,.1398,.268,.409,.828,.934,.967,.986,                  4P17
.992,.996,.999,.992,.982,.969,.934,.896,.818,.742,                     4P17
.677,.618,.57,.525,.487,                                               4P17
MVNU,35,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
LVGEGB,.01,.02,.03,.04,.06,.08,.1,.2,.3,.4,
.6,.8,1,1.25,1.5,1.75,2,2.5,3,4,5,6,7,8,9,
10,
*VJG,35,25,                                                            VJG
8
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[redacted]

APPENDIX D. PROGRAM 18-O INPUT DATA FOR ENTIRE REACTOR-SHIELD ASSEMBLY

```
MVNORD,35,201,20,100,12,0,25,
MVCR,35,0,2,0,0,1,0,0,0,
   EDS,1,21.872,-38.1,21.872,-22.5,33.872,-22.5,33.872,-38.1,        REDS1A
 .1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                          REDS1B
 18,2,6,26,                                                           REDS1E
 2,3,0,1,                                                             REDS1G
 1,21.872, 22.5,21.872,-7.5,33.872,-7.5,33.872,-22.5,                 REDS2A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS2B
 18,3,7,1,                                                            REDS2E
 2,3,0,1,                                                             REDS2G
 1,21.872, 7.5,21.872,7.5,33.872,7.5,33.872,-7.5,                     REDS3A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS3B
 18,4,8,2,                                                            REDS3E
 2,3,0,1,                                                             REDS3G
 1,21.872,7.5,21.872,22.5,33.872,22.5,33.872,7.5,                     REDS4A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS4B
 18,5,9,3,                                                            REDS4E
 2,3,0,1,                                                             REDS4G
 1,21.872,22.5,21.872,38.1,33.872,38.1,33.872,22.5,                   REDS5A
 0,1147.312384,0,1147.312384,1,1,1,1,0,0,0,0,                         REDS5B
 18,28,10,4,                                                          REDS5E
 2,3,0,1,                                                             REDS5G
 1,33.872, 38.1,33.872,-22.5,45.872,-22.5,45.872,-38.1,               REDS6A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS6B
 1,7,11,26,                                                           REDS6E
 2,3,0,1,                                                             REDS6G
 1,33.872, 22.5,33.872,-7.5,45.872,-7.5,45.872,-22.5,                 REDS7A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS7B
 2,8,12,6,                                                            REDS7E
 2,3,0,1,                                                             REDS7G
 1,33.872, 7.5,33.872,7.5,45.872,7.5,45.872,-7.5,                     REDS8A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS8B
 3,9,13,7,                                                            REDS8E
 2,3,0,1,                                                             REDS8G
 1,33.872,7.5,33.872,22.5,45.872,22.5,45.872,7.5,                     REDS9A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS9B
 4,10,14,8,                                                           REDS9E
 2,3,0,1,                                                             REDS9G
 1,33.872,22.5,33.872,38.1,45.872,38.1,45.872,22.5,                   REDS10A
 0,2104.2404,0,2104.2404,1,1,1,1,0,0,0,0,                             REDS10B
 5,28,15,9,                                                           REDS10E
 2,3,0,1,                                                             REDS10G
 1,45.872, 38.1,45.872,-22.5,57.15,-22.5,57.15,-38.1,                 REDS11A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                             REDS11B
 6,12,22,26,                                                          REDS11E
 2,3,0,1,                                                             REDS11G
 1,45.872, 22.5,45.872,-7.5,57.15,-7.5,57.15,-22.5,                   REDS12A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                             REDS12B
 7,13,22,11,                                                          REDS12E
 2,3,0,1,                                                             REDS12G
 1,45.872, 7.5,45.872,7.5,57.15,7.5,57.15,-7.5,                       REDS13A
 0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                             REDS13B
 8,14,22,12,                                                          REDS13E
   3,0,1,                                                             REDS13G
   45.872,7.5,45.872,22.5,57.15,22.5,57.15,7.5,                       REDS14A
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0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                          REDS14B
9,15,22,13,                                                       REDS14E
2,3,0,1,                                                          REDS14G
1,45.872,22.5,45.872,38.1,57.15,38.1,57.15,22.5,                  REDS15A
0,3266.1225,0,3266.1225,1,1,1,1,0,0,0,0,                          REDS15B
10,28,22,14,                                                      REDS15E
2,3,0,1,                                                          REDS15G
2,0,-38.1,0,38.1,13.0175,38.1,13.0175,-38.1,                      REDS16A
0,169.45531,0,169.45531,0,1,1,9,0,0,0,0,                          REDS16B
0,31,17,33,                                                       REDS16E
0,3,0,1,                                                          REDS16G
3,13.0175,-51.94,13.0175,48.26,17.323,48.26,17.323,-51.94,        REDS17A
0,300.08633,0,300.08633,1,1,1,11,2,1,3,2,                         REDS17B
 38.1,38.1,252.1744,-50.67,-41.91,41.91,204.2041,252.1744,        REDS17C
33,16,31,196,146,34,19,18,30,89,84,41,                            REDS17E
2,2,2,3,3,0,0,0,0,1,1,1,                                          REDS17G
4,17.323, 41.91,17.323,41.91,21.872,41.91,21.872, 41.91,          REDS18A
0,478.38438,0,478.38438,1,17,1,8,0,0,6,0,                         REDS18B
 38.1,-22.5,-7.5,7.5,22.5,38.1,                                   REDS18C
17,30,26,1,2,3,4,5,28,19,                                         REDS18E
2,3,0,0,0,0,0,0,0,1,                                              REDS18G
6,17.323, 50.67,17.323,-41.91,57.15,-41.91,57.15, 50.67,          REDS19A
0,3266.1225,0,3266.1225,1,1,1,16,0,1,0,0,                         REDS19B
478.38438,                                                        REDS19C
17,18,26,20,34,                                                   REDS19E
2,3,3,0,1,                                                        REDS19G
7,57.15,-50.67,57.15,-41.91,67.31,-41.91,67.31,-50.67,            REDS20A
0,4530.6361,0,4530.6361,1,1,1,15,0,0,0,0,                         REDS20B
19,22,21,34,                                                      REDS20E
2,3,0,1,                                                          REDS20G
10,67.31, 50.67,67.31,-41.91,79.36,-41.91,79.36,-50.67,           REDS21A
0,6298.0096,0,6298.0096,1,1,1,14,0,1,0,0,                         REDS21B
6199.9876,                                                        REDS21C
20,23,32,24,34,                                                   REDS21E
2,3,3,0,1,                                                        REDS21G
8,57.15,-41.91,57.15,41.91,67.31,41.91,67.31,-41.91,              REDS22A
0,4530.6361,0,4530.6361,1,5,70,12,6,0,0,0,                        REDS22B
 38.1,-22.5,-7.5,7.5,22.5,38.1,                                   REDS22C
26,11,12,13,14,15,28,30,23,20,                                    REDS22E
2,2,2,2,2,2,2,3,0,1,                                              REDS22G
9,67.31,-41.91,67.31,41.91,78.74,41.91,78.74,-41.91,              REDS23A
0,6199.9876,0,6199.9876,1,6,71,13,0,0,0,0,                        REDS23B
22,29,32,21,                                                      REDS23E
2,3,0,1,                                                          REDS23G
13,79.36, 50.67,79.36,48.26,83.82,48.26,83.82,-50.67,             REDS24A
0,7025.7924,0,7025.7924,1,44,73,81,2,0,0,0,                       REDS24B
 41.91,41.91,                                                     REDS24C
21,32,29,141,25,34,                                               REDS24E
2,2,2,3,0,1,                                                      REDS24G
2,83.82,-51.94,83.82,48.26,86.46,48.26,86.46,-51.94,              REDS25A
0,7475.3316,0,7475.3316,1,1,74,1,1,0,0,1,                         REDS25B
 50.67,7098.0625,                                                 REDS25C
34,24,141,27,122,127,                                             REDS25E
2,2,3,0,1,1,                                                      REDS25G
,21.872, 41.91,21.872,-38.1,57.15,-38.1,57.15,-41.91,             REDS26A
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0,3266.1225,0,3266.1225,1,1,1,7,0,2,0,0,                          REDS26B
1147.312384,2104.2404,                                            REDS26C
1° -1,6,11,22,19,                                                 REDS26E
2   ,3,3,0,1,                                                     REDS26G
11,86.46, 51.94,86.46,48.26,87,48.26,87,-51.94,                   REDS27A
0,7569,0,7569,1,1,1,1,0,0,0,0,                                    REDS27B
25,139,201,120,                                                   REDS27E
2,3,0,1,                                                          REDS27G
5,21.872,38.1,21.872,41.91,57.15,41.91,57.15,38.1,                REDS28A
0,3266.1225,0,3266.1225,1,4,1,1,0,0,0,2,                          REDS28B
1147.3128,2104.2404,                                              REDS28C
18,30,22,5,10,15,                                                 REDS28E
2,3,0,1,1,1,                                                      REDS28G
19,67.31,41.91,67.31,48.26,79.36,48.26,79.36,41.91,               REDS29A
0,6298.0096,0,6298.0096,1,25,1,1,0,0,0,1,                         REDS29B
6199.9876,                                                        REDS29C
30,141,24,23,32,                                                  REDS29E
2,3,0,1,1,                                                        REDS29G
18,17.323,41.91,17.323,48.26,67.31,48.26,67.31,41.91,             REDS30A
0,4530.6361,0,4530.6361,1,18,1,1,0,1,0,2,                         REDS30B
3456.0994,478.38438,3266.1225,                                    REDS30C
17,146,141,29,18,28,22,                                           REDS30E
2,3,3,0,1,1,1,                                                    REDS30G
7,0,38.1,0,48.26,13.0175,48.26,13.0175,38.1,                      REDS31A
0,169.45531,0,169.45531,0,87,1,1,0,1,0,0,                         REDS31B
4.1209,                                                           REDS31C
0,164,197,17,16,                                                  REDS31E
0,3,3,0,1,                                                        REDS31G
17,78.74, 41.91,78.74,41.91,79.36,41.91,79.36,-41.91,             REDS32A
0,6298.0096,0,6298.0096,1,1,72,1,0,0,0,0,                         REDS32B
23,29,24,21,                                                      REDS32E
2,3,0,1,                                                          REDS32G
7,0,-51.94.0,-38.1,13.0175,-38.1,13.0175,-51.94,                  REDS33A
0,169.45531,0,169.45531,0,1,1,10,0,0,0,0,                         REDS33B
0,16,17,93,                                                       REDS33E
0,3,0,1,                                                          REDS33G
2,17.323, 51.94,17.323,-50.67,83.82,-50.67,83.82, 51.94,          REDS34A
0,7025.7924,0,7025.7924,1,1,1,1,0,3,0,2,                          REDS34B
3266.1225,4530.6361,6298.0096,327.9721,6992.3044,                 REDS34C
17,19,20,21,24,25,41,35,122,                                      REDS34E
2,3,3,3,3,0,1,1,1,                                                REDS34G
2,18.11,-53.85,18.11,-51.94,83.62,-51.94,83.62,-53.85,            REDS35A
0,6992.3044,0,6992.3044,1,1,1,1,0,0,0,2,                          REDS35B
4294.1809,6814.5025,                                              REDS35C
41,34,122,36,65,68,                                               REDS35E
2,3,0,1,1,1,                                                      REDS35G
2,18.11,-55.5,18.11,-53.85,65.53,-53.85,65.53,-55.5,              REDS36A
0,4294.1809,0,4294.1809,1,1,1,19,0,0,0,1,                         REDS36B
423.1249,                                                         REDS36C
41,35,65,40,37,                                                   REDS36E
2,3,0,1,1,                                                        REDS36G
2,20.57,-57.73,20.57,-55.5,65.53,-55.5,28.58,-57.73,              REDS37A
0,4294.1809,16.569507,816.8164,1,1,1,26,0,0,0,0,                  REDS37B
40,36,38,39,                                                      REDS37E
2,  1,1,                                                          REDS37G
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2,58.25,-63.27,28.58,-57.73,65.53,-55.5,64.44,-63.27,                REDS38A
 5.3555957,16.569507,.14028314,4152.5136,1,1,1,29,1,0,0,0,           REDS38B
 60.38,                                                              REDS38C
42,39,37,71,57,                                                      REDS38E
2,2,2,0,1,                                                           REDS38G
16,20.57, 60.38,20.57,-57.73,28.58,-57.73,42.7723285,-60.38,         REDS39A
0,816.8164,-5.3555957,1829.4721,1,1,1,28,0,0,0,1,                    REDS39B
1422.0441,                                                           REDS39C
40,37,38,43,42,                                                      REDS39E
2,3,0,1,1,                                                           REDS39G
3,18.11,-60.38,18.11,-55.5,20.57,-55.5,20.57,-60.38,                 REDS40A
0,423.1249,0,423.1249,1,1,1,27,0,0,1,0,                              REDS40B
 57.73,                                                              REDS40C
41,36,39,37,43,                                                      REDS40E
2,3,0,0,1,                                                           REDS40G
3,15.88,-66.17,15.88,-51.94,18.11,-51.94,18.11,-66.17,               REDS41A
0,327.9721,0,327.9721,1,1,1,57,0,1,4,0,                              REDS41B
300.08633,-63.27,-60.38,-55.5,-53.85,                                REDS41C
84,17,34,45,43,40,36,35,83,                                          REDS41E
2,3,3,0,0,0,0,0,1,                                                   REDS41G
16,37.71, 63.27,37.71,-60.38,42.7723285,-60.38,58.25,-63.27,         REDS42A
0,1829.4721,-5.3555957,3393.0625,1,1,1,30,0,0,0,0,                   REDS42B
43,39,38,44,                                                         REDS42E
2,3,0,1,                                                             REDS42G
16,18.11, 63.27,18.11,-60.38,37.71,-60.38,37.71,-63.27,              REDS43A
0,1422.0441,0,1422.0441,1,1,1,31,0,1,0,0,                            REDS43B
423.1249,                                                            REDS43C
41,40,39,42,45,                                                      REDS43E
2,3,3,0,1,                                                           REDS43G
17,37.71, 66.17,37.71,-63.27,58.25,-63.27,58.25,-66.17,              REDS44A
0,3393.0625,0,3393.0625,1,1,1,32,0,0,0,0,                            REDS44B
45,42,57,46,                                                         REDS44E
2,3,0,1,                                                             REDS44G
17,18.11, 66.17,18.11,-63.27,37.71,-63.27,37.71,-66.17,              REDS45A
0,1422.0441,0,1422.0441,1,1,1,33,0,0,0,0,                            REDS45B
41,43,44,47,                                                         REDS45E
2,3,0,1,                                                             REDS45G
16,37.71, 70.23,37.71,-66.17,58.25,-66.17,58.25,-70.23,              REDS46A
0,3393.0625,0,3393.0625,1,1,1,34,0,0,0,0,                            REDS46B
47,44,58,48,                                                         REDS46E
2,3,0,1,                                                             REDS46G
16,18.11, 70.23,18.11,-66.17,37.71,-66.17,37.71,-70.23,              REDS47A
0,1422.0441,0,1422.0441,1,1,1,35,0,0,0,0,                            REDS47B
83,45,46,49,                                                         REDS47E
2,3,0,1,                                                             REDS47G
16,37.71, 75.51,37.71,-70.23,58.25,-70.23,58.25,-75.51,              REDS48A
0,3393.0625,0,3393.0625,1,1,1,37,0,0,0,0,                            REDS48B
49,46,58,50,                                                         REDS48E
2,3,0,1,                                                             REDS48G
16,18.11, 75.51,18.11,-70.23,37.71,-70.23,37.71,-75.51,              REDS49A
0,1422.0441,0,1422.0441,1,1,1,38,0,0,0,0,                            REDS49B
83,47,48,51,                                                         REDS49E
2,3,0,1,                                                             REDS49G
16,37.71, 83.34,37.71,-75.51,58.25,-75.51,58.25,-83.34,              REDS50A
0,3393.0625,0,3393.0625,1,1,1,1,0,0,0,0,                             REDS50B
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51,48,59,52,                                                        REDS50E
2,3,0,1,                                                            REDS50G
16,18.11, 83.34,18.11,-75.51,37.71,-75.51,37.71,-83.34,             REDS51A
   422.0441,0,1422.0441,1,1,1,1,0,0,0,0,                            REDS51B
 ,49,50,53,                                                         REDS51E
2,3,0,1,                                                            REDS51G
16,37.71, 95.34,37.71,-83.34,58.25,-83.34,58.25,-95.34,             REDS52A
0,3393.0625,0,3393.0625,1,1,1,47,0,0,0,0,                           REDS52B
53,50,59,54,                                                        REDS52E
2,3,0,1,                                                            REDS52G
16,18.11, 95.34,18.11,-83.34,37.71,-83.34,37.71,-95.34,             REDS53A
0,1422.0441,0,1422.0441,1,1,1,48,0,0,0,0,                           REDS53B
83,51,52,55,                                                        REDS53E
2,3,0,1,                                                            REDS53G
16,37.71, 110.26,37.71,-95.34,58.25,-95.34,58.25, 110.26,           REDS54A
0,3393.0625,0,3393.0625,1,1,1,52,0,0,0,0,                           REDS54B
55,52,60,56,                                                        REDS54E
2,3,0,1,                                                            REDS54G
16,18.11, 110.26,18.11,-95.34,37.71,-95.34,37.71, 110.26,           REDS55A
0,1422.0441,0,1422.0441,1,1,1,53,0,0,0,0,                           REDS55B
83,53,54,56,                                                        REDS55E
2,3,0,1,                                                            REDS55G
16,17.42, 120.93,17.42,-110.26,58.25,-110.26,58.25,-120.93,         REDS56A
0,3393.0625,0,3393.0625,1,1,1,54,0,1,0,1,                           REDS56B
1422.0441,1651.6096,                                                REDS56C
82,55,54,60,81,80,                                                  REDS56E
2,3,3,0,1,1,                                                        REDS56G
12,58.25, 66.17,58.25,-63.27,64.44,-63.27,64.44,-66.17,             REDS57A
0,4152.5136,0,4152.5136,1,1,1,1,0,0,0,0,                            REDS57B
44,38,61,58,                                                        REDS57E
2,3,0,1,                                                            REDS57G
12,58.25, 75.51,58.25,-66.17,64.44,-66.17,64.44,-75.51,             REDS58A
0,4152.5136,0,4152.5136,1,1,1,36,1,0,1,0,                           REDS58B
 70.23,-70.23,                                                      REDS58C
48,46,57,62,61,59,                                                  REDS58E
2,2,3,0,0,1,                                                        REDS58G
12,58.25, 95.34,58.25,-75.51,64.44,-75.51,64.44,-95.34,             REDS59A
0,4152.5136,0,4152.5136,1,1,1,46,1,0,0,0,                           REDS59B
-83.34,                                                             REDS59C
52,50,58,63,60,                                                     REDS59E
2,2,3,0,1,                                                          REDS59G
12,58.25, 120.93,58.25,-95.34,64.44,-95.34,64.44, 120.93,           REDS60A
0,4152.5136,0,4152.5136,1,1,1,51,1,0,1,0,                           REDS60B
 110.26,-99.64,                                                     REDS60C
56,54,59,64,63,80,                                                  REDS60E
2,2,3,0,0,1,                                                        REDS60G
16,64.44, 70.23,64.44,-63.27,64.44,-63.27,72.8,-70.23,              REDS61A
0,0,-1.2011494,5299.84,1,1,1,40,1,0,0,0,                            REDS61B
 66.17,                                                             REDS61C
58,57,0,71,62,                                                      REDS61E
2,2,0,3,1,                                                          REDS61G
16,64.44, 75.51,64.44,-70.23,72.8,-70.23,75.44,-75.51,              REDS62A
0,5299.84,-.5,5691.1936,1,1,1,39,0,0,0,0,                           REDS62B
58,61,72,63,                                                        REDS62E
2,3,0,1,                                                            REDS62G
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16,64.44, 99.64,64.44,-75.51,75.44,-75.51,75.44,-99.64,     REDS63A
0,5691.1936,0,5691.1936,1,1,1,49,1,0,0,0,                   REDS63B
 95.34,                                                     REDS63C
 0,59,62,74,64,                                             REDS63E
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2,2,3,0,1,                                                          REDS63G
16,64.44, 120.93,64.44,-99.64,75.44,-99.64,65.66, 120.93,           REDS64A
0,5691.1936,.45937059,4311.2356,1,1,1,1,0,0,0,0,                    REDS64B
   63,75,80,                                                        REDS64E
2,3,1,1,                                                            REDS64G
16,65.53, 55.5,65.53,-53.85,82.55,-53.85,82.55,-55.5,               REDS65A
0,6814.5025,0,6814.5025,1,1,1,20,0,0,0,0,                           REDS65B
36,35,68,66,                                                        REDS65E
2,3,0,1,                                                            REDS65G
16,73.41, 59.87,65.53,-55.5,82.55,-55.5,82.55,-59.87,               REDS66A
 1.8032037,6814.5025,0,6814.5025,1,1,1,21,0,0,0,0,                  REDS66B
71,65,68,67,                                                        REDS66E
1,3,0,1,                                                            REDS66G
16,82.55, 72.17,73.41,-59.87,82.55,-59.87,82.55,-72.17,             REDS67A
 .74308943,6814.5025,0,0,22,1,1,1,0,0,0,0,                          REDS67B
73,66,68,0,                                                         REDS67E
1,3,0,0,                                                            REDS67G
16,82.55, 78.99,82.55,-53.85,83.62,-53.85,83.62,-78.99,             REDS68A
0,6992.3044,0,6992.3044,1,1,1,1,3,0,0,0,                            REDS68B
 72.17,-59.87,-55.5,                                                REDS68C
73,67,66,65,35,122,69,                                              REDS68E
2,2,2,2,3,0,1,                                                      REDS68G
17,82.55, 91.97,82.55,-78.99,83.62,-78.99,83.62,-91.97,             REDS69A
0,6992.3044,0,6992.3044,1,1,1,1,0,0,0,0,                            REDS69B
73,68,122,70,                                                       REDS69E
2,3,0,1,                                                            REDS69G
16,82.55, 107.72,82.55,-91.97,83.62,-91.97,83.62, 107.72,           REDS70A
0,6992.3044,0,6992.3044,1,1,1,1,1,0,0,0,                            REDS70B
 98.67,                                                             REDS70C
76,73,69,122,128,                                                   REDS70E
2,2,3,0,1,                                                          REDS70G
2,64.44,-63.27,65.53,-55.5,73.41,-59.87,72.8,-70.23,                REDS71A
.14028314,-1.8032037,.05888031,-1.2011494,1,1,42,41,0,0,0,0,        REDS71B
38,66,72,61,                                                        REDS71E
2,0,1,2,                                                            REDS71G
2,75.44,-75.51,72.8,-70.23,73.41,-59.87,75.44,-75.51,               REDS72A
 .5,.05888031,-.12979539,0,1,1,1,1,0,0,0,0,                         REDS72B
62,71,73,0,                                                         REDS72E
2,2,0,0,                                                            REDS72G
2,75.44,-75.51,73.41,-59.87,82.55,-72.17,82.55,-98.67,              REDS73A
-.12979539,-.74308943,0,-.30699482,1,1,23,43,0,0,2,0,               REDS73B
 91.97,-78.99,                                                      REDS73C
72,67,70,69,68,74,                                                  REDS73E
2,0,0,0,0,1,                                                        REDS73G
2,75.44,-99.64,75.44,-75.51,82.55,-98.67,79.2,-107.72,              REDS74A
0,-.30699482,.37016575,-.46534653,1,1,1,50,0,0,0,0,                 REDS74B
63,73,76,75,                                                        REDS74E
2,3,0,2,                                                            REDS74G
2,63.75,-138.84,65.66,-120.93,75.44,-99.64,79.2,-107.72,            REDS75A
.10664433,.45937059,-.46534653,.49646529,1,1,1,83,0,0,0,1,          REDS75B
5677.9833,                                                          REDS75C
80,64,74,79,77,                                                     REDS75E
2,2,3,0,0,                                                          REDS75G
16,79.2,-107.72,82.55,-98.67,82.55,-98.67,82.55,-107.72,            REDS76A
.  )16575,0,0,6814.5025,1,1,1,1,0,0,0,0,                            REDS76B
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74,0,70,77,                                                                   REDS76E
2,0,0,1,                                                                      REDS76G
16,75.3523939,-115.47,79.2,-107.72,82.55,-107.72,82.55,-115.47,               REDS77A
.49646529,6814.5025,0,6814.5025,1,1,1,85,0,0,1,0,                            REDS77B
 111.22,                                                                      REDS77C
75,76,78,128,79,                                                              REDS77E
3,3,0,0,1,                                                                    REDS77G
12,82.55, 115.47,82.55,-111.22,86.46,-111.22,86.46,-115.47,                   REDS78A
0,7475.3316,0,7475.3316,1,1,1,1,0,0,0,1,                                      REDS78B
7240.3081,                                                                    REDS78C
77,128,119,79,109,                                                            REDS78E
2,3,0,1,1,                                                                    REDS78G
-16,63.75, 138.84,75.3523939,-115.47,85.09,-115.47,73.41,-138.84,             REDS79A
.49646529,7240.3081,.49978605,5389.0281,1,1,84,86,0,1,0,0,                    REDS79B
6814.5025,                                                                    REDS79C
-75,77,78,107,103,                                                            REDS79E
3,3,3,0,1,                                                                    REDS79G
2,40.64,-138.84,40.64,-120.93,65.66,-120.93,63.75,-138.84,                    REDS80A
0,4311.2356,.10664433,4064.0625,1,1,1,55,0,2,0,1,                             REDS80B
3393.0625,4152.5136,2619.3924,                                                REDS80C
81,56,60,64,75,102,103,                                                       REDS80E
2,3,3,3,0,1,1,                                                                REDS80G
2,11.81,-139.6,11.81,-120.93,40.64,-120.93,40.64, 139.6,                      REDS81A
0,1651.6096,0,1651.6096,1,1,1,56,0,2,1,1,                                     REDS81B
252.1744,303.4564,-138.84,326.8864,                                           REDS81C
92,87,82,56,102,80,99,101,                                                    REDS81E
2,3,3,3,0,0,1,1,                                                              REDS81G
11,15.88, 120.93,15.88,-110.26,17.42,-110.26,17.42,-120.93,                   REDS82A
0,303.4564,0,303.4564,1,1,1,1,1,0,0,0,                                        REDS82B
 116.99,                                                                      REDS82C
87,86,83,56,81,                                                               REDS82E
2,2,3,0,1,                                                                    REDS82G
20,15.88, 110.26,15.88,-66.17,18.11,-66.17,18.11, 110.26,                     REDS83A
0,327.9721,0,327.9721,58,1,1,1,2,0,4,1,                                       REDS83B
 105.41,-93.47,-95.34,-83.34, 75.51,-70.23,303.4564,                          REDS83C
86,85,84,41,55,53,51,49,47,82,56,                                             REDS83E
2,2,2,3,0,0,0,0,0,1,1,                                                        REDS83G
2,14.29,-93.47,14.29,-51.94,15.88,-51.94,15.88,-93.47,                        REDS84A
0,252.1744,0,252.1744,1,1,1,1,0,0,1,0,                                        REDS84B
 66.17,                                                                       REDS84C
89,17,83,41,85,                                                               REDS84E
2,3,0,0,1,                                                                    REDS84G
2,10.54,-105.41,14.29,-93.47,15.88,-93.47,15.88,-105.41,                      REDS85A
.31407035,252.1744,0,252.1744,1,1,1,64,0,0,0,1,                               REDS85B
139.4761,                                                                     REDS85C
90,84,83,88,86,                                                               REDS85E
2,3,0,1,1,                                                                    REDS85G
16,11.81, 116.99,11.81,-105.41,15.88,-105.41,15.88,-116.99,                   REDS86A
0,252.1744,0,252.1744,1,1,1,1,0,0,1,0,                                        REDS86B
 110.26,                                                                      REDS86C
88,85,82,83,87,                                                               REDS86E
2,3,0,0,1,                                                                    REDS86G
2,11.81,-120.93,11.81,-116.99,15.88,-116.99,15.88,-120.93,                    REDS87A
0,252.1744,0,252.1744,1,1,1,1,1,0,0,0,                                        REDS87B
 118.11,                                                                      REDS87C
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92,88,86,82,81,                                                        REDS87E
2,2,3,0,1,                                                             REDS87G
? `0.54,-118.11,10.54,-105.41,11.81,-105.41,11.81,-118.11,             REDS88A
(  39.4761,0,139.4761,1,1,1,1,0,0,1,0,                                 REDS88B
 116.99,                                                               REDS88C
91,85,87,86,92,                                                        REDS88E
2,3,0,0,1,                                                             REDS88G
11,13.0175,-93.47,13.0175,-51.94,14.29, 51.94,14.29,-93.47,            REDS89A
0,204.2041,0,204.2041,59,1,1,1,1,0,0,0,                                REDS89B
 66.17,                                                                REDS89C
94,93,17,84,90,                                                        REDS89E
2,2,3,0,1,                                                             REDS89G
11,8.64,-105.41,13.0175,-93.47,14.29,-93.47,10.54,-105.41,             REDS90A
.36662479,204.2041,.31407035,111.0916,66,1,1,1,0,0,0,0,                REDS90B
95,89,85,91,                                                           REDS90E
2,3,0,1,                                                               REDS90G
11,8.64,-118.11,8.64,-105.41,10.54,-105.41,10.54, 118.11,              REDS91A
0,111.0916,0,111.0916,65,1,1,1,0,0,0,0,                                REDS91B
96,90,88,92,                                                           REDS91E
2,3,0,1,                                                               REDS91G
11,8.64,-151.51,8.64,-118.11,11.81,-118.11,11.81, 151.51,              REDS92A
0,139.4761,0,139.4761,1,1,1,2,1,1,3,0,                                 REDS92B
 127.66,111.0916,-144.45,-139.6,-120.93,                               REDS92C
97,96,91,88,100,99,81,87,0,                                            REDS92E
2,2,3,3,0,0,0,0,0,                                                     REDS92G
7,0,-66.17,0,-51.94,13.0175,-51.94,13.0175,-66.17,                     REDS93A
0,169.45531,0,169.45531,0,1,1,60,0,0,0,1,                              REDS93B
4.1209,                                                                REDS93C
0,33,89,98,94,                                                         REDS93E
0,3,0,1,1,                                                             REDS93G
7,2.03,-93.47,2.03, 66.17,13.0175,-66.17,13.0175, 93.47,               REDS94A
0,169.45531,0,169.45531,1,1,1,61,0,0,0,0,                              REDS94B
98,93,89,95,                                                           REDS94E
2,3,0,1,                                                               REDS94G
7,2.03,-105.41,2.03,-93.47,13.0175,-93.47,8.64,-105.41,                REDS95A
0,169.45531,.36662479,74.6496,1,1,1,62,0,0,0,0,                        REDS95B
98,94,90,96,                                                           REDS95E
2,3,0,1,                                                               REDS95G
7,2.03,-127.66,2.03,-105.41,8.64,-105.41,8.64,-127.66,                 REDS96A
0,74.6496,0,74.6496,1,1,1,63,0,0,1,0,                                  REDS96B
-118.11,                                                               REDS96C
98,95,92,91,97,                                                        REDS96E
2,3,0,0,1,                                                             REDS96G
2,2.03,-151.51,2.03,-127.66,8.64,-127.66,8.64,-151.51,                 REDS97A
0,74.6496,0,74.6496,1,1,1,2,0,0,0,0,                                   REDS97B
98,96,92,0,                                                            REDS97E
2,3,0,0,                                                               REDS97G
2,0,-151.51,0,-66.17,2.03,-66.17,2.03,-151.51,                         REDS98A
0,4.1209,0,4.1209,0,1,1,2,0,0,3,0,                                     REDS98B
 127.66,-105.41,-93.47,                                                REDS98C
0,93,97,96,95,94,0,                                                    REDS98E
0,3,0,0,0,0,0,                                                         REDS98G
17,11.81, 144.45,11.81,-139.6,18.08,-139.6,18.08, 144.45,              REDS99A
0,326.8864,0,326.8864,1,1,1,1,0,0,0,0,                                 REDS99B
9   1,101,100,                                                         REDS99E
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2,3,0,1,                                                                  REDS99G
2,11.81,-151.51,11.81,-144.45,18.08,-144.45,18.08,-151.51,                REDS100A
0,326.8864,0,326.8864,1,1,1,2,0,0,0,0,                                    REDS100B
92,99,101,0,                                                              REDS100E
2,3,0,0,                                                                  REDS100G
2,18.08,-151.51,18.08,-139.6,51.18,-139.6,51.18,-151.51,                  REDS101A
0,2619.3924,0,2619.3924,1,1,1,2,1,1,0,0,                                  REDS101B
 144.45,1651.6096,                                                        REDS101C
100,99,81,102,103,0,                                                      REDS101E
2,2,3,3,0,0,                                                              REDS101G
17,40.64, 139.6,40.64,-138.84,51.18,-138.84,51.18,-139.6,                 REDS102A
0,2619.3924,0,2619.3924,1,1,1,1,0,0,0,0,                                  REDS102B
81,80,103,101,                                                            REDS102E
2,3,0,1,                                                                  REDS102G
2,51.18,-151.51,51.18,-138.84,73.41,-138.84,67.25,-151.51,                REDS103A
0,5389.0281,.48618785,4522.5625,1,1,1,2,1,1,0,0,                          REDS103B
 139.6,4064.0625,                                                         REDS103C
101,102,80,79,104,0,                                                      REDS103E
2,2,3,3,0,0,                                                              REDS103G
11,67.25, 151.51,73.41,-138.84,74.93,-138.84,68.55,-151.51,               REDS104A
.48618785,5614.5049,.50355169,4699.1025,1,1,1,2,0,0,0,0,                  REDS104B
103,113,105,0,                                                            REDS104E
2,3,0,0,                                                                  REDS104G
2,68.55,-151.51,74.93,-138.84,83.82,-138.84,83.82,-149.81,                REDS105A
.50355169,7025.7924,0,8.9823529,1,1,1,2,0,0,1,0,                          REDS105B
 143.46,                                                                  REDS105C
104,113,115,114,0,                                                        REDS105E
2,3,0,0,0,                                                                REDS105G
2,73.41,-138.84,85.09,-120.07,85.09,-120.07,85.09,-125.78,                REDS106A
.62226958,0,0,.89433384,1,0,1,1,0,0,1,0,                                  REDS106B
 123.88,                                                                  REDS106C
107,0,110,108,113,                                                        REDS106E
3,0,0,0,0,                                                                REDS106G
11,73.41, 138.84,85.09,-115.47,85.09,-115.47,85.09,-120.07,               REDS107A
.49978605,0,0,.62226958,1,0,1,1,0,0,1,0,                                  REDS107B
 118.79,                                                                  REDS107C
79,0,108,109,106,                                                         REDS107E
2,0,0,0,0,                                                                REDS107G
2,85.09,-123.88,85.09,-118.79,87,-118.79,87,-123.88,                      REDS108A
0,7569,0,7569,1,1,1,1,1,0,0,0,                                            REDS108B
 120.07,                                                                  REDS108C
106,107,109,111,110,                                                      REDS108E
2,2,3,0,1,                                                                REDS108G
2,85.09,-118.79,85.09,-115.47,88.65,-115.47,88.65,-118.79,                REDS109A
0,7858.8225,0,7858.8225,1,1,1,1,0,1,0,1,                                  REDS109B
7475.3316,7569,                                                           REDS109C
107,78,119,112,108,111,                                                   REDS109E
2,3,3,0,1,1,                                                              REDS109G
2,85.09,-125.78,85.09,-123.88,102.87,-123.88,102.87,-125.78,              REDS110A
0,10582.2369,0,10582.2369,1,1,1,1,0,1,0,0,                                REDS110B
7569,                                                                     REDS110C
106,108,111,117,113,                                                      REDS110E
2,3,3,0,1,                                                                REDS110G
14,87,-123.88,87,-118.79,102.87,-118.79,102.87,-123.88,                   REDS111A
0,10582.2369,0,10582.2369,1,1,1,1,0,1,0,0,                                REDS111B
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7858.8225,                                                          REDS111C
108,109,112,117,110,                                                REDS111E
2-2-3,0,1,                                                          REDS111G
2    .65,-118.79,88.65,-108.16,104.14,-108.16,104.14,-118.79,       REDS112A
0,10845.1396,0,10845.1396,1,1,1,1,1,0,1,1,                          REDS112B
 115.47,-112.16,10582.2369,                                         REDS112C
109,119,123,116,118,111,117,                                        REDS112E
2,2,3,0,0,1,1,                                                      REDS112G
15,73.41, 138.84,85.09,-125.78,102.87,-125.78,102.87,-138.84,       REDS113A
.8933384,10582.2369,0,10582.2369,1,1,1,1,0,0,0,2,                   REDS113B
5614.5049,7025.7924,                                                REDS113C
106,110,117,104,105,114,                                            REDS113E
3,3,0,1,1,1,
2,83.82,-143.46,83.82,-138.84,104.14,-138.84,104.14,-143.46,        REDS114A
0,10845.1396,0,10845.1396,1,1,1,1,0,1,0,0,                          REDS114B
10582.2369,                                                         REDS114C
105,113,117,116,115,                                                REDS114E
2,3,3,0,1,                                                          REDS114G
14,83.82, 149.81,83.82,-143.46,104.14,-143.46,104.14,-149.81,       REDS115A
0,10845.1396,0,10845.1396,1,1,1,2,0,0,0,0,                          REDS115B
105,114,116,0,                                                      REDS115E
2,3,0,0,                                                            REDS115G
14,104.14,-149.81,104.14,-112.16,116.84,-112.16,116.84,-149.81,     REDS116A
0,13651.5856,0,13651.5856,1,1,2,2,3,0,0,0,                          REDS116B
 143.46,-138.84,-118.79,                                            REDS116C
115,114,117,112,118,0,0,                                            REDS116E
2,2,2,2,3,0,0,                                                      REDS116G
2,102.87, 138.84,102.87,-118.79,104.14, 118.79,104.14,-138.84,      REDS117A
0,10845.1396,0,10845.1396,1,1,1,1,2,0,0,0,                          REDS117B
 125.78,-123.88,                                                    REDS117C
113,110,111,112,116,114,                                            REDS117E
2,2,2,3,0,1,                                                        REDS117G
2,104.14, 112.16,104.14,-108.16,116.84, 108.16,116.84,-112.16,      REDS118A
0,13651.5856,0,13651.5856,1,1,2,1,0,0,0,0,                          REDS118B
112,125,0,116,                                                      REDS118E
2,3,0,1,                                                            REDS118G
11,86.46, 115.47,86.46,-108.16,88.65,-108.16,88.65,-115.47,         REDS119A
0,7858.8225,0,7858.8225,1,1,1,1,1,1,0,0,                            REDS119B
 111.22,7569,                                                       REDS119C
78,128,120,201,112,109,                                             REDS119E
2,2,3,3,0,1,                                                        REDS119G
11,86.46, 108.16,86.46,-51.94,87,-51.94,87,-108.16,                 REDS120A
0,7569,0,7569,1,1,1,1,1,0,0,0,                                      REDS120B
 107.72,                                                            REDS120C
128,127,27,201,119,                                                 REDS120E
2,2,3,0,1,                                                          REDS120G
16,84.25, 107.72,84.25,-82.72,84.25,-82.72,86.46, 107.72,           REDS121A
0,0,-.0884,7475.3316,1,1,1,1,0,0,0,0,                               REDS121B
122,0,127,128,                                                      REDS121E
2,0,3,1,                                                            REDS121G
11,83.62, 107.72,83.62,-51.94,84.25,-51.94,84.25, 107.72,           REDS122A
0,7098.0625,0,7098.0625,1,1,24,1,3,1,1,0,                           REDS122B
 91.97,-78.99,-53.85,7025.7924,-82.72,                              REDS122C
70,69,68,35,34,25,121,127,128,                                      REDS122E
2,  ?,2,3,3,0,0,1,                                                  REDS122G
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14,88.65, 108.16,88.65,-75.51,104.14,-75.51,104.14,-108.16,          REDS123A
0,10845.1396,0,10845.1396,1,1,80,82,0,0,0,0,                          REDS123B
201,124,125,112,                                                      REDS123E
2,3,0,1,                                                              REDS123G
14,88.65, 75.51,88.65,-51.94,104.14,-51.94,104.14,-75.51,             REDS124A
0,10845.1396,0,10845.1396,1,1,79,1,0,1,0,0,                           REDS124B
-8085.6064,                                                           REDS124C
201,129,130,125,123,                                                  REDS124E
2,3,3,0,1,                                                            REDS124G
14,104.14,-108.16,104.14,-51.94,133.12, 51.94,116.84,-108.16,         REDS125A
0,17720.934,.28957666,13651.5856,1,0,2,1,1,0,0,0,                     REDS125B
 75.51,                                                               REDS125C
123,124,126,0,118,                                                    REDS125E
2,2,3,0,1,                                                            REDS125G
14,104.14,-51.94,104.14,54.61,133.12,54.61,133.12,-51.94,             REDS126A
0,17720.934,0,17720.934,1,1,2,1,1,0,0,0,                              REDS126B
0,                                                                    REDS126C
130,131,132,0,125,                                                    REDS126E
2,2,3,0,1,                                                            REDS126G
2,84.25,-82.72,84.25,-51.94,86.46,-51.94,86.46,-107.72,               REDS127A
0,7475.3316,0,-.0884,1,1,78,1,0,0,0,0,                                REDS127B
122,25,120,121,                                                       REDS127E
2,3,0,2,                                                              REDS127G
17,82.55, 111.22,82.55,-107.72,86.46,-107.72,86.46,-111.22,           REDS128A
0,7475.3316,0,7475.3316,1,1,1,1,0,2,1,0,                              REDS128B
6992.3044,7098.0625,-108.16,                                          REDS128C
77,70,122,121,119,120,78,                                             REDS128E
2,3,3,3,0,0,1,                                                        REDS128G
14,88.65, 51.94,88.65,54.61,89.92,54.61,89.92,-51.94,                 REDS129A
0,8085.6064,0,8085.6064,1,1,1,1,0,0,1,0,                              REDS129B
0,                                                                    REDS129C
201,132,130,131,124,                                                  REDS129E
2,3,0,0,1,                                                            REDS129G
14,89.92, 51.94,89.92,0,104.14,0,104.14,-51.94,                       REDS130A
0,10845.1396,0,10845.1396,1,1,76,68,0,0,0,0,                          REDS130B
129,131,126,124,                                                      REDS130E
2,3,0,1,                                                              REDS130G
14,89.92,0,89.92,54.61,104.14,54.61,104.14,0,                         REDS131A
0,10845.1396,0,10845.1396,1,69,77,1,0,0,0,0,                          REDS131B
129,132,126,130,                                                      REDS131E
2,3,0,1,                                                              REDS131G
14,88.65,54.61,97.26,79.25,133.12,79.25,133.12,54.61,                 REDS132A
.34943182,17720.934,0,17720.934,1,1,2,1,0,0,0,2,                      REDS132B
8085.6064,10845.1396,                                                 REDS132C
136,133,0,129,131,126,                                                REDS132E
3,3,0,1,1,1,                                                          REDS132G
14,97.26,79.25,97.26,90.17,133.12,90.17,133.12,79.25,                 REDS133A
0,17720.934,0,17720.934,1,1,2,1,0,0,0,0,                              REDS133B
136,134,0,132,                                                        REDS133E
2,3,0,1,                                                              REDS133G
14,97.26,90.17,97.26,133.86,125.22,133.86,133.12,90.17,               REDS134A
0,15680.048,-.18081941,17720.934,1,103,2,1,0,0,0,0,                   REDS134B
136,135,0,133,                                                        REDS134E
2,3,0,1,                                                              REDS134G
14,97.26,133.86,74.5,191.64,91.19,191.64,125.22,133.86,               REDS135A
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.39390793,8315.6161,-.58895812,15680.048,1,2,2,1,2,0,0,0,      REDS135B
139.57,161.67,                                                  REDS135C
137,138,200,0,0,134,                                            REDS135E
2  ,2,0,0,1,                                                    REDS135G
2,88.65,54.61,88.65,133.86,97.26,133.86,97.26,79.25,           REDS136A
0,9459.5076,0,.34943182,1,1,102,1,0,0,1,0,                      REDS136B
90.17,                                                          REDS136C
201,137,133,134,132,                                            REDS136E
2,  0,0,0,                                                      REDS136G
2,[illegible].65,133.86,88.65,139.57,95.010786,139.57,97.26,133.86,   REDS137A
0,9027.0494,-.39390793,9459.5076,1,1,1,1,0,0,0,0,               REDS137B
201,138,135,136,                                                REDS137E
2,3,0,1,                                                        REDS137G
2,87,139.57,84.33,161.67,86.305421,161.67,95.010786,139.57,    REDS138A
.12081448,7448.6256,-.39390793,9027.0494,1,1,1,1,0,0,0,1,      REDS138B
7858.8225,                                                      REDS138C
140,200,135,201,137,                                            REDS138E
2,3,0,1,1,                                                      REDS138G
11,86.46,48.26,86.46,139.57,87,139.57,87,48.26,                 REDS139A
0,7569,0,7569,1,1,1,1,7,0,0,0,                                  REDS139B
51.82,61,70.36,86.87,90.47,111.96,130.89,                       REDS139C
141,142,144,145,151,152,154,155,140,201,27,                     REDS139E
2,2,2,2,2,2,2,2,3,0,1,                                          REDS139G
11,86.46,139.57,83.79,161.67,84.33,161.67,87,139.57,            REDS140A
.12081448,7111.5489,-.12081448,7569,1,1,1,1,0,0,0,0,            REDS140B
198,200,138,139,                                                REDS140E
2,3,0,1,                                                        REDS140G
2,58.788599,48.26,62.728988,51.82,86.46,51.82,86.46,48.26,      REDS141A
1.1068507,7475.3316,0,7475.3316,1,1,1,1,1,2,0,3,                REDS141B
50.8,5768.4025,6280.5625,4530.6361,6298.0096,7025.7924,         REDS141C
146,166,143,165,142,139,30,29,24,25,                            REDS141E
2,2,3,3,3,0,1,1,1,1,                                            REDS141G
2,79.25,51.82,79.25,61,86.46,61,86.46,51.82,                    REDS142A
0,7475.3316,0,7475.3316,1,1,1,1,0,0,0,0,                        REDS142B
165,144,139,141,                                                REDS142E
2,3,0,1,                                                        REDS142G
2,62.728988,51.82,72.889878,61,75.95,61,75.95,51.82,            REDS143A
1.1068507,5768.4025,0,5768.4025,1,1,1,1,0,0,0,0,                REDS143B
166,144,165,141,                                                REDS143E
2,3,0,1,                                                        REDS143G
2,72.889877,61,83.25,70.36,86.46,70.36,86.46,61,                REDS144A
1.1068507,7475.3316,0,7475.3316,1,1,1,1,0,0,0,2,                REDS144B
5768.4025,6280.5625,                                            REDS144C
166,145,139,143,165,142,                                        REDS144E
2,3,0,1,1,1,                                                    REDS144G
2,83.25,70.36,83.25,86.87,86.46,86.87,86.46,70.36,              REDS145A
0,7475.3316,0,7475.3316,1,1,1,1,0,0,0,0,                        REDS145B
167,151,139,144,                                                REDS145E
2,3,0,1,                                                        REDS145G
2,15.88,48.26,15.88,50.8,61.6,50.8,58.788599,48.26,             REDS146A
0,3794.56,1.1068507,3456.0994,1,1,1,1,0,0,0,1,                  REDS146B
300.08633,                                                      REDS146C
196,147,141,17,30,                                              REDS146E
2,3,0,1,1,                                                      REDS146G
2,  ,88,50.8,15.88,56.64,56.69,56.64,61.6,50.8,                 REDS147A
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0,3213.7561,-.84075342,3794.56,1,45,1,1,0,2,0,0,                    REDS147B
280.8976,713.9584,                                                  REDS147C
196,160,157,148,166,146,                                            REDS147E
2,3,3,3,3,1,                                                        REDS147G
2,26.72,56.64,26.72,70.36,73.66,70.36,56.69,56.64,                  REDS148A
0,5425.7956,1.2368805,3213.7561,1,91,1,1,0,2,0,0,                   REDS148B
802.0224,3296.1097,                                                 REDS148C
157,158,150,149,166,147,                                            REDS148E
2,3,3,3,0,1,                                                        REDS148G
2,57.411756,70.36,70.87,86.87,82.9,86.87,73.66,70.36,               REDS149A
.81515712,6872.41,.55966081,5425.7956,1,1,1,1,2,0,0,0,              REDS149B
76.05,83.44,                                                        REDS149C
150,170,171,151,167,148,                                            REDS149E
2,2,2,3,0,1,                                                        REDS149G
2,78.32,70.36,62.05,76.05,62.05,76.05,57.411756,70.36,              REDS150A
5.92794376,0,.815157116,3296.109728,1,1,1,1,0,0,0,0,                REDS150B
169,0,149,148,                                                      REDS150E
3,0,0,1,                                                            REDS150G
2,64.77,86.87,39.1,90.47,86.46,90.47,86.46,86.87,                   REDS151A
 7.1305556,7475.3316,0,7475.3316,1,94,1,1,0,5,0,3,                  REDS151B
1930.7236,2242.0225,4651.24,6199.9876,6298.0096,                    REDS151C
5022.5569,6872.41,6930.5625,                                        REDS151D
175,185,184,181,153,168,152,139,171,149,167,145,                    REDS151E
2,3,3,3,3,3,3,0,1,1,1,1,                                            REDS151G
2,79.36,90.47,79.36,111.96,86.46,111.96,86.46,90.47,                REDS152A
0,7475.3316,0,7475.3316,1,1,1,1,0,0,0,0,                            REDS152B
168,154,139,151,                                                    REDS152E
2,3,0,1,                                                            REDS152G
2,68.2,90.47,68.2,111.96,78.74,111.96,78.74,90.47,                  REDS153A
0,6199.9876,0,6199.9876,1,1,1,1,1,0,0,0,                            REDS153B
108.92,                                                             REDS153C
181,182,154,168,151,                                                REDS153E
2,2,3,0,1,                                                          REDS153G
2,61.6,111.96,54.15,130.89,86.46,130.89,86.46,111.96,               REDS154A
 .3935552,7475.3316,0,7475.3316,1,101,1,1,0,0,0,3,                  REDS154B
4651.24,6199.9876,6298.0096,                                        REDS154C
188,155,139,182,153,168,152,                                        REDS154E
2,3,0,1,1,1,1,                                                      REDS154G
2,45.871012,130.89,46.756442,139.57,86.46,139.57,86.46,130.89,      REDS155A
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71.76,585.64,                                                       REDS158C
179,159,169,172,176,148,                                            REDS158D
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7    ),                                                           REDS159C
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10,
*VJG,35,25,                                                     VJG
8
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