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Informal Report

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**Gamma Measurements on Spherical
Shells of ^{239}Pu and ^{238}U**

University of California

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Gamma Measurements on Spherical Shells of ^{239}Pu and ^{238}U

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GAMMA MEASUREMENTS ON SPHERICAL SHELLS OF ^{239}Pu AND ^{238}U

by

P. J. Bendt and E. T. Journey

ABSTRACT

The gamma spectra from two ^{239}Pu spherical shells and an identical ^{238}U shell 67-mm o.d. and 2.2 mm thick have been measured with NaI(Tl) and Ge(Li) detectors. The plutonium shells differed in the ^{240}Pu content. The intrinsic gamma radiation at 2 m from the shells was 93.3 $\mu\text{rem/h}$ (5.93% ^{240}Pu); 67.3 $\mu\text{rem/h}$ (2.65% ^{240}Pu); and 0.69 $\mu\text{rem/h}$ (tuballoy with 0.2% ^{235}U). The NaI(Tl) spectrum is given in photons/cm²-s and in mrem/h for 10 keV energy bins to 1 MeV for the plutonium shells, and for 25 keV energy bins to 3 MeV for the tuballoy shell. The decay chains leading to the prominent gamma lines in the Ge(Li) spectra are discussed.

I. INTRODUCTION

We have measured the photon flux vs. energy from two spherical shells of ^{239}Pu containing different amounts of ^{240}Pu , and from a shell of ^{238}U . The measurements were undertaken to provide comparisons in a simple geometry with Monte Carlo calculations of the gamma transport.

II. THE EXPERIMENT

Two spherical shells were fabricated from ^{239}Pu containing different amounts of ^{240}Pu and ^{241}Pu . The amounts of ^{240}Pu were 2.65% and 5.93%. An identical shell was fabricated of depleted ^{238}U containing 0.2% ^{235}U (tuballoy). The Pu shells were 67-mm o.d. and 2.2 mm thick and weighed ~ 455 g each. The tuballoy shell had the same dimensions, and weighed 550 g. The shells were machined in two hemispheres, with a step where they fitted together. The shells were enclosed in close-fitting 304 SS jackets 0.3 mm thick, which were electron-beam welded around the equator. The jackets were vacuum tight, and the voids inside were filled with helium gas at atmospheric pressure through a 2-mm diam stem.

The NaI(Tl) detector was 63.5-mm diam and 150 mm long and was surrounded by a NaI(Tl) annulus.

The photons were counted in anti-coincidence with pulses from the annulus, to improve the ratio between the full-energy peak and Compton scattering events. The method used to unfold the NaI(Tl) pulse-height distribution has been described previously¹. The photon intensity from the Pu spheres was measured at 2 m and divided into 10 keV energy bins. The photon intensity from the tuballoy sphere was measured at 0.5 m and divided into 25 keV energy bins. The integral dose rate was obtained by converting photon intensity to microrem/h at each energy, and summing over energy².

The Ge(Li) detector had a volume of 26 cm³ and was cooled to liquid nitrogen temperature. The Ge(Li) measurements were also made in anti-coincidence with a NaI(Tl) annulus. The narrow resolution of the Ge(Li) detector made it possible to identify individual gamma rays. The intensities of the gamma rays were normalized to the intensity of the 662 keV ^{137}Cs line from an I.A.E.A. source located 50 cm from the detector. During the measurements, the spheres were located 57.8 cm from the Ge(Li) detector.

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Fig. 1. NaI(Tl) spectrum from the ^{239}Pu sphere containing 2.65% ^{240}Pu . The points are 10 keV energy bins.

Fig. 2. NaI(Tl) spectrum from the ^{239}Pu sphere containing 5.93% ^{240}Pu . The points are 10 keV energy bins.

III. RESULTS OF THE NaI(Tl) MEASUREMENTS

The photon intensities using the NaI(Tl) detector are shown in Figs. 1-3. The dose rates from the spheres at 2 m, integrated over energy, are given in Table I. In Appendix A, the plutonium spectra are given in 10 keV energy bins out to one MeV, and the tuballoy spectrum in 25 keV energy bins out to three MeV.

TABLE I

Integral dose rates at 2 m from the spheres. The tuballoy sphere was measured at 0.5 m, and the dose rate has been divided by 16, for comparison with the plutonium spheres.

Sphere	Dose rate (microrem/h)
^{239}Pu (5.93% ^{240}Pu)	93.3 ± 5.6
^{239}Pu (2.65% ^{240}Pu)	67.3 ± 4.0
^{238}U (0.2% ^{235}U)	0.69 ± 0.04

IV. THE LINE SPECTRA FROM ^{239}Pu SPHERES

The energies and intensities of the line spectra are shown in Figs. 4-6 and are given in Appendix B. We looked for experimental verification of the difference in ^{240}Pu content of the ^{239}Pu spheres. Plutonium-240 decays by alpha emission to ^{236}U , and the gamma spectrum is due to transitions between levels in ^{236}U (Fig. 7). Of the five strongest lines, only the 160.3 keV line was observable, and it was not fully resolved from a line at 161.5 keV in the ^{239}Pu spectrum. From the isotopic analysis of the spheres, the ratio of the amounts of ^{240}Pu is 2.24; from the intensities of the 160.3 keV line, the ratio is $2.1 \pm 18\%$.

The difference in ^{241}Pu content of the spheres was shown by two lines. Plutonium-241 (14.7 yr) decays 99.75% by β^- emission to ^{241}Am (432 yr) and 0.25% alpha emission to ^{237}U (6.75 days) (Fig. 7). The ^{237}U emits a gamma at 148.6 keV, and its decay by β^- excites a gamma at 208 keV in ^{237}Np . Due to the short half-life of ^{237}U , the intensities of

these lines are in the ratio of the amounts of ^{241}Pu . This ratio is $4.9 \pm 5\%$.

Due to the long half-life of ^{241}Am , (432 yr), the amount present depends on how long ^{241}Am has been growing in from decay of ^{241}Pu , as well as the amount of ^{241}Pu present. From the intensities of the prominent ^{241}Am gamma at 59.5 keV, which accompanies alpha decay to ^{237}Np , the amounts of ^{241}Am in the ^{239}Pu spheres are in the ratio $1.7 \pm 5\%$. This indicates the time interval since reprocessing the 5.93% ^{240}Pu material is about 1/3 as long as the time interval since reprocessing the 2.65% ^{240}Pu material.

V. THE LINE SPECTRUM FROM THE ^{238}U SPHERE

Uranium-238 decays by alpha emission to ^{234}Th , with decay by β^- to the 1.17 m metastable $^{234\text{m}}\text{Pa}$. Here the chain branches: 98.6% of the $^{234\text{m}}\text{Pa}$ decays by β^- to the ^{234}U ground state; 1.27% of the $^{234\text{m}}\text{Pa}$ decays to excited states in ^{234}U ; 0.13% of $^{234\text{m}}\text{Pa}$ decays with a 73.9 keV gamma to ^{234}Pa (6.70 h) (Fig. 8). The ^{234}Pa ground state decays by β^- to a different set of levels in ^{234}U .

Fig. 3. NaI(Tl) spectrum from the tuballoy sphere containing 0.2% ^{235}U . The points are 25 keV energy bins.

Fig. 4. Ge(Li) spectrum from the ^{239}Pu sphere containing 2.65% ^{240}Pu . The vertical scale is the counts/channel in 3000 s at 57.8 cm.

Fig. 5. Ge(Li) spectrum from the ^{239}Pu sphere containing 5.93% ^{240}Pu . The vertical scale is the counts/channel in 2000 s at 57.8 cm.

Fig. 6. Ge(Li) spectrum from the tuballoy sphere containing 0.2% ^{235}U . The vertical scale is the counts/channel in 50 000 s at 57.8 cm.

Fig. 7. The decay chains and prominent gamma rays from the decay of ^{240}Pu and ^{241}Pu .

Fig. 8. The decay chains and prominent gamma rays from the decay of ^{235}U and ^{238}U .

The only gammas from ^{234}Pa are at 63.3, 83.3 and 92.4 keV. Prominent lines in ^{234}U accompanying the 1.17 m activity occur at 257.9, 743.0, 766.6, 786.4, and 1001.0 keV. Prominent lines accompanying the 6.70 h activity occur at 565, 569, 880.5, 883.2, 926, 927.1, and 946 keV.

The line intensities from the 0.2% ^{235}U in the sphere are magnified 6.3 times by the shorter half-life of ^{235}U relative to ^{238}U . Uranium-235 decays by alpha emission to ^{231}Th , and four gammas from ^{231}Th were observed at 143.8, 163.4, 185.5, and

205.3 keV. We estimate 90% of the intensity of the line at 185.5 keV comes from the 0.2% ^{235}U in the tuballoy, rather than from the decay products of ^{238}U .

REFERENCES

1. P. J. Bendt and E. T. Jurney, "Gamma Spectra from ^{233}U , ^{235}U , and ^{239}Pu During Thermal Neutron Irradiation," Los Alamos Scientific Laboratory report LA-7451-MS (1978).
2. ANSI/ANS-6.1.1-1977 (N666), published by the American Nuclear Society, 555 N Kensington Ave., LaGrange Park, IL 60535.

APPENDIX A

The photon spectra taken with the NaI(Tl) detector. The Pu spectra were taken at 2 m and are divided into 10 keV energy bins. The tuballoy spectrum was taken at 0.5 m and is divided into 25 keV energy bins. The gamma ray intensities in the tuballoy spectrum have been normalized to 2 m by dividing them by 16.

<div> <div>PHOTON SPECTRUM</div> <div>=====</div> <div> <div>239Pu (5.93% 240Pu)</div> </div> </div>							
BIN NO.	E (LO) (KEV)	E (KEV)	E (HI) (KEV)	PHOTONS/ SQCM/SEC/BIN	UNCERT	REM/ HR/BIN	UNCERT
1	0.0	5.0	10.0	0.	0.	0.	0.
2	10.0	15.0	20.0	0.	0.	0.	0.
3	20.0	25.0	30.0	8.08E+00	3.4E-01	7.22E-03	3.1E-04
4	30.0	35.0	40.0	2.51E+00	1.8E-01	1.10E-03	8.1E-05
5	40.0	45.0	50.0	2.33E-01	3.4E-02	7.38E-05	1.1E-05
6	50.0	55.0	60.0	4.76E+01	3.8E-01	1.30E-02	1.1E-04
7	60.0	65.0	70.0	8.85E+01	1.9E-01	2.30E-02	4.9E-05
8	70.0	75.0	80.0	9.74E+00	1.2E-01	2.52E-03	3.1E-05
9	80.0	85.0	90.0	2.09E+00	8.0E-02	5.54E-04	2.1E-05
10	90.0	95.0	100.0	6.86E+00	9.1E-02	1.49E-03	2.5E-05
11	100.0	105.0	110.0	1.50E+01	7.1E-02	4.35E-03	2.1E-05
12	110.0	115.0	120.0	1.05E+01	4.8E-02	3.22E-03	1.5E-05
13	120.0	125.0	130.0	5.69E+00	3.5E-02	1.45E-03	1.1E-05
14	130.0	135.0	140.0	2.40E+00	2.6E-02	8.32E-04	9.2E-06
15	140.0	145.0	150.0	9.29E-01	2.1E-02	3.42E-04	7.8E-06
16	150.0	155.0	160.0	5.60E-01	1.8E-02	2.19E-04	7.2E-06
17	160.0	165.0	170.0	4.58E-01	1.7E-02	1.90E-04	7.2E-06
18	170.0	175.0	180.0	3.56E-01	1.6E-02	1.56E-04	7.0E-06
19	180.0	185.0	190.0	2.90E-01	1.5E-02	1.35E-04	6.9E-06
20	190.0	195.0	200.0	5.67E-01	1.8E-02	2.77E-04	9.0E-06
21	200.0	205.0	210.0	1.34E+00	2.2E-02	6.47E-04	1.1E-05
22	210.0	215.0	220.0	1.64E+00	2.2E-02	8.95E-04	1.2E-05
23	220.0	225.0	230.0	9.60E-01	1.9E-02	5.43E-04	1.1E-05
24	230.0	235.0	240.0	3.36E-01	1.4E-02	1.99E-04	8.4E-06
25	240.0	245.0	250.0	1.71E-01	1.1E-02	1.05E-04	6.8E-06
26	250.0	255.0	260.0	1.62E-01	1.1E-02	1.04E-04	6.9E-06
27	260.0	265.0	270.0	2.03E-01	1.2E-02	1.16E-04	8.0E-06
28	270.0	275.0	280.0	1.79E-01	1.1E-02	1.24E-04	7.9E-06
29	280.0	285.0	290.0	1.50E-01	1.1E-02	1.08E-04	7.6E-06
30	290.0	295.0	300.0	1.45E-01	1.1E-02	1.23E-04	8.3E-06
31	300.0	305.0	310.0	2.55E-01	1.4E-02	1.97E-04	1.0E-05
32	310.0	315.0	320.0	4.62E-01	1.7E-02	3.67E-04	1.3E-05
33	320.0	325.0	330.0	8.35E-01	2.0E-02	6.44E-04	1.6E-05
34	330.0	335.0	340.0	1.29E+00	2.1E-02	1.09E-03	1.8E-05
35	340.0	345.0	350.0	1.59E+00	2.1E-02	1.37E-03	1.9E-05
36	350.0	355.0	360.0	1.78E+00	2.1E-02	1.58E-03	1.9E-05
37	360.0	365.0	370.0	2.12E+00	2.0E-02	1.93E-03	1.9E-05
38	370.0	375.0	380.0	2.70E+00	2.0E-02	2.52E-03	1.9E-05
39	380.0	385.0	390.0	3.41E+00	1.9E-02	2.97E-03	1.8E-05
40	390.0	395.0	400.0	3.10E+00	1.7E-02	3.03E-03	1.7E-05
41	400.0	405.0	410.0	2.82E+00	1.6E-02	2.80E-03	1.6E-05
42	410.0	415.0	420.0	2.56E+00	1.4E-02	2.59E-03	1.4E-05
43	420.0	425.0	430.0	2.21E+00	1.3E-02	2.28E-03	1.3E-05
44	430.0	435.0	440.0	1.63E+00	1.1E-02	1.71E-03	1.1E-05
45	440.0	445.0	450.0	1.01E+00	8.6E-03	1.08E-03	9.2E-06
46	450.0	455.0	460.0	5.76E-01	6.8E-03	6.25E-04	7.4E-06
47	460.0	465.0	470.0	3.38E-01	5.6E-03	3.73E-04	6.1E-06
48	470.0	475.0	480.0	2.00E-01	4.6E-03	2.23E-04	5.2E-06
49	480.0	485.0	490.0	1.06E-01	4.0E-03	1.19E-04	4.5E-06
50	490.0	495.0	500.0	4.00E-02	3.5E-03	4.58E-05	4.1E-06
51	500.0	505.0	510.0	1.87E-02	3.4E-03	2.23E-05	4.0E-06
52	510.0	515.0	520.0	1.16E-02	3.3E-03	1.40E-05	4.8E-06
53	520.0	525.0	530.0	8.86E-03	3.2E-03	1.09E-05	3.9E-06
54	530.0	535.0	540.0	9.51E-03	3.0E-03	1.18E-05	3.8E-06
55	540.0	545.0	550.0	8.36E-03	2.8E-03	1.06E-05	3.6E-06
56	550.0	555.0	560.0	8.41E-03	2.8E-03	1.08E-05	3.6E-06
57	560.0	565.0	570.0	1.13E-02	2.7E-03	1.47E-05	3.5E-06
58	570.0	575.0	580.0	8.55E-03	2.8E-03	1.12E-05	3.6E-06
59	580.0	585.0	590.0	1.80E-02	2.8E-03	2.40E-05	3.8E-06
60	590.0	595.0	600.0	1.80E-02	2.8E-03	2.43E-05	3.8E-06
61	600.0	605.0	610.0	2.64E-02	3.0E-03	3.60E-05	4.0E-06
62	610.0	615.0	620.0	4.06E-02	3.1E-03	5.62E-05	4.3E-06
63	620.0	625.0	630.0	6.07E-02	3.4E-03	8.50E-05	4.8E-06
64	630.0	635.0	640.0	7.90E-02	3.5E-03	1.12E-04	5.0E-06
65	640.0	645.0	650.0	9.30E-02	3.6E-03	1.33E-04	5.2E-06
66	650.0	655.0	660.0	9.80E-02	3.7E-03	1.42E-04	5.3E-06
67	660.0	665.0	670.0	9.27E-02	3.7E-03	1.36E-04	5.4E-06
68	670.0	675.0	680.0	7.25E-02	3.4E-03	1.08E-04	5.0E-06
69	680.0	685.0	690.0	6.27E-02	3.3E-03	9.40E-05	4.9E-06
70	690.0	695.0	700.0	4.55E-02	3.1E-03	6.49E-05	4.7E-06
71	700.0	705.0	710.0	3.74E-02	2.9E-03	5.74E-05	4.4E-06
72	710.0	715.0	720.0	3.25E-02	2.7E-03	5.04E-05	4.2E-06
73	720.0	725.0	730.0	3.43E-02	2.7E-03	5.36E-05	4.3E-06
74	730.0	735.0	740.0	2.56E-02	2.6E-03	4.05E-05	4.2E-06
75	740.0	745.0	750.0	2.46E-02	2.6E-03	3.93E-05	4.1E-06

76	750.0	755.0	760.0	3.04E-02	2.6E-03	4.49E-05	4.2E-06
77	760.0	765.0	770.0	2.88E-02	2.5E-03	4.48E-05	4.1E-06
78	770.0	775.0	780.0	2.83E-02	2.5E-03	4.45E-05	4.1E-06
79	780.0	785.0	790.0	2.25E-02	2.4E-03	3.73E-05	4.0E-06
80	790.0	795.0	800.0	1.59E-02	2.3E-03	2.67E-05	3.8E-06
81	800.0	805.0	810.0	1.04E-02	2.2E-03	1.76E-05	3.8E-06
82	810.0	815.0	820.0	8.86E-03	2.2E-03	1.51E-05	3.7E-06
83	820.0	825.0	830.0	8.70E-03	2.1E-03	1.50E-05	3.7E-06
84	830.0	835.0	840.0	7.15E-03	2.2E-03	1.24E-05	3.8E-06
85	840.0	845.0	850.0	7.41E-03	2.2E-03	1.10E-05	3.9E-06
86	850.0	855.0	860.0	5.79E-03	2.2E-03	1.02E-05	3.9E-06
87	860.0	865.0	870.0	6.89E-03	2.2E-03	1.23E-05	4.0E-06
88	870.0	875.0	880.0	4.90E-03	2.2E-03	8.40E-06	4.0E-06
89	880.0	885.0	890.0	2.42E-03	2.2E-03	4.38E-06	4.1E-06
90	890.0	895.0	900.0	1.04E-04	2.2E-03	1.91E-07	3.9E-06
91	900.0	905.0	910.0	5.42E-03	2.2E-03	9.97E-06	4.0E-06
92	910.0	915.0	920.0	1.55E-03	2.1E-03	2.88E-06	3.9E-06
93	920.0	925.0	930.0	5.26E-03	2.1E-03	9.83E-06	3.9E-06
94	930.0	935.0	940.0	1.74E-03	2.0E-03	3.28E-06	3.7E-06
95	940.0	945.0	950.0	1.40E-03	2.0E-03	2.66E-06	3.8E-06
96	950.0	955.0	960.0	4.15E-03	2.0E-03	7.94E-06	3.9E-06
97	960.0	965.0	970.0	2.50E-03	2.0E-03	4.41E-06	3.9E-06
98	970.0	975.0	980.0	1.71E-03	2.0E-03	3.31E-06	3.8E-06
99	980.0	985.0	990.0	2.15E-05	2.0E-03	4.21E-08	3.9E-06
100	990.0	995.0	1000.0	2.95E-03	2.0E-03	5.41E-06	3.9E-06

SUMMED DOSE RATE = .09327 MREM/HR, UNCERTAINTY = .00561 MREM/HR

PHOTON SPECTRUM ^{239}Pu (2.65" ^{24}Pu)
 =====

BIN NO.	E(LO) (KEV)	E(HI) (KEV)	PHOTONS/ SQCM/SEC/BIN	UNCERT	MREM/ HR/BIN	UNCERT
1	0.0	10.0	0.	0.	0.	0.
2	10.0	15.0	0.	0.	0.	0.
3	20.0	25.0	4.53E+00	2.0E-01	4.05E-03	1.8E-04
4	30.0	35.0	1.25E+00	9.7E-02	5.48E-04	4.3E-05
5	40.0	45.0	3.44E-01	3.8E-02	1.09E-04	1.2E-05
6	50.0	55.0	2.70E+01	2.3E-01	7.40E-03	6.4E-05
7	60.0	65.0	4.83E+01	1.3E-01	1.25E-02	3.4E-05
8	70.0	75.0	5.62E+00	8.5E-02	1.45E-03	2.2E-05
9	80.0	85.0	1.53E+00	5.9E-02	4.06E-04	1.6E-05
10	90.0	95.0	4.98E+00	6.9E-02	1.37E-03	1.9E-05
11	100.0	105.0	1.04E+01	5.7E-02	3.01E-03	1.6E-05
12	110.0	115.0	7.34E+00	4.0E-02	2.25E-03	1.2E-05
13	120.0	125.0	4.33E+00	3.0E-02	1.41E-03	9.7E-06
14	130.0	135.0	2.13E+00	2.3E-02	7.38E-04	3.0E-06
15	140.0	145.0	8.12E-01	1.8E-02	2.99E-04	6.7E-06
16	150.0	155.0	3.49E-01	1.4E-02	1.36E-04	5.6E-06
17	160.0	165.0	3.04E-01	1.4E-02	1.26E-04	5.7E-06
18	170.0	175.0	2.69E-01	1.3E-02	1.18E-04	5.8E-06
19	180.0	185.0	2.44E-01	1.3E-02	1.13E-04	5.9E-06
20	190.0	195.0	3.67E-01	1.5E-02	1.79E-04	7.2E-06
21	200.0	205.0	6.23E-01	1.7E-02	3.20E-04	8.8E-06
22	210.0	215.0	6.43E-01	1.7E-02	3.47E-04	9.2E-06
23	220.0	225.0	3.60E-01	1.4E-02	2.04E-04	8.2E-06
24	230.0	235.0	1.77E-01	1.1E-02	1.05E-04	6.5E-06
25	240.0	245.0	1.40E-01	1.0E-02	8.45E-05	6.2E-06
26	250.0	255.0	1.54E-01	1.1E-02	9.95E-05	6.8E-06
27	260.0	265.0	1.69E-01	1.1E-02	1.13E-04	7.4E-06
28	270.0	275.0	1.51E-01	1.1E-02	1.05E-04	7.3E-06
29	280.0	285.0	1.29E-01	9.8E-03	9.31E-05	7.1E-06
30	290.0	295.0	1.68E-01	1.1E-02	1.25E-04	8.4E-06
31	300.0	305.0	2.63E-01	1.4E-02	2.03E-04	1.1E-05
32	310.0	315.0	4.55E-01	1.7E-02	3.62E-04	1.3E-05
33	320.0	325.0	8.13E-01	2.0E-02	6.67E-04	1.6E-05
34	330.0	335.0	1.22E+00	2.1E-02	1.03E-03	1.8E-05
35	340.0	345.0	1.54E+00	2.1E-02	1.13E-03	1.9E-05
36	350.0	355.0	1.77E+00	2.1E-02	1.58E-03	1.9E-05
37	360.0	365.0	2.44E+00	2.1E-02	1.95E-03	1.9E-05
38	370.0	375.0	2.77E+00	2.0E-02	2.58E-03	1.9E-05
39	380.0	385.0	3.20E+00	1.9E-02	3.06E-03	1.8E-05
40	390.0	395.0	3.16E+00	1.8E-02	3.08E-03	1.7E-05
41	400.0	405.0	2.88E+00	1.6E-02	2.86E-03	1.6E-05
42	410.0	415.0	2.62E+00	1.4E-02	2.66E-03	1.4E-05
43	420.0	425.0	2.26E+00	1.3E-02	2.33E-03	1.3E-05
44	430.0	435.0	1.66E+00	1.1E-02	1.74E-03	1.1E-05
45	440.0	445.0	1.01E+00	8.6E-03	1.08E-03	9.2E-06
46	450.0	455.0	5.66E-01	6.7E-03	6.14E-04	7.3E-06
47	460.0	465.0	3.37E-01	5.5E-03	3.71E-04	6.1E-06
48	470.0	475.0	2.09E-01	4.7E-03	2.34E-04	5.2E-06
49	480.0	485.0	1.06E-01	4.0E-03	1.21E-04	4.5E-06
50	490.0	495.0	4.76E-02	3.6E-03	5.46E-05	4.1E-06
51	500.0	505.0	1.79E-02	3.4E-03	2.13E-05	4.0E-06
52	510.0	515.0	9.07E-03	3.2E-03	1.10E-05	3.9E-06
53	520.0	525.0	3.80E-03	3.1E-03	4.66E-06	3.8E-06
54	530.0	535.0	8.67E-03	2.9E-03	1.08E-05	3.7E-06
55	540.0	545.0	7.31E-03	2.8E-03	9.23E-06	3.5E-06
56	550.0	555.0	2.36E-03	2.7E-03	3.03E-06	3.4E-06
57	560.0	565.0	3.75E-03	2.6E-03	4.86E-06	3.4E-06
58	570.0	575.0	8.16E-03	2.7E-03	1.07E-05	3.6E-06
59	580.0	585.0	1.42E-02	2.7E-03	1.89E-05	3.6E-06

60	590.0	595.0	600.0	2.16E-02	2.8E-03	2.92E-05	3.8E-06
61	600.0	605.0	610.0	3.11E-02	3.0E-03	4.75E-05	4.1E-06
62	610.0	615.0	620.0	4.02E-02	3.1E-03	5.56E-05	4.3E-06
63	620.0	625.0	630.0	5.21E-02	3.3E-03	7.30E-05	4.6E-06
64	630.0	635.0	640.0	7.45E-02	3.5E-03	1.06E-04	4.9E-06
65	640.0	645.0	650.0	8.38E-02	3.5E-03	1.70E-04	5.0E-06
66	650.0	655.0	660.0	8.91E-02	3.5E-03	1.29E-04	5.1E-06
67	660.0	665.0	670.0	7.49E-02	3.5E-03	1.10E-04	5.1E-06
68	670.0	675.0	680.0	6.42E-02	3.3E-03	9.52E-05	4.8E-06
69	680.0	685.0	690.0	4.80E-02	3.1E-03	7.20E-05	4.6E-06
70	690.0	695.0	700.0	3.72E-02	2.9E-03	5.43E-05	4.4E-06
71	700.0	705.0	710.0	2.85E-02	2.8E-03	4.37E-05	4.2E-06
72	710.0	715.0	720.0	2.63E-02	2.7E-03	4.06E-05	4.2E-06
73	720.0	725.0	730.0	2.84E-02	2.7E-03	4.44E-05	4.2E-06
74	730.0	735.0	740.0	1.92E-02	2.6E-03	3.74E-05	4.1E-06
75	740.0	745.0	750.0	2.13E-02	2.5E-03	3.40E-05	4.0E-06
76	750.0	755.0	760.0	2.99E-02	2.6E-03	4.42E-05	4.1E-06
77	760.0	765.0	770.0	2.41E-02	2.5E-03	3.92E-05	4.0E-06
78	770.0	775.0	780.0	2.76E-02	2.5E-03	4.44E-05	4.1E-06
79	780.0	785.0	790.0	2.29E-02	2.4E-03	3.40E-05	4.0E-06
80	790.0	795.0	800.0	1.69E-02	2.3E-03	2.42E-05	3.8E-06
81	800.0	805.0	810.0	1.05E-02	2.2E-03	1.78E-05	3.7E-06
82	810.0	815.0	820.0	6.82E-03	2.1E-03	1.16E-05	3.6E-06
83	820.0	825.0	830.0	6.73E-03	2.1E-03	1.16E-05	3.6E-06
84	830.0	835.0	840.0	3.08E-03	2.1E-03	5.34E-06	3.7E-06
85	840.0	845.0	850.0	4.58E-03	2.1E-03	8.02E-06	3.7E-06
86	850.0	855.0	860.0	2.84E-03	2.1E-03	5.02E-06	3.7E-06
87	860.0	865.0	870.0	3.54E-03	2.1E-03	6.31E-06	3.8E-06
88	870.0	875.0	880.0	2.06E-03	2.2E-03	3.70E-06	3.9E-06
89	880.0	885.0	890.0	5.70E-04	2.2E-03	1.03E-06	3.9E-06
90	890.0	895.0	900.0	3.10E-03	2.2E-03	5.46E-06	4.0E-06
91	900.0	905.0	910.0	3.51E-03	2.1E-03	6.47E-06	3.8E-06
92	910.0	915.0	920.0	1.35E-03	2.1E-03	2.51E-06	3.9E-06
93	920.0	925.0	930.0	2.70E-03	2.0E-03	5.05E-06	3.7E-06
94	930.0	935.0	940.0	4.63E-03	2.0E-03	8.72E-06	3.8E-06
95	940.0	945.0	950.0	1.61E-03	2.0E-03	3.05E-06	3.8E-06
96	950.0	955.0	960.0	-2.59E-04	2.0E-03	-4.96E-07	3.8E-06
97	960.0	965.0	970.0	8.44E-04	2.0E-03	1.43E-06	3.9E-06
98	970.0	975.0	980.0	3.37E-03	2.0E-03	6.45E-06	3.8E-06
99	980.0	985.0	990.0	8.90E-04	2.0E-03	1.74E-06	4.0E-06
100	990.0	995.0	1000.0	1.09E-03	1.9E-03	2.15E-06	3.8E-06

SUMMED DOSE RATE = .06727 MREM/HR, UNCERTAINTY = .00404 MREM/HR

^{238}U (0.2% ^{235}U)

BIN NO.	E(LO) (KEV)	E (KEV)	E(HI) (KEV)	PHOTONS/ SQCM/SEC/BIN	UNCERT	MREM/ HR/BIN	UNCERT
1	0.0	12.5	25.0	0.	0.	0.	0.
2	25.0	17.5	50.0	0.	0.	0.	0.
3	50.0	42.5	75.0	3.69E-02	1.3E-03	9.45E-06	3.3E-07
4	75.0	47.5	100.0	8.57E-02	1.2E-03	2.78E-05	3.1E-07
5	100.0	112.5	125.0	2.00E-02	7.0E-04	6.31E-06	2.1E-07
6	125.0	117.5	150.0	6.86E-03	4.7E-04	2.41E-06	1.7E-07
7	150.0	142.5	175.0	1.02E-02	5.3E-04	4.18E-06	2.2E-07
8	175.0	147.5	200.0	1.21E-02	5.5E-04	5.49E-06	2.6E-07
9	200.0	212.5	225.0	1.11E-02	5.2E-04	5.91E-06	2.8E-07
10	225.0	237.5	250.0	1.20E-02	5.3E-04	7.20E-06	3.2E-07
11	250.0	262.5	275.0	1.30E-02	5.2E-04	8.62E-06	3.5E-07
12	275.0	287.5	300.0	1.27E-02	5.1E-04	9.25E-06	3.7E-07
13	300.0	312.5	325.0	1.32E-02	5.1E-04	1.04E-05	4.0E-07
14	325.0	317.5	350.0	1.29E-02	5.0E-04	1.10E-05	4.2E-07
15	350.0	362.5	375.0	1.30E-02	4.9E-04	1.18E-05	4.4E-07
16	375.0	387.5	400.0	1.30E-02	4.7E-04	1.25E-05	4.5E-07
17	400.0	412.5	425.0	1.21E-02	4.6E-04	1.23E-05	4.6E-07
18	425.0	417.5	450.0	1.18E-02	4.6E-04	1.24E-05	4.8E-07
19	450.0	462.5	475.0	1.17E-02	4.5E-04	1.28E-05	4.9E-07
20	475.0	487.5	500.0	1.15E-02	4.4E-04	1.30E-05	5.0E-07
21	500.0	512.5	525.0	1.09E-02	4.3E-04	1.31E-05	5.1E-07
22	525.0	517.5	550.0	1.07E-02	4.2E-04	1.34E-05	5.2E-07
23	550.0	562.5	575.0	1.01E-02	4.0E-04	1.30E-05	5.2E-07
24	575.0	587.5	600.0	9.26E-03	3.9E-04	1.24E-05	5.2E-07
25	600.0	612.5	625.0	8.77E-03	3.8E-04	1.21E-05	5.2E-07
26	625.0	617.5	650.0	8.10E-03	3.7E-04	1.15E-05	5.2E-07
27	650.0	662.5	675.0	8.46E-03	3.7E-04	1.24E-05	5.5E-07
28	675.0	687.5	700.0	8.75E-03	3.6E-04	1.32E-05	5.4E-07
29	700.0	712.5	725.0	1.02E-02	3.6E-04	1.57E-05	5.5E-07
30	725.0	717.5	750.0	1.39E-02	3.7E-04	2.21E-05	5.9E-07
31	750.0	762.5	775.0	1.68E-02	3.8E-04	2.73E-05	6.2E-07
32	775.0	787.5	800.0	1.49E-02	3.5E-04	2.47E-05	5.9E-07
33	800.0	812.5	825.0	9.69E-03	3.1E-04	1.65E-05	5.2E-07
34	825.0	817.5	850.0	6.75E-03	2.8E-04	1.17E-05	4.8E-07
35	850.0	862.5	875.0	6.12E-03	2.7E-04	1.09E-05	4.8E-07
36	875.0	887.5	900.0	6.45E-03	2.7E-04	1.17E-05	4.9E-07
37	900.0	912.5	925.0	6.71E-03	2.7E-04	1.24E-05	4.9E-07
38	925.0	917.5	950.0	8.09E-03	2.7E-04	1.53E-05	5.0E-07
39	950.0	962.5	975.0	1.40E-02	2.9E-04	2.70E-05	5.6E-07

40	975.0	947.5	1000.0	2.15E-02	3.1E-04	4.42E-05	6.1E-07
41	1000.0	1012.5	1025.0	2.33E-02	3.0E-04	4.45E-05	5.9E-07
42	1025.0	1037.5	1050.0	1.94E-02	2.4E-04	2.46E-05	4.0E-07
43	1050.0	1062.5	1075.0	5.99E-03	2.0E-04	1.29E-05	4.1E-07
44	1075.0	1087.5	1100.0	2.56E-03	1.8E-04	5.19E-06	3.8E-07
45	1100.0	1112.5	1125.0	1.71E-03	1.6E-04	3.64E-06	3.8E-07
46	1125.0	1137.5	1150.0	1.60E-03	1.7E-04	3.47E-06	3.6E-07
47	1150.0	1165.0	1175.0	1.75E-03	1.6E-04	3.46E-06	3.4E-07
48	1175.0	1187.5	1200.0	1.63E-03	1.6E-04	4.09E-06	3.5E-07
49	1200.0	1217.5	1225.0	1.53E-03	1.5E-04	3.25E-06	3.5E-07
50	1225.0	1237.5	1250.0	1.57E-03	1.5E-04	3.61E-06	3.4E-07
51	1250.0	1262.5	1275.0	1.43E-03	1.4E-04	2.97E-06	3.4E-07
52	1275.0	1287.5	1300.0	1.35E-03	1.5E-04	2.96E-06	3.5E-07
53	1300.0	1317.5	1312.5	1.14E-03	1.5E-04	2.73E-06	3.5E-07
54	1325.0	1337.5	1350.0	6.37E-04	1.6E-04	1.55E-06	3.9E-07
55	1350.0	1362.5	1375.0	6.89E-04	1.6E-04	1.70E-06	3.9E-07
56	1375.0	1387.5	1400.0	1.02E-03	1.7E-04	2.54E-06	4.2E-07
57	1400.0	1417.5	1425.0	8.93E-04	1.8E-04	1.45E-06	4.0E-07
58	1425.0	1437.5	1450.0	8.66E-04	1.8E-04	2.31E-06	4.0E-07
59	1450.0	1462.5	1500.0	8.40E-04	1.6E-04	2.13E-06	4.2E-07
60	1475.0	1487.5	1525.0	8.14E-04	1.3E-04	2.10E-06	3.5E-07
61	1500.0	1512.5	1550.0	8.16E-04	1.3E-04	2.10E-06	3.9E-07
62	1525.0	1537.5	1575.0	8.98E-04	1.3E-04	1.42E-06	3.9E-07
63	1550.0	1572.5	1575.0	7.08E-04	1.1E-04	1.45E-06	2.9E-07
64	1575.0	1587.5	1600.0	6.10E-04	9.4E-05	1.45E-06	2.9E-07
65	1600.0	1612.5	1625.0	3.21E-04	9.4E-05	8.49E-07	2.8E-07
66	1625.0	1637.5	1650.0	4.10E-04	9.4E-05	1.15E-06	2.8E-07
67	1650.0	1662.5	1675.0	4.66E-04	9.7E-05	1.34E-06	2.8E-07
68	1675.0	1687.5	1700.0	4.09E-04	9.8E-05	1.17E-06	2.8E-07
69	1700.0	1712.5	1725.0	6.98E-04	1.0E-04	2.01E-06	2.9E-07
70	1725.0	1737.5	1750.0	7.79E-04	1.1E-04	2.27E-06	3.1E-07
71	1750.0	1762.5	1775.0	8.37E-04	1.1E-04	2.43E-06	3.2E-07
72	1775.0	1787.5	1800.0	8.85E-04	1.1E-04	2.43E-06	2.9E-07
73	1800.0	1812.5	1825.0	9.08E-04	9.5E-05	3.00E-06	2.9E-07
74	1825.0	1837.5	1850.0	9.91E-04	9.5E-05	3.00E-06	2.9E-07
75	1850.0	1862.5	1875.0	8.26E-04	9.6E-05	2.53E-06	2.7E-07
76	1875.0	1887.5	1900.0	7.80E-04	8.3E-05	2.21E-06	2.6E-07
77	1900.0	1912.5	1925.0	5.80E-04	7.8E-05	1.41E-06	2.6E-07
78	1925.0	1937.5	1950.0	2.36E-04	7.8E-05	7.40E-07	2.4E-07
79	1950.0	1962.5	1975.0	2.66E-04	7.3E-05	7.40E-07	2.4E-07
80	1975.0	1987.5	2000.0	1.77E-04	7.3E-05	5.23E-07	2.3E-07
81	2000.0	2012.5	2025.0	1.70E-04	7.3E-05	5.23E-07	2.4E-07
82	2025.0	2037.5	2050.0	1.57E-04	7.3E-05	5.06E-07	2.4E-07
83	2050.0	2062.5	2075.0	9.10E-04	7.5E-05	2.24E-07	2.5E-07
84	2075.0	2087.5	2100.0	-4.73E-04	7.5E-05	1.10E-07	2.6E-07
85	2100.0	2112.5	2125.0	-3.31E-05	7.7E-05	8.43E-08	2.6E-07
86	2125.0	2137.5	2150.0	2.53E-05	7.5E-05	2.06E-07	2.5E-07
87	2150.0	2162.5	2175.0	6.21E-05	7.2E-05	1.06E-07	2.4E-07
88	2175.0	2187.5	2200.0	3.14E-05	7.2E-05	3.77E-07	2.7E-07
89	2200.0	2212.5	2225.0	1.11E-04	7.8E-05	1.96E-07	2.7E-07
90	2225.0	2237.5	2250.0	5.44E-05	7.1E-05	2.44E-07	2.6E-07
91	2250.0	2262.5	2275.0	6.96E-05	7.3E-05	2.42E-07	2.5E-07
92	2275.0	2287.5	2300.0	4.63E-05	7.3E-05	1.43E-07	2.6E-07
93	2300.0	2312.5	2325.0	2.61E-05	6.9E-05	9.22E-08	2.5E-07
94	2325.0	2337.5	2350.0	-6.53E-05	7.3E-05	-3.38E-08	2.6E-07
95	2350.0	2362.5	2375.0	-9.75E-05	7.1E-05	-3.52E-07	2.6E-07
96	2375.0	2387.5	2400.0	-9.75E-05	7.8E-05	-2.71E-07	2.7E-07
97	2400.0	2412.5	2425.0	1.23E-05	8.0E-05	4.41E-08	2.9E-07
98	2425.0	2442.5	2450.0	-3.46E-05	7.9E-05	-1.24E-07	2.9E-07
99	2475.0	2487.5	2500.0	-6.34E-05	8.1E-05	-2.13E-07	3.0E-07
100	2500.0	2512.5	2525.0	-5.26E-05	8.8E-05	-1.93E-07	3.3E-07
101	2525.0	2537.5	2550.0	-5.77E-05	9.5E-05	-2.17E-07	3.6E-07
102	2550.0	2562.5	2575.0	-1.23E-05	9.4E-05	-4.17E-06	3.7E-07
103	2575.0	2587.5	2600.0	9.98E-05	1.0E-04	3.40E-07	3.6E-07
104	2600.0	2612.5	2625.0	9.98E-05	1.0E-04	3.42E-07	3.9E-07
105	2625.0	2637.5	2650.0	2.29E-04	9.7E-05	8.44E-07	3.7E-07
106	2650.0	2662.5	2675.0	-1.32E-05	8.0E-05	-1.29E-07	3.4E-07
107	2675.0	2687.5	2700.0	-3.14E-05	7.8E-05	-1.22E-07	3.1E-07
108	2700.0	2712.5	2725.0	-4.64E-05	7.1E-05	-1.2E-07	2.8E-07
109	2725.0	2737.5	2750.0	-1.8E-05	6.8E-05	-8.2E-08	2.7E-07
110	2750.0	2762.5	2775.0	4.84E-05	6.3E-05	1.32E-07	2.5E-07
111	2775.0	2787.5	2800.0	6.11E-05	6.2E-05	2.44E-07	2.5E-07
112	2800.0	2812.5	2825.0	-3.16E-05	6.1E-05	-1.24E-07	2.6E-07
113	2825.0	2837.5	2850.0	1.44E-05	6.0E-05	5.47E-08	2.5E-07
114	2850.0	2862.5	2875.0	3.33E-06	6.4E-05	1.34E-08	2.5E-07
115	2875.0	2887.5	2900.0	4.13E-06	6.1E-05	1.70E-07	2.5E-07
116	2900.0	2912.5	2925.0	4.13E-06	6.1E-05	1.70E-07	2.5E-07
117	2925.0	2937.5	2950.0	4.10E-06	6.4E-05	1.70E-07	2.5E-07
118	2950.0	2962.5	2975.0	9.86E-06	6.4E-05	4.71E-07	2.5E-07
119	2975.0	2987.5	3000.0	6.16E-06	6.5E-05	2.57E-07	2.7E-07

SUMMED DOSE RATE = *00069 MREM/H* UNCERTAINTY = *00004 MREM/MR

APPENDIX B

The energy and intensity of the gamma rays in the Ge(Li) spectra from the spheres. The gamma ray intensity is normalized to the intensity of the 662 keV ^{137}Cs line from an I.A.E.A. source located 50 cm from the Ge(Li) detector.

^{239}Pu (5.93% ^{240}Pu)

Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)	Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)
59.5	.04	7.81	1.00	332.7	.03	6.47	.71
68.6	.05	.45	.05	336.0	.08	1.32	.18
77.6	.05	.57	.07	341.6	.08	.70	.09
94.5	.10	11.16	2.25	345.0	.02	5.88	.62
98.4	.08	33.49	5.04	362.0	.25	.17	.05
103.6	.08	17.73	3.13	367.0	.10	1.07	.15
110.9	.07	8.81	1.14	368.6	.09	1.23	.17
114.0	.22	5.46	1.48	371.1	.21	.31	.07
115.5	.42	4.99	1.07	373.0	.25	.43	.10
117.0	.16	6.32	1.39	375.1	.01	18.65	1.89
120.5	.15	1.88	.39	380.2	.03	3.79	.40
125.1	1.02	.10	.17	382.8	.03	3.12	.33
129.2	.05	6.32	.90	392.9	.02	7.02	.76
141.9	.18	.07	.01	399.8	.30	.05	.05
144.2	.04	.43	.05	413.7	.01	20.67	2.12
146.2	.07	.19	.02	422.6	.04	1.62	.19
148.6	.01	1.39	.14	426.8	.10	.29	.05
152.8	.25	.04	.01	445.8	.08	.16	.02
160.1	.08	.23	.03	451.5	.03	3.00	.35
161.5	.08	.25	.03	457.5	.21	.03	.01
164.6	.03	.45	.05	461.3	.19	.03	.01
171.3	.05	.24	.03	470.2	.53	.01	.00
179.2	.05	.13	.02	481.7	.11	.10	.02
189.4	.08	.20	.04	598.0	.26	.03	.01
195.7	.03	.33	.04	612.5	.26	.03	.01
203.6	.06	1.97	.26	617.7	.28	.06	.02
208.0	.02	9.89	1.08	619.2	.22	.06	.02
221.9	.20	.09	.02	624.5	.26	.02	.01
225.3	.12	.11	.02	633.1	.13	.06	.01
237.6	.34	.04	.02	637.8	.18	.06	.01
243.3	.09	.12	.02	640.1	.09	.18	.02
248.7	.32	.03	.01	642.6	.17	.08	.01
255.4	.03	.44	.05	646.0	.04	.34	.04
264.1	.22	.17	.04	652.2	.11	.15	.03
267.5	.06	.60	.09	654.9	.20	.06	.02
277.4	.04	.33	.04	659.0	.08	.24	.04
307.9	.19	.05	.01	662.6	.09	.24	.04
311.7	.05	.31	.04	703.7	.19	.10	.03
316.4	.12	.11	.02	717.5	.18	.08	.01
320.9	.03	.50	.05	722.3	.10	.13	.02
323.7	.03	.46	.05	726.3	.22	.10	.02
				766.6	.20	.05	.01
				769.4	.05	.28	.03

²³⁹Pu (2.65% ²⁴⁰Pu)

Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)	Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)
59.5	.03	4.67	.51	336.1	.04	1.32	.15
68.5	.07	.53	.07	341.6	.07	.82	.10
77.6	.07	.62	.09	345.0	.02	6.37	.66
94.5	.05	9.60	1.20	362.0	.52	.21	.10
98.4	.04	24.34	2.73	367.1	.16	1.25	.26
100.4	.25	2.69	.67	368.7	.16	1.27	.27
103.6	.04	13.01	1.54	375.0	.02	20.69	2.21
110.9	.06	7.89	.99	380.2	.05	4.19	.52
114.7	.13	5.23	.81	382.8	.06	3.44	.45
116.6	.11	7.08	.99	392.9	.02	7.70	.81
120.6	.14	1.86	.35	399.3	.34	.07	.04
125.0	.23	.14	.04	413.7	.03	22.71	2.61
129.2	.01	7.14	.74	422.6	.02	1.84	.19
141.9	.12	.05	.01	426.7	.04	.37	.04
144.2	.02	.46	.05	430.1	.13	.08	.01
146.2	.04	.21	.02	445.8	.17	.16	.03
148.6	.02	.30	.03	451.5	.02	3.28	.35
152.8	.21	.03	.01	457.7	.38	.03	.02
160.0	.15	.11	.02	461.2	.31	.02	.02
161.4	.06	.29	.03	481.5	.11	.10	.02
164.6	.11	.10	.02	597.7	.17	.04	.01
171.3	.02	.26	.03	612.6	.18	.02	.01
179.1	.04	.18	.02	617.1	.14	.08	.02
189.3	.04	.27	.03	618.7	.14	.07	.02
195.7	.03	.38	.04	624.4	.32	.01	.00
203.5	.01	2.14	.22	632.7	.15	.07	.02
208.0	.01	2.12	.22	636.0	.80	.02	.01
225.4	.22	.12	.05	637.9	.41	.06	.02
237.6	.30	.05	.03	640.0	.12	.20	.03
243.3	.27	.08	.04	645.8	.06	.34	.05
255.4	.02	.52	.05	651.9	.07	.16	.02
264.0	.04	.21	.03	654.8	.16	.05	.01
267.6	.07	.14	.02	658.8	.05	.21	.03
297.5	.03	.47	.05	662.3	.11	.11	.02
302.9	.20	.06	.02	664.5	.18	.04	.01
308.0	.26	.05	.01	703.7	.09	.10	.02
311.8	.05	.32	.04	717.8	.13	.08	.02
315.5	.12	.13	.02	722.2	.17	.07	.02
320.9	.03	.55	.06	756.4	.08	.09	.01
323.8	.03	.56	.06	769.3	.07	.31	.04
332.9	.02	5.72	.59				

^{238}U (0.2% ^{235}U)

Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)	Energy (keV)	Uncert in Energy (keV)	Intensity (Ph/cm ² /s)	Uncert in Int. (Ph/cm ² /s)
63.3	.02	.177	.020	876.1	.22	.010	.002
72.3	.17	.005	.001	880.5	.07	.036	.004
74.4	.24	.004	.001	883.4	.09	.028	.003
83.3	.09	.008	.001	987.9	.18	.013	.002
91.8	.03	.402	.044	991.8	.21	.023	.004
93.9	.04	.284	.032	996.0	.14	.043	.006
97.7	.02	.492	.053	946.1	.04	.055	.006
110.4	.03	.294	.032	1001.0	.03	1.294	.142
113.8	.06	.124	.015	1099.1	.25	.004	.001
131.0	.16	.002	.000	1112.9	.44	.005	.001
143.5	.06	.009	.002	1115.7	.06	.049	.005
163.3	.08	.006	.001	1120.5	.29	.005	.001
145.5	.01	.096	.010	1125.4	.19	.008	.001
205.1	.05	.011	.002	1173.3	.25	.005	.001
216.6	.24	.002	.001	1183.8	.14	.022	.004
226.5	.17	.003	.001	1217.4	.15	.008	.002
227.9	.03	.023	.003	1292.7	.09	.045	.007
263.7	.74	.001	.000	1372.6	.18	.007	.002
265.0	.61	.001	.001	1394.0	.20	.007	.002
510.3	.21	.007	.002	1408.6	.32	.004	.001
549.1	.07	.018	.003	1414.9	.30	.003	.001
621.0	.13	.013	.003	1434.3	.13	.017	.003
698.6	.17	.008	.002	1441.2	.22	.007	.002
702.1	.15	.009	.002	1510.3	.19	.020	.004
705.8	.19	.008	.002	1527.4	.36	.003	.001
723.2	.24	.009	.002	1549.8	.38	.003	.001
740.1	.18	.016	.003	1554.1	.14	.013	.002
742.7	.03	.119	.013	1574.0	.32	.007	.001
766.3	.02	.424	.044	1736.2	.34	.009	.003
781.6	.49	.011	.003	1738.6	.14	.030	.004
786.1	.06	.075	.009	1745.9	.14	.014	.003
791.9	.44	.005	.002	1809.9	.16	.005	.001
794.4	.37	.008	.002	1831.8	.15	.031	.005
796.6	.23	.012	.002	1846.3	.39	.006	.001
805.8	.11	.015	.003	1868.4	.29	.011	.002
825.2	.21	.008	.002	1875.5	.15	.014	.002
831.5	.16	.011	.003	1894.0	.25	.003	.001
851.4	.14	.010	.002	1911.5	.27	.009	.002
				1936.9	.28	.004	.001