LA-3954

LOS ALAMOS SCIENTIFIC LABORATORY
of the
University of California
LOS ALAMOS • NEW MEXICO

Fission Product Energy Release and Inventory from ^{239}Pu Fast Fission

UNITED STATES
ATOMIC ENERGY COMMISSION
CONTRACT W-7405-ENG. 36

Printed in the United States of America. Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U. S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy $3.00; Microfiche $0.65

LA-3954
UC-80, REACTOR
TECHNOLOGY
TID-4500

LOS ALAMOS SCIENTIFIC LABORATORY
of the
University of California
LOS ALAMOS • NEW MEXICO

Report written: November 1967

Report distributed: October 22, 1968

Fission Product Energy Release and Inventory from ^{239}Pu Fast Fission

by

M. E. Battat
Donald J. Dudziak
H. R. Hicks

FISSION PRODUCT ENERGY RELEASE AND INVENTORY FROM ^{239}Pu FAST FISSION

by

M. E. Battat, Donald J. Dudziak, and H. R. Hicks

ABSTRACT

By use of currently available experimental and calculated fission product yields from fast fission of ^{239}Pu, the fission product code, FPIC, has been expanded to include the capability of calculating fission product decay powers for ^{239}Pu fast fission. The revised code, FPIC/U-Pu, is operational on the CDC-6600 computer. Summation calculations of beta, gamma, and total decay powers from ^{235}U thermal fission and from ^{239}Pu fast fission were compared for both an instantaneous burst and infinite irradiation. Shutdown times ranged from 10 to 10^9 sec, and significant (>10%) differences occur principally for very short and very long shutdown times. The decay powers from ^{235}U thermal fission were compared with previous studies for an instantaneous burst and for infinite irradiation, and good agreement was found over the applicable shutdown times. Calculations of beta, gamma, and total fission product decay powers from ^{239}Pu fast fission for a specific irradiation history were then compared with the corresponding experimental measurements by K. Johnston of AWRE, as well as with ^{235}U thermal fission calculations. For gamma and total decay power, the ^{239}Pu fast fission calculations generally agreed better with the experiment, whereas for beta decay power, the ^{235}U thermal fission calculations were generally better. Similar conclusions were drawn from comparisons of instantaneous burst calculations with the corresponding analytical fits derived from the experimental data.

INTRODUCTION

In evaluating the safety aspects and shielding requirements for a power reactor, it is necessary to know the energy release which accompanies the decay of fission products. For ^{235}U thermal fission, the large amount of experimental data on fission yields permits fairly accurate computations of decay power to be made. Many compilations of the decay properties of mixed fission products from ^{235}U thermal fission have been published,[1] including the summation studies of Perkins and King[2] and a later revision by Perkins.[3] Perkins' summation study was further updated by Koebberling et al.,[4] who also incorporated their data in an IBM-7090/7094 computer code, the Lockheed Fission Product Inventory Code (FPIC). In contrast to ^{235}U thermal fission, the experimental data on fission product yields from ^{239}Pu fast fission are sparse; hence, calculations of decay powers for ^{239}Pu fast fission are necessarily based on the small amount of experimental data. Fission yields versus mass number have been reported by Burris and Dillon[5] and by Weaver et al.[6] Fission product yields from fast (≈1 MeV) neutron fission of ^{239}Pu have also been estimated by Anderson,[7] using the 16 measured yields published through June 1965. From these 16 yields, together with six reflected data points, Anderson obtained estimates of unmeasured mass chain yields. From these mass chain yields, and using Wolfsberg's[8] modification of the equal-charge-displacement hypothesis, Anderson then arrived at independent and cumulative fission yields, versus Z and A, for ^{239}Pu fast fission.

CALCULATION OF DECAY POWER FOR ^{239}Pu FAST FISSION

To permit calculation of fission product decay powers for ^{235}U thermal and ^{239}Pu fast fission, Anderson's calculated yields for ^{239}Pu fast fission were incorporated, as an added input, in the Lockheed FPIC code. As originally written, the FPIC code contained data for 200 nuclides with half-lives greater than 10 sec and fission yields greater than 0.001%; the ^{239}Pu data first added to the FPIC library were for these 200 nuclides.

While the plutonium data were being added, some changes were also made in the FPIC library; a major change was the addition of the nuclide ^{91}Y, which was not included in the original library. For the most part, the remaining changes were to correct typographical errors and for internal consistency.

The changes made in the FPIC library are detailed in Appendix A. These changes, together with the ^{239}Pu fast fission yields, were included in a new code, FPIC/U-Pu, written for the CDC-6600 computer.

The nuclide decay data and ^{235}U thermal and ^{239}Pu fast fission yields used as input in the FPIC/U-Pu code are tabulated in Appendix B. Also included, for completeness, are the body-organ dose conversion factors as originally specified in the Lockheed FPIC code. The operating instructions for the FPIC/U-Pu code are listed in Appendix C.

COMPARISON OF ^{235}U DECAY POWER CALCULATIONS WITH PREVIOUS STUDIES

In regard to the ^{235}U thermal fission data, calculations made with the FPIC/U-Pu code for instantaneous fission (10 f/sec for 0.1 sec) and infinite irradiation (1 f/sec for 10^{20} sec) were compared with results of previous studies. For instantaneous fission, it was found convenient to compare with the summation study of Perkins;[3] for infinite irradiation, the review of Shure and Dudziak[9] was chosen. Results of these comparisons are shown in Table 1. In connection with Table 1, it is important to note the following: (1) the FPIC/U-Pu library considers only nuclides with half-lives greater than 10 sec, (2) Perkins' study includes only nuclides with half-lives greater than about 1 min, and (3) the review of Shure and Dudziak includes total decay power data for shutdown times as low as 0.1 sec. Thus, although the figures based on Perkins' summation study and the FPIC/U-Pu code are not quite valid for shutdown times below several hundred seconds, they have been included to indicate the deviation to be expected for short shutdown times. For shutdown times greater than 10^3 sec and instantaneous fission, the beta and total decay powers calculated from FPIC/U-Pu are within $\pm 6\%$ of Perkins' data, with the gamma power deviating by about $\pm 12\%$. For shutdown times greater than 10^3 sec and infinite irradiation, the ratio of FPIC/U-Pu to Shure and Dudziak's values varies between 0.95 and 1.02 for beta and total power and between 0.95 and 1.08 for the gamma power.

CALCULATED DECAY POWERS - ^{235}U THERMAL AND ^{239}Pu FAST FISSION

It is of interest to compare results obtained with the FPIC/U-Pu code for ^{235}U thermal and ^{239}Pu fast fission decay powers. As before, two cases were considered--instantaneous fission and infinite irradiation. Results of these calculations are displayed in Tables 2 and 3, respectively. The ratio of ^{239}Pu:^{235}U total decay powers varies in a complicated manner and ranges from about 0.67 to 1.5 for shutdown times shown in Tables 2 and 3. For shutdown times between 10^2 sec and one year, the ratio of total decay power (Pu:U) for instantaneous fission varies between 0.78 and 1.3; for infinite irradiation, this ratio ranges from 0.89 to 1.0. The detailed behavior of this ratio for beta, gamma, and total decay powers can be inferred from the calculated values shown in Tables 2 and 3. Although the ^{239}Pu decay powers given in Tables 2 and 3 are based on a semitheoretical approach, it is reasonable to suggest that the ratios shown in these tables give some indication of the effect of using ^{235}U thermal fission product data for fission products from plutonium-fueled fast reactors.

COMPARISON OF SUMMATION STUDIES WITH EXPERIMENT

Calorimetric experiments of fission product energy release after fast fission of ^{239}Pu have been performed by Johnston.[10] In these experiments, Johnston exposed four similar plutonium samples in the Dounreay Fast Reactor, the irradiations being intermittent over periods as long as 125 days. Total exposures at power ranged up to 37 days. He obtained data for shutdown times from 45 to 125 days,[11] with separate beta and gamma contributions being deduced from the measurements. The beta and gamma contributions were separated by the use of thin-walled capsules, a removable gamma absorber in the calorimeter, and suitable corrections for gamma energy escape, ^{239}Pu alpha heating, etc. His samples numbered 1 and 2 were exposed near the center of the core, and samples numbered 3 and 4 near the core edge. After two beta and gamma decay power measurements at 45 and 66 days, sample 1 was

TABLE 1

CALCULATED ^{235}U THERMAL FISSION DECAY POWERS
COMPARED WITH PREVIOUS SUMMATION STUDIES

U-235 THERMAL FISS. FPIC=FPIC/U-PU. REF A=PERKINS. REF B=SHURE AND DUDZIAK

TS (SEC)		BETA--MEV/FISS REF A-B	BETA--MEV/FISS FPIC	FPIC/ REF	GAMMA-MEV/FISS REF A-B	GAMMA-MEV/FISS FPIC	FPIC/ REF	TOTAL-MEV/FISS REF A-B	TOTAL-MEV/FISS FPIC	FPIC/ REF
1E+1	INS		2.18E-02			7.36E-03			2.91E-02	
	INF	4.70E+00	3.66E+00	.78	5.30E+00	3.71E+00	.70	1.00E+01	7.37E+00	.74
1E+2	INS	3.47E-03	5.13E-03	1.48	3.49E-03	4.93E-03	1.41	6.96E-03	1.01E-02	1.45
	INF	3.05E+00	2.85E+00	.93	3.53E+00	3.16E+00	.90	6.58E+00	6.01E+00	.91
2E+2	INS	2.02E-03	2.66E-03	1.32	2.30E-03	2.94E-03	1.28	4.32E-03	5.60E-03	1.30
	INF	2.58E+00	2.48E+00	.96	3.00E+00	2.77E+00	.92	5.58E+00	5.25E+00	.94
4E+2	INS	9.88E-04	1.18E-03	1.19	1.21E-03	1.39E-03	1.15	2.20E-03	2.57E-03	1.17
	INF	2.14E+00	2.13E+00	1.00	2.54E+00	2.37E+00	.93	4.68E+00	4.50E+00	.96
1E+3	INS	4.20E-04	4.31E-04	1.03	4.43E-04	4.47E-04	1.01	8.63E-04	8.78E-04	1.02
	INF	1.72E+00	1.72E+00	1.00	2.01E+00	1.91E+00	.95	3.73E+00	3.63E+00	.97
2E+3	INS	2.02E-04	2.03E-04	1.00	2.24E-04	2.12E-04	.95	4.26E-04	4.15E-04	.97
	INF	1.42E+00	1.44E+00	1.01	1.70E+00	1.62E+00	.95	3.12E+00	3.06E+00	.98
4E+3	INS	8.41E-05	8.64E-05	1.03	1.08E-04	9.89E-05	.92	1.92E-04	1.85E-04	.96
	INF	1.18E+00	1.18E+00	1.00	1.40E+00	1.33E+00	.95	2.58E+00	2.51E+00	.97
1E+4	INS	2.57E-05	2.68E-05	1.04	3.62E-05	3.16E-05	.87	6.19E-05	5.84E-05	.94
	INF	9.20E-01	8.99E-01	.98	1.03E+00	9.99E-01	.97	1.95E+00	1.90E+00	.97
2E+4	INS	1.12E-05	1.15E-05	1.03	1.28E-05	1.11E-05	.87	2.40E-05	2.26E-05	.94
	INF	7.58E-01	7.26E-01	.96	8.12E-01	8.13E-01	1.00	1.57E+00	1.54E+00	.98
4E+4	INS	4.84E-06	4.78E-06	.99	4.82E-06	4.34E-06	.90	9.66E-06	9.12E-06	.94
	INF	6.10E-01	5.80E-01	.95	6.60E-01	6.79E-01	1.03	1.27E+00	1.26E+00	.99
7E+4	INS	2.18E-06	2.11E-06	.97	2.35E-06	2.19E-06	.93	4.53E-06	4.30E-06	.95
	INF	5.10E-01	4.85E-01	.95	5.60E-01	5.87E-01	1.05	1.07E+00	1.07E+00	1.00
1E+5	INS	1.24E-06	1.19E-06	.96	1.44E-06	1.39E-06	.97	2.68E-06	2.58E-06	.96
	INF	4.53E-01	4.37E-01	.96	5.05E-01	5.35E-01	1.06	9.58E-01	9.72E-01	1.01
2E+5	INS	4.06E-07	3.86E-07	.95	5.49E-07	5.64E-07	1.03	9.55E-07	9.50E-07	.99
	INF	3.82E-01	3.70E-01	.97	4.18E-01	4.49E-01	1.07	8.00E-01	8.19E-01	1.02
4E+5	INS	1.49E-07	1.41E-07	.95	2.45E-07	2.63E-07	1.07	3.94E-07	4.04E-07	1.03
	INF	3.35E-01	3.25E-01	.97	3.47E-01	3.74E-01	1.08	6.82E-01	6.99E-01	1.02
1E+6	INS	5.74E-08	5.47E-08	.95	1.00E-07	1.11E-07	1.11	1.57E-07	1.66E-07	1.05
	INF	2.85E-01	2.75E-01	.96	2.55E-01	2.74E-01	1.07	5.40E-01	5.49E-01	1.02
2E+6	INS	2.89E-08	2.79E-08	.97	4.55E-08	5.09E-08	1.12	7.44E-08	7.88E-08	1.06
	INF	2.44E-01	2.37E-01	.97	1.88E-01	2.00E-01	1.06	4.32E-01	4.37E-01	1.01
4E+6	INS	1.34E-08	1.32E-08	.99	1.77E-08	1.93E-08	1.09	3.11E-08	3.25E-08	1.05
	INF	2.02E-01	1.99E-01	.99	1.33E-01	1.37E-01	1.03	3.35E-01	3.36E-01	1.00
1E+7	INS	4.66E-09	4.60E-09	.99	4.98E-09	5.01E-09	1.01	9.64E-09	9.61E-09	1.00
	INF	1.59E-01	1.54E-01	.97	7.90E-02	8.10E-02	1.03	2.38E-01	2.35E-01	.99
2E+7	INS	2.01E-09	1.98E-09	.99	1.60E-09	1.59E-09	.99	3.61E-09	3.57E-09	.99
	INF	1.29E-01	1.24E-01	.96	5.00E-02	5.14E-02	1.03	1.79E-01	1.75E-01	.98
4E+7	INS	8.40E-10	8.19E-10	.97	1.96E-10	2.00E-10	1.02	1.04E-09	1.02E-09	.98
	INF	1.02E-01	9.92E-02	.97	3.70E-02	3.85E-02	1.04	1.39E-01	1.38E-01	.99
1E+8	INS	2.00E-10	1.94E-10	.97	3.13E-11	3.36E-11	1.07	2.31E-10	2.28E-10	.98
	INF	7.85E-02	7.44E-02	.95	3.25E-02	3.46E-02	1.06	1.11E-01	1.09E-01	.98

dissolved for mass spectrometric and radiochemical analysis to determine the plutonium isotopic composition and the total number of fissions in the sample (estimated accuracy, ±3%).

Using the FPIC/U-Pu code, Johnston's irradiation histories (see Table 1 of Ref. 11) have been duplicated* by summation calculations with both the ^{239}Pu fast fission and ^{235}U thermal fission libraries. The results for samples 2, 3, and 4 are shown in Tables 4, 5, and 6 where H_β, H_γ, and $H_{\beta+\gamma}$ are the beta, gamma, and total decay powers, respectively. Johnston estimates his maximum random errors to be ±5 μW per measurement.

On the basis of these summation studies, it appears that using the ^{239}Pu fast fission yields generally provides significantly better agreement of the gamma and total decay powers with Johnston's experiment. However, for beta decay power, the ^{235}U thermal fission yields more adequately represent the experimental results, which are consistently underestimated by the ^{239}Pu fast fission calculations.

*In order to perform calculations duplicating the experiment, the exact masses of PuO_2 in each sample must be known. These data are in Table 5 of Ref. 11.

TABLE 2

CALCULATED ^{235}U THERMAL FISSION AND ^{239}Pu
FAST FISSION DECAY POWERS FOR INSTANTANEOUS FISSION

TS(SEC)	BETA--MEV/F-SEC PU239	U235	239/ 235	GAMMA-MEV/F-SEC PU239	U235	239/ 235	TOTAL-MEV/F-SEC PU239	U235	239/ 235
1.00E+01	1.35E-02	2.18E-02	.62	6.09E-03	7.36E-03	.83	1.96E-02	2.91E-02	.67
1.00E+02	4.32E-03	5.13E-03	.84	3.49E-03	4.93E-03	.71	7.81E-03	1.01E-02	.78
2.00E+02	2.39E-03	2.66E-03	.90	2.14E-03	2.94E-03	.73	4.53E-03	5.60E-03	.81
3.00E+02	1.56E-03	1.67E-03	.93	1.46E-03	1.94E-03	.75	3.02E-03	3.61E-03	.84
4.00E+02	1.13E-03	1.18E-03	.96	1.09E-03	1.39E-03	.78	2.21E-03	2.57E-03	.86
1.00E+03	4.22E-04	4.20E-04	1.01	4.25E-04	4.47E-04	.95	8.48E-04	8.67E-04	.98
2.00E+03	2.01E-04	2.02E-04	1.00	2.16E-04	2.12E-04	1.02	4.17E-04	4.13E-04	1.01
3.60E+03	9.51E-05	9.90E-05	.96	1.11E-04	1.12E-04	1.00	2.06E-04	2.11E-04	.98
4.00E+03	8.21E-05	8.64E-05	.95	9.77E-05	9.89E-05	.99	1.80E-04	1.85E-04	.97
1.00E+04	2.21E-05	2.68E-05	.83	2.77E-05	3.16E-05	.88	4.98E-05	5.84E-05	.85
2.00E+04	8.78E-06	1.15E-05	.77	9.31E-06	1.11E-05	.84	1.81E-05	2.26E-05	.80
4.00E+04	3.73E-06	4.78E-06	.78	3.85E-06	4.34E-06	.89	7.58E-06	9.12E-06	.83
7.00E+04	1.77E-06	2.11E-06	.84	2.02E-06	2.19E-06	.92	3.79E-06	4.30E-06	.88
8.64E+04	1.31E-06	1.51E-06	.86	1.56E-06	1.68E-06	.93	2.86E-06	3.19E-06	.90
1.00E+05	1.06E-06	1.19E-06	.88	1.30E-06	1.39E-06	.93	2.35E-06	2.58E-06	.91
2.00E+05	3.73E-07	3.86E-07	.97	5.42E-07	5.64E-07	.96	9.15E-07	9.50E-07	.96
4.00E+05	1.38E-07	1.41E-07	.98	2.50E-07	2.63E-07	.95	3.88E-07	4.04E-07	.96
6.05E+05	8.36E-08	8.95E-08	.93	1.66E-07	1.81E-07	.92	2.49E-07	2.70E-07	.92
1.00E+06	4.79E-08	5.47E-08	.88	9.84E-08	1.11E-07	.88	1.46E-07	1.66E-07	.88
2.00E+06	2.28E-08	2.79E-08	.82	4.42E-08	5.09E-08	.87	6.70E-08	7.88E-08	.85
2.63E+06	1.69E-08	2.11E-08	.80	3.14E-08	3.58E-08	.88	4.83E-08	5.69E-08	.85
4.00E+06	1.04E-08	1.32E-08	.79	1.76E-08	1.93E-08	.91	2.80E-08	3.25E-08	.86
1.00E+07	4.05E-09	4.60E-09	.88	4.91E-09	5.01E-09	.98	8.97E-09	9.61E-09	.93
1.58E+07	2.75E-09	2.67E-09	1.03	2.49E-09	2.55E-09	.97	5.24E-09	5.22E-09	1.00
2.00E+07	2.24E-09	1.98E-09	1.14	1.57E-09	1.59E-09	.99	3.82E-09	3.57E-09	1.07
3.16E+07	1.49E-09	1.10E-09	1.35	5.05E-10	4.48E-10	1.13	1.99E-09	1.55E-09	1.29
4.00E+07	1.18E-09	8.19E-10	1.44	2.70E-10	2.00E-10	1.35	1.45E-09	1.02E-09	1.42
1.00E+08	2.89E-10	1.94E-10	1.49	6.17E-11	3.36E-11	1.84	3.51E-10	2.27E-10	1.54
3.16E+08	2.43E-11	4.68E-11	.52	2.46E-11	2.15E-11	1.14	4.89E-11	6.83E-11	.71
1.00E+09	1.26E-11	2.65E-11	.48	1.44E-11	1.30E-11	1.11	2.71E-11	3.95E-11	.68

In evaluating the significance of the percent difference between experiment and summation calculations, as given in Tables 4, 5, and 6, the inherent errors in the experiment must be considered. The 95% confidence limits given by Johnston are $\pm 7\%$ for beta, $\pm 10\%$ for gamma, and $\pm 6\%$ for total. Thus, the percent differences in Table 6 for total decay power are almost all within the experimental error. The disagreement between experiment and the ^{239}Pu fast fission summation study could also be partially due to systematic errors in either the experiment or in the yields as calculated by Anderson.[7] The yield values also depend upon incident neutron energy, the dependence being most sensitive at mass numbers close to and on either side of the peaks in the mass yield curve. Thus, an additional uncertainty arises from the different spectra of the neutrons inducing fission, between the experiment in the Dounreay Fast Reactor (median fission energy ≈0.5 MeV) and the ≈1 MeV energy used by Anderson. As can be seen from Tables 7 and 8, for an instantaneous burst, it is just such isotopes with a sensitive yield dependence which are dominant contributors to the decay powers at the shutdown times covered by the experiment. Though it appears less likely, uncertainties in the total beta energy release per disintegration could also be a significant factor in accounting for the discrepancies. Differences between calculation and experiment could also arise from difficulties in determining precise shutdown times for reproduction of the reactor operating history, although this error should be quite small.

COMPARISON OF ANALYTICAL FITS WITH CALCULATIONS: INSTANTANEOUS BURST

From his experimental results, Johnston derived analytical fits to the data, in the usual form,

$$H(t) = A\ N\ \sigma\ f[t^{-\chi} - (t + T)^{-\chi}], \qquad (1)$$

TABLE 3

CALCULATED ^{235}U THERMAL FISSION AND ^{239}Pu FAST FISSION DECAY POWERS FOR INFINITE IRRADIATION

TS(SEC)	BETA--MEV/FISS PU239	U235	239/235	GAMMA-MEV/FISS PU239	U235	239/235	TOTAL-MEV/FISS PU239	U235	239/235
1.00E+01	3.21E+00	3.66E+00	.88	3.19E+00	3.71E+00	.86	6.41E+00	7.37E+00	.87
1.00E+02	2.60E+00	2.85E+00	.91	2.78E+00	3.16E+00	.88	5.38E+00	6.00E+00	.90
2.00E+02	2.28E+00	2.48E+00	.92	2.51E+00	2.77E+00	.90	4.78E+00	5.25E+00	.91
3.00E+02	2.08E+00	2.27E+00	.92	2.33E+00	2.54E+00	.92	4.41E+00	4.80E+00	.92
4.00E+02	1.95E+00	2.13E+00	.92	2.20E+00	2.37E+00	.93	4.16E+00	4.50E+00	.92
1.00E+03	1.56E+00	1.72E+00	.90	1.81E+00	1.91E+00	.95	3.37E+00	3.64E+00	.93
2.00E+03	1.27E+00	1.44E+00	.88	1.52E+00	1.62E+00	.94	2.78E+00	3.05E+00	.91
3.60E+03	1.05E+00	1.21E+00	.86	1.27E+00	1.37E+00	.92	2.32E+00	2.59E+00	.90
4.00E+03	1.01E+00	1.18E+00	.86	1.23E+00	1.33E+00	.92	2.24E+00	2.51E+00	.89
1.00E+04	7.63E-01	8.99E-01	.85	9.17E-01	9.99E-01	.92	1.68E+00	1.90E+00	.89
2.00E+04	6.27E-01	7.26E-01	.86	7.59E-01	8.13E-01	.93	1.39E+00	1.54E+00	.90
4.00E+04	5.15E-01	5.80E-01	.89	6.44E-01	6.79E-01	.95	1.16E+00	1.26E+00	.92
7.00E+04	4.38E-01	4.85E-01	.90	5.61E-01	5.87E-01	.96	1.00E+00	1.07E+00	.93
8.64E+04	4.13E-01	4.56E-01	.91	5.32E-01	5.56E-01	.96	9.46E-01	1.01E+00	.93
1.00E+05	3.97E-01	4.37E-01	.91	5.13E-01	5.35E-01	.96	9.10E-01	9.73E-01	.94
2.00E+05	3.35E-01	3.70E-01	.91	4.31E-01	4.49E-01	.96	7.66E-01	8.19E-01	.94
4.00E+05	2.91E-01	3.25E-01	.90	3.59E-01	3.74E-01	.96	6.51E-01	7.00E-01	.93
6.05E+05	2.70E-01	3.03E-01	.89	3.18E-01	3.30E-01	.96	5.88E-01	6.33E-01	.93
1.00E+06	2.45E-01	2.75E-01	.89	2.68E-01	2.74E-01	.98	5.13E-01	5.50E-01	.93
2.00E+06	2.13E-01	2.37E-01	.90	2.03E-01	2.00E-01	1.02	4.16E-01	4.37E-01	.95
2.63E+06	2.00E-01	2.22E-01	.90	1.79E-01	1.73E-01	1.04	3.80E-01	3.95E-01	.96
4.00E+06	1.82E-01	1.99E-01	.92	1.47E-01	1.37E-01	1.08	3.29E-01	3.36E-01	.98
1.00E+07	1.46E-01	1.54E-01	.94	9.40E-02	8.10E-02	1.16	2.40E-01	2.35E-01	1.02
1.58E+07	1.26E-01	1.34E-01	.94	7.35E-02	6.00E-02	1.23	2.00E-01	1.94E-01	1.03
2.00E+07	1.16E-01	1.24E-01	.93	6.52E-02	5.14E-02	1.27	1.81E-01	1.76E-01	1.03
3.16E+07	9.48E-02	1.07E-01	.88	5.45E-02	4.10E-02	1.33	1.49E-01	1.48E-01	1.01
4.00E+07	8.37E-02	9.92E-02	.84	5.14E-02	3.85E-02	1.34	1.35E-01	1.38E-01	.98
1.00E+08	4.65E-02	7.44E-02	.62	4.46E-02	3.46E-02	1.29	9.10E-02	1.09E-01	.83
3.16E+08	3.00E-02	5.83E-02	.52	3.73E-02	2.93E-02	1.27	6.74E-02	8.76E-02	.77
1.00E+09	1.84E-02	3.41E-02	.54	2.44E-02	1.77E-02	1.38	4.29E-02	5.18E-02	.83

TABLE 4

FISSION PRODUCT BETA DECAY POWER (H_β)

Experimental ^{239}Pu Values and FPIC/U-Pu Results

		^{239}Pu Fast Fission			^{235}U Thermal Fission	
Sample	t (days)	Experiment (μW)	FPIC (μW)	% Difference from Experiment	FPIC (μW)	% Difference from Experiment
2	46	286	243	-15.0	290	1.4
	67	218	191	-12.4	219	0.4
	76	201	177	-11.9	198	- 1.5
	90	179	160	-10.6	173	- 3.4
	110	153	141	- 7.8	146	- 4.6
	144	127	119	- 6.3	113	-11.0
3	54	241	220	- 8.7	256	6.2
	62	217	200	- 7.8	229	5.5
	75	188	176	- 6.4	195	3.7
	97	153	148	- 3.3	158	3.3
	125	131	127	- 3.1	125	- 4.6
4	53	243	229	- 5.8	268	10.3
	61	233	208	-10.7	240	3.0
	74	199	182	- 8.5	204	2.5
	96	169	154	- 8.9	164	- 3.0
	124	137	131	- 4.4	130	- 5.1

TABLE 5

FISSION PRODUCT GAMMA DECAY POWER (H_γ)

Experimental ^{239}Pu Values and FPIC/U-Pu Results

		^{239}Pu Fast Fission			^{235}U Thermal Fission	
Sample	t (days)	Experiment (μW)	FPIC (μW)	% Difference from Experiment	FPIC (μW)	% Difference from Experiment
2	46	339	340	0.3	357	5.3
	67	232	238	2.6	246	6.0
	76	198	211	6.6	217	9.6
	90	172	179	4.1	183	6.4
	110	136	144	5.9	147	8.1
	144	94	103	9.6	105	11.7
3	54	250	293	17.2	308	23.2
	62	212	253	19.3	263	24.0
	75	170	207	21.8	213	25.3
	97	128	158	23.4	161	25.8
	125	100	118	18.0	120	20.0
4	53	278	308	10.8	325	16.9
	61	229	266	16.2	277	21.0
	74	186	217	16.7	224	20.4
	96	134	165	23.1	168	25.4
	124	111	123	10.8	125	12.6

TABLE 6

FISSION PRODUCT TOTAL DECAY POWER ($H_{\beta+\gamma}$)

Experimental ^{239}Pu Values and FPIC/U-Pu Results

		^{239}Pu Fast Fission			^{235}U Thermal Fission	
Sample	t (days)	Experiment (μW)	FPIC (μW)	% Difference from Experiment	FPIC (μW)	% Difference from Experiment
2	46	625	583	-6.7	647	3.5
	67	450	429	-4.7	465	3.3
	76	399	388	-2.8	415	4.0
	90	351	339	-3.4	356	1.4
	110	289	285	-1.4	293	1.4
	144	221	222	0.4	218	-1.4
3	54	491	513	4.5	564	14.9
	62	429	453	5.6	492	14.7
	75	358	383	7.0	408	14.0
	97	281	306	8.9	319	13.5
	125	231	245	6.1	245	6.1
4	53	521	537	3.1	593	13.8
	61	462	474	2.6	517	11.9
	74	385	399	3.6	428	11.2
	96	303	319	5.3	332	9.6
	124	248	254	2.4	255	2.8

where A and χ are constants to be determined, t is time after shutdown, and T is time of operation at constant flux f. All times are given in days. The macroscopic fission cross section is given by the usual notation, $N\sigma$. Each set of beta, gamma, and total decay power data was fit and averages were taken. Then, in the limit as $T \to 0$, expressions for the instantaneous burst of fissions were derived. In the process of comparing the experimental decay powers with those calculated for the experiment by use of the analytical fits, inconsistencies were discovered, especially for sample 4. When these difficulties were brought to his attention, Johnston revised his analytical fits[12] so that Eqs. 4 to 6 of Ref. 10 now read (H in watts)

$$H_{\beta+\gamma} = 1.93 \times 10^{-13}\ N\sigma\ f[t^{-0.29} - (t + T)^{-0.29}] \tag{2}$$

$$H_{\gamma} = 1.57 \times 10^{-13}\ N\sigma\ f[t^{-0.53} - (t + T)^{-0.53}] \tag{3}$$

$$H_{\beta} = 1.62 \times 10^{-13}\ N\sigma\ f[t^{-0.06} - (t + T)^{-0.06}], \tag{4}$$

where t and T are in days. For an instantaneous burst, the derived equations now become (cf. Table 3 of Ref. 10)

$$H_{\beta+\gamma} = 6.48 \times 10^{-19}\ t^{-1.29} \quad \text{W/fiss} \tag{5}$$

$$H_{\gamma} = 9.63 \times 10^{-19}\ t^{-1.53} \quad \text{W/fiss} \tag{6}$$

$$H_{\beta} = 1.12 \times 10^{-19}\ t^{-1.06} \quad \text{W/fiss}\ . \tag{7}$$

TABLE 7

BETA DECAY POWER CONTRIBUTIONS FROM DOMINANT ISOTOPES

FPIC/U-Pu Instantaneous Burst Calculations

t (days)	Isotope	% Contribution ^{239}Pu Fast	% Contribution ^{235}U Thermal
50	^{144}Pr	14	14
	^{140}La	13	13
	^{91}Y(a)	12	21
	^{143}Pr	9	8
	^{89}Sr	8	18
	SUM	56	74
100	^{144}Pr	25	28
	^{140}La	2	2
	^{91}Y(a)	14	27
	^{143}Pr	1	1
	^{89}Sr	9	20
	SUM	51	78
175	^{144}Pr	33	44
	^{140}La	0	0
	^{91}Y(a)	10	22
	^{143}Pr	0	0
	^{89}Sr	5	13
	SUM	48	79

(a) This isotope was added to the FPIC library.

TABLE 8

GAMMA DECAY POWER CONTRIBUTIONS FROM DOMINANT ISOTOPES

FPIC/U-Pu Instantaneous Burst Calculations

t (days)	Isotope	% Contribution ^{239}Pu Fast	% Contribution ^{235}U Thermal
50	^{95}Zr	18	19
	^{95}Nb	15	16
	^{103}Ru	15	7
	^{106}Rh	1	0
	SUM	49	42
100	^{95}Zr	28	32
	^{95}Nb	37	43
	^{103}Ru	17	9
	^{106}Rh	3	0
	SUM	85	84
175	^{95}Zr	28	32
	^{95}Nb	50	57
	^{103}Ru	10	5
	^{106}Rh	6	0
	SUM	94	94

The revision of the composite fits as given above stems from changes in the coefficients of the individual fits for sample 4. As given on p. 31 of Ref. 11, the equations for sample 4 should now read (H in watts)

$$H_{\beta+\gamma} = 1.84 \times 10^{-13}\ N\sigma\ f[t^{-0.27} - (t + T)^{-0.27}] \tag{8}$$

$$H_{\gamma} = 1.59 \times 10^{-13}\ N\sigma\ f[t^{-0.54} - (t + T)^{-0.54}] \tag{9}$$

$$H_{\beta} = 1.84 \times 10^{-13}\ N\sigma\ f[t^{-0.05} - (t + T)^{-0.05}]. \tag{10}$$

Additional comparisons have been made between the FPIC/U-Pu calculations following an instantaneous burst of fissions and Johnston's analytical fits as given in Eqs. 5, 6, and 7. Both the ^{239}Pu fast fission and the ^{235}U thermal fission libraries were used for the FPIC/U-Pu calculations. Plots of the three sets of calculations are shown in Figs. 1, 2, and 3 for beta, gamma, and total decay powers, respectively. The comparison for ^{239}Pu fast fission shows a significant improvement over those which were reported using the old analytical fits.[13] Whereas the maximum differences between calculated and experimental decay powers were 6% for total, 25% for gamma, and 20% for beta,[13] with the new fits the corresponding figures are 7%, 21%, and 14%. On the basis of the new comparisons, it appears that the use of the ^{239}Pu fast fission, rather than ^{235}U thermal fission yields, generally improves the agreement of the summation calculations with Johnston's analytical expression for gamma and total decay power (Figs. 2 and 3). The beta decay power, however, still shows best agreement of Johnston's analytical expression with the ^{235}U thermal fission summation calculation (Fig. 1). Before drawing conclusions as to the superiority of either set of fission yields, however, it is well to examine the errors inherent in using the analytical fits. The fits to the data for H_{γ} and $H_{\beta+\gamma}$ for each individual sample are reported by Johnston to agree with the data within the experimental errors.[11] The resulting best fit for all samples combined had an added uncertainty due to variations among samples. In the case of the H_{β} fits, the constants for Eq. 1 differed very significantly among samples, giving least confidence in the H_{β} analytical fits. The accuracy of the fits in reproducing the experimental data from which they were derived is discussed later. In any event, the general agreement of the instantaneous burst summation studies with the derived fits follows the same pattern as the comparisons for the reproduction of the experiment; i.e., the gamma and total decay powers agree best between the experimental results and the ^{239}Pu fast fission summation study, while the beta decay power agrees best with ^{235}U thermal fission results. It might be well to point out now that comparisons of measured ^{239}Pu fast fission decay powers with ^{235}U thermal fission summation studies may seem like what the late K. T. Spinney called an "inspired extrapolation of irrelevant data." However, since these irrelevant ^{235}U thermal fission data are the choice of many fast reactor shielders, and the experimental data for yields from ^{239}Pu fast fission are obviously still quite sparse, the comparisons are not completely unjustified. As was mentioned previously, an additional uncertainty arises from the different spectra of the neutrons inducing fissions in the experiment and calculations.

In connection with these comparisons, it is interesting to examine the source of the difference between the ^{239}Pu fast fission and ^{235}U thermal fission summation calculations for beta and gamma decay powers. By observing the percent contribution of the dominant isotopes contributing to the respective beta and gamma decay powers in the two cases, the effects of the different yields from ^{239}Pu fast fission and ^{235}U thermal fission can be observed. Table 7 summarizes the contributions from the five principal contributors to the beta decay power after an instantaneous burst, and Table 8 does the same for the four principal gamma contributors. The largest variations naturally occur for mass chain yields near the top of the steep slopes of the mass chain yield curve, where the yields are most sensitive to slight lateral shifts in the curve. ^{89}Sr and ^{91}Y show this behavior.

COMPARISON OF ANALYTICAL FITS WITH EXPERIMENTAL DATA

Johnston's data were further examined from the point of view of the accuracy with which the analytical fits represent the experimental data. Thus,

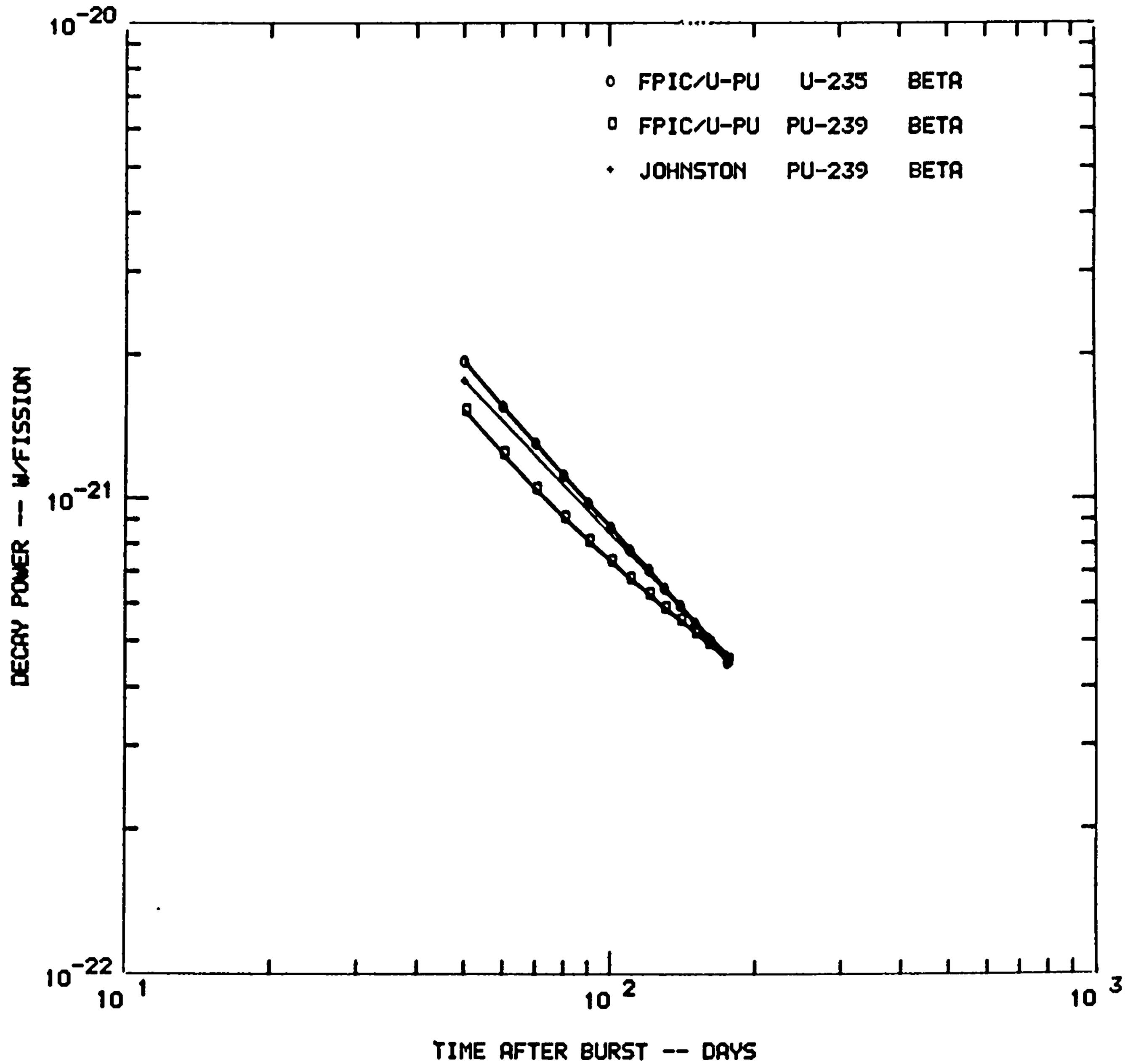

Fig. 1. Fission product beta decay powers following an instantaneous burst of fissions.

calculations were performed with the analytical fits given in Eqs. 2, 3, and 4 for an operating history duplicating the experimental one. The resulting ^{239}Pu fast fission decay powers and percent deviations from the experimental values are shown in Tables 9 through 11. In Table 11, the total decay power was computed both by the equation for total decay power itself ($H_{\beta+\gamma}$) and by summing the equstions for H_β and H_γ.

One minor source of error in duplicating the operating history may be the following:

The reproduction of the reactor operating history using the analytical fits was performed for each of the individual irradiation periods (6 periods for sample 2 and 10 periods for samples 3 and 4) shown in Table 1 of Ref. 11, whereas the derivation of the fits was performed for the average flux over each operating period (4 periods for sample 2 and 6 periods for samples 3 and 4). In each case where a mean flux was used by Johnston for contiguous irradiation periods, the flux during the penultimate such period was lower than during the last one.

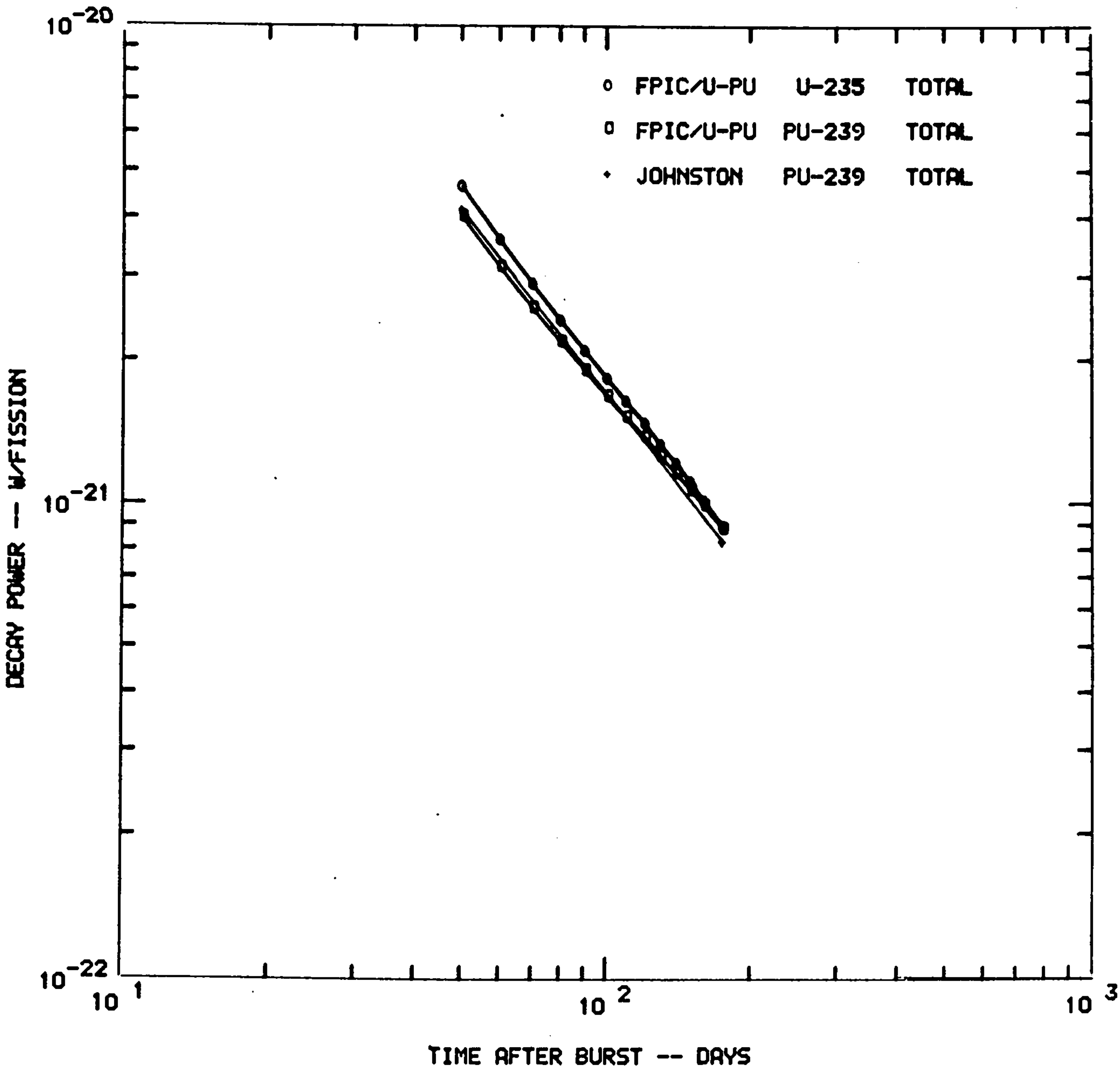

Fig. 2. Fission product gamma decay powers following an instantaneous burst of fissions.

Since the last irradiation has the greater relative importance, this would tend to increase the calculated values of H_β, H_γ, and $H_{\beta+\gamma}$. However, no such trend is visible in the data of Tables 9 to 11.

Johnston's analytical fitting was performed for each individual sample separately, and then the constants for each sample were averaged (arithmetically) to get a single equation to represent the data from all three samples. In order to isolate this effect, each individual equation was also coded, and the results for H_β and H_γ are shown in the last two columns of Tables 9 and 10, respectively. The agreement between experiment and the individual fits is generally within the experimental errors quoted by Johnston. The individual fits are, as would be expected, generally a better representation of the data than the composite fits. Although not shown in Table 11, values of $H_{\beta+\gamma}$ were calculated for each individual sample, and generally agreed better with experiment than did the composite fit.

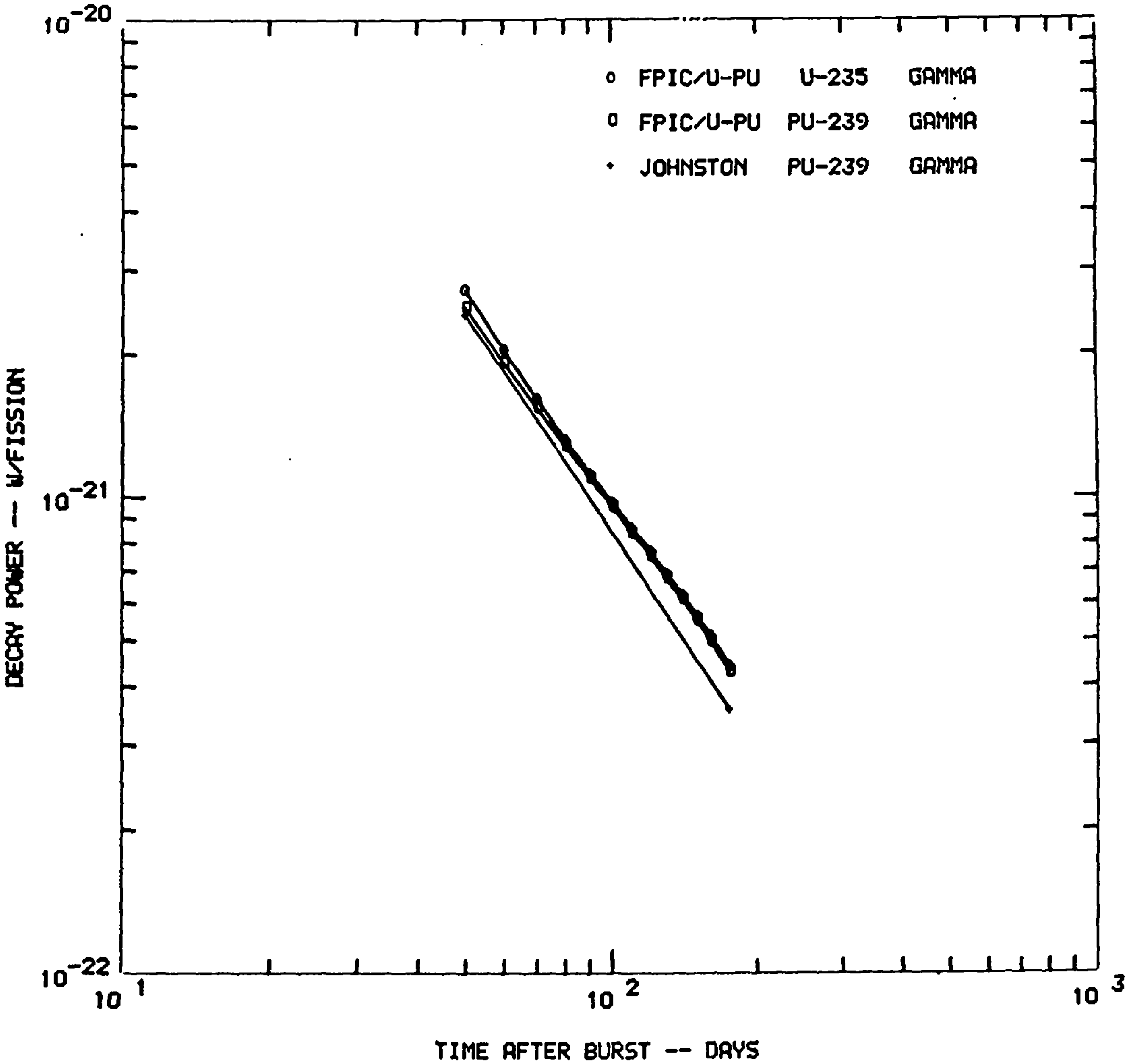

Fig. 3. Fission product total decay powers following an instantaneous burst of fissions.

REFERENCES

1. S. K. Penny, D. K. Trubey, and J. Gurney, "Bibliography, Subject Index, and Author Index of the Literature Examined by the Radiation Shielding Information Center," Oak Ridge National Laboratory Report, ORNL-RSIC-5(Rev. 1) (1966), pp. 15-19.

2. J. F. Perkins and R. W. King, "Energy Release from the Decay of Fission Products," Nucl. Sci. Eng. 3, 726 (1958).

3. J. F. Perkins, "Decay of U-235 Fission Products," Redstone Arsenal Report RR-TR-63-11 (1963).

4. K. O. Koebberling, W. E. Krull, and J. H. Wilson, "Lockheed Fission Product Inventory Code," Lockheed-Georgia Company Internal Report ER-6906 (1964).

5. L. Burris, Jr., and I. G. Dillon, "Estimation of Fission Product Spectra in Discharged Fuel from Fast Reactors," Argonne National Laboratory Report ANL-5742 (1957).

6. L. E. Weaver, P. O. Strom, and P. A. Killeen, "Estimated Total Chain and Independent Fission Yields for Several Neutron-Induced Fission Processes," Naval Radiological Defense Laboratory Report NRDL-TR-633 (1963).

TABLE 9

FISSION PRODUCT BETA DECAY POWER FROM ^{239}Pu FAST FISSION

Johnston's Analytical Fits and the Experimental Data from Which They Were Derived

			Composite Fit[a]		Individual Fit[c]	
Sample	t (days)	Experiment (μW)	Fit (μW)	% Difference[b] from Experiment	Fit (μW)	% Difference from Experiment
2	46	286	278	-2.8	282	-1.4
	67	218	215	-1.4	220	0.9
	76	201	197	-2.0	202	0.5
	90	179	174	-2.8	179	0.0
	110	153	149	-2.6	154	0.6
	144	127	120	-5.5	125	-1.6
3	54	241	248	2.9	239	-0.8
	62	217	224	3.2	215	-0.9
	75	188	195	3.7	186	-1.1
	97	153	160	4.6	151	-1.3
	125	131	131	0.0	123	-6.1
4	53	243	255	4.9	253	4.1
	61	233	231	-0.8	229	-1.7
	74	199	201	1.0	199	0.0
	96	169	165	-2.4	164	-3.0
	124	137	135	-1.4	135	-1.4

(a) See Eq. 4.

(b) Johnston[10] quotes a 95% confidence limit of ±7% for values of H_β derived from the analytical fit. It does not, however, include the error incurred in fitting the data; i.e., the error reflected here.

(c) See equations on p. 31 of Ref. 11, for samples 2 and 3.

TABLE 10

FISSION PRODUCT GAMMA DECAY POWER FROM ^{239}Pu FAST FISSION

Johnston's Analytical Fits and the Experimental Data from Which They Were Derived

			Composite Fit[a]		Individual Fit[c]	
Sample	t (days)	Experiment (μW)	Fit (μW)	% Difference[b] from Experiment	Fit (μW)	% Difference from Experiment
2	46	339	308	- 9.1	340	0.3
	67	232	208	-10.3	231	-0.4
	76	198	182	- 8.1	202	2.0
	90	172	151	-12.2	168	-2.3
	110	136	121	-11.0	135	-0.7
	144	94	88	- 6.4	99	5.3
3	54	250	266	6.4	249	-0.4
	62	212	228	7.5	213	0.5
	75	170	183	7.6	172	1.2
	97	128	136	6.2	127	-0.8
	125	100	101	1.0	94	-6.0
4	53	278	273	-1.8	270	-2.9
	61	229	234	2.2	231	0.9
	74	186	189	1.6	186	0.0
	96	134	140	4.5	138	3.0
	124	111	104	-6.3	102	-8.1

(a) See Eq. 3.

(b) Johnston[10] quotes a 95% confidence limit of ±10% for values of H_γ derived from the analytical fit. It does not, however, include the error incurred in fitting the data; i.e., the error reflected here.

(c) See equations on p. 31 of Ref. 11, for samples 2 and 3.

TABLE 11

FISSION PRODUCT TOTAL DECAY POWER FROM ^{239}Pu FAST FISSION

Johnston's Analytical Fits and the Experimental Data from Which They Were Derived, Using the Composite Fit for $H_{\beta+\gamma}$ and the Sum of the Composite Fits for H_β and H_γ

			$H_{\beta+\gamma}$[a]		$H_\beta + H_\gamma$	
Sample	t (days)	Experiment (μW)	Fit (μW)	% Difference[b] from Experiment	Fit (μW)	% Difference from Experiment
2	46	625	586	-6.2	586	-6.2
	67	450	426	-5.3	424	-5.8
	76	399	381	-4.5	379	-5.0
	90	351	326	-7.1	325	-7.4
	110	289	270	-6.6	270	-6.6
	144	221	207	-6.3	208	-5.9
3	54	491	514	4.7	514	4.7
	62	429	453	5.6	452	5.4
	75	358	379	5.9	378	5.6
	97	281	297	5.7	296	5.3
	125	231	231	0.0	232	0.4
4	53	521	528	1.3	528	1.3
	61	462	466	0.9	465	0.6
	74	385	390	1.3	389	1.0
	96	303	306	1.0	305	0.7
	124	248	239	-3.6	239	-3.6

(a) See Eq. 2.

(b) Johnston[10] quotes a 95% confidence limit of ±6% for values of $H_{\beta+\gamma}$ derived from the analytical fit. It does not, however, include the error incurred in fitting the data; i.e., the error reflected here.

7. C. A. Anderson, Jr., "Fission Product Yields from Fast (≈1 MeV) Neutron Fission of Pu-239," Los Alamos Scientific Laboratory Report LA-3383 (1965).

8. K. Wolfsberg, "A Method for Estimating Fractional Yields from Low- and Medium-Energy Neutron Induced Fission," Los Alamos Scientific Laboratory Report LA-3169 (1964).

9. K. Shure and D. J. Dudziak, "Calculating Energy Released by Fission Products," Trans. Am. Nucl. Soc. 4, (1) 30 (1961).

10. K. Johnston, "A Calorimetric Determination of Fission Product Heating in Fast Reactor Plutonium Fuel," J. Nucl. Energy, Parts A/B, 19, 527 (1965).

11. K. Johnston and D. G. Vallis, "Fission Product Heating in Fast Reactor Plutonium Fuel," UK Atomic Weapons Research Establishment Report AWRE-0-68/64 (1964).

12. K. Johnston, AWRE, private communication (1968).

13. M. E. Battat, Donald J. Dudziak, and H. R. Hicks, "Fission Product Decay from Fast Fission of ^{239}Pu," Trans. Am. Nucl. Soc. 10 (2), 524 (1967).

APPENDIX A

THE CHANGES MADE IN THE U-235 THERMAL FISSION DATA OF THE LOCKHEED FISSION PRODUCT INVENTORY CODE (FPIC) ARE LISTED BELOW. THESE CHANGES WERE INCORPORATED IN THE FPIC/U-PU CODE, THE INPUT DATA FOR WHICH ARE GIVEN IN APPENDIX B.

1. ADDITION OF COMPLETE NUCLIDE DATA FOR Y-91. THIS WAS OMITTED IN THE ORIGINAL COMPILATION. FOR DATA USED, SEE ENTRY FOR THIS NUCLIDE IN APPENDIX B.
2. TE-133A CHANGE CUMULATIVE YIELD - Y(2) - FROM 5.4 TO 1.72 PERCENT.
3. PD-110 CHANGE NUCLIDE IDENTIFICATION FROM PD-110 TO PD-112.
4. CHANGES IN DECAY CONSTANTS. DECAY CONSTANTS USED WERE OBTAINED FROM JULY 1965 (EIGHTH EDITION) CHART OF THE NUCLIDES BY DAVID T. GOLDMAN.

-NUCLIDE-	-ITEM CHANGED-	-OLD VALUE-	-NEW VALUE-
I-137	LAMBDA-2	2.89E-03	2.89 E-02
XE-137	LAMBDA-1	2.89E-03	2.89 E-02
BR-89	LAMBDA-2	1.50E-01	1.54 E-01
RB-91	LAMBDA-2	8.25E-04	9.625E-03
SR-91	LAMBDA-1	8.25E-04	9.625E-03
TC-102M	LAMBDA-1	1.00E-03	1.06 E-03
TC-102	LAMBDA-1	1.00E-03	1.06 E-03
RU-107	LAMBDA-2	2.28E-03	2.75 E-03
RH-107	LAMBDA-1	2.88E-03	2.75 E-03
CD-118	LAMBDA-2	2.78E-04	2.31 E-04
IN-118	LAMBDA-1	2.78E-04	2.31 E-04
TE-125M	LAMBDA-1	1.38E-07	8.14 E-09
TE-125M	LAMBDA-2	1.10E-08	1.38 E-07
TE-127A	LAMBDA-2	2.04E-05	2.07 E-05
BA-137M	LAMBDA-1	7.39E-10	7.32 E-10
CS-142	LAMBDA-2	1.16E-02	3.01 E-01
BA-142	LAMBDA-1	1.16E-02	3.01 E-01

APPENDIX B

FOR REFERENCE PURPOSES, A LISTING OF THE NUCLIDE DECAY DATA FOR U-235 THERMAL AND PU-239 FAST FISSION ARE SHOWN IN THIS APPENDIX. THESE DATA ARE THE INPUT DATA USED IN THE FPIC/U-PU CODE. FOR EACH NUCLIDE, FIVE LINES OF DATA ARE SHOWN. DEFINITIONS OF THE SYMBOLS USED ARE -

```
LINE 1   NUCLIDE     = NAME OF NUCLIDE
         LAMBDA1     = DECAY CONSTANT (1/SEC) OF PARENT
         LAMBDA2     = DECAY CONSTANT (1/SEC) OF NUCLIDE
         Y235TH(1)   = INDEPENDENT YIELD (PERCENT) OF NUCLIDE, U-235
                       THERMAL FISSION
         Y235TH(2)   = TOTAL YIELD (PERCENT) OF NUCLIDE, U-235 THERMAL
         E(BETA)     = AVERAGE BETA ENERGY, MEV/DECAY
         E(GAMMA)    = AVERAGE GAMMA ENERGY, MEV/DECAY

LINE 2   Y239FA(1)   = INDEPENDENT YIELD (PERCENT) OF NUCLIDE, PU-239
                       FAST FISSION
         Y239FA(2)   = TOTAL YIELD (PERCENT) OF NUCLIDE, PU-239 FAST

LINE 3   GAMMA ENERGY (MEV/DECAY) FOR ENERGY GROUP EG(I)
         EG(1)  0.1  TO 0.4  MEV
         EG(2)  0.4  TO 0.9  MEV
         EG(3)  0.9  TO 1.35 MEV
         EG(4)  1.35 TO 1.8  MEV
         EG(5)  1.8  TO 2.2  MEV
         EG(6)  2.2  TO 2.6  MEV
         EG(7)  GREATER THAN 2.6 MEV
```

LINES 4 AND 5

THE DOSE CONVERSION FACTORS (REM/CURIE) FOR THE BODY ORGANS LISTED ARE GIVEN. THESE DATA REPRESENT CONVERSION FACTORS FOR ACCUMULATED DOSE FOR 70 YEARS EXPOSURE AND ACCOUNT FOR THE FRACTION OF INHALED NUCLIDE ACTIVITY THAT IS DEPOSITED IN EACH BODY ORGAN. EXCEPT FOR Y-91, THE FIGURES ARE REPRODUCED FROM THE LOCKHEED-GEORGIA REPORT ER-6906. (REF 4)

```
-NUCLIDE   -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                 -Y239FA(1)-Y239FA(2)
-EG(1)     -EG(2)     -EG(3)     -EG(4)    -EG(5)    -EG(6)    -EG(7)
-BONE      -G.I.      -KIDNEY    -LIVER    -LUNG     -MUSCLE
-PANCREAS  -PROSTATE  -SPLEEN    -TESTIS   -THYROID  -WHOLEBODY

GE77M       1.000E 00 1.280E-02 0.         4.800E-03 7.710E-01 1.950E-01
                                0.         1.900E-02
 1.950E-01 0.         0.        0.         0.        0.        0.
 0.        0.         0.        0.         0.        0.
 0.        0.         0.        0.         0.        0.
GE77        1.280E-02 1.710E-05 2.100E-03 3.100E-03 6.370E-01 1.126E 00
                                2.000E-03 6.000E-03
 3.030E-01 4.310E-01 1.660E-01 1.080E-01 9.400E-02 2.400E-02 0.
 0.        7.875E 03 1.521E 03 8.975E 01 5.520E 03 0.
 0.        0.        0.        0.        0.        1.097E 02
GE78        1.000E 00 9.170E-05 0.        2.000E-02 4.450E-01 0.
                                9.820E-03 3.900E-02
 0.        0.        0.        0.        0.        0.        0.
 0.        2.432E 02 7.464E 01 4.105E 00 1.686E 02 0.
 0.        0.        0.        0.        0.        4.740E 00
AS77A       1.280E-02 4.970E-06 1.400E-03 5.200E-03 2.210E-01 2.300E-02
                                0.        1.300E-02
 1.600E-02 7.000E-03 0.        0.        0.        0.        0.
 0.        3.679E 03 5.209E 02 1.364E 02 3.474E 03 0.
 0.        0.        0.        0.        0.        1.105E 02
AS77B       1.710E-05 4.970E-06 0.        3.100E-03 2.210E-01 2.300E-02
                                0.        6.000E-03
 1.600E-02 7.000E-03 0.        0.        0.        0.        0.
 0.        3.679E 03 5.209E 02 1.364E 02 3.474E 03 0.
 0.        0.        0.        0.        0.        1.105E 02
```

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
AS78	9.170E-05	1.270E-04	0.	2.000E-02	1.449E 00	8.830E-01
			3.810E-04	3.900E-02		
1.600E-02	4.290E-01	2.470E-01	6.100E-02	7.300E-02	2.200E-02	3.500E-02
0.	1.164E 03	1.181E 02	3.099E 01	8.053E 02	0.	
0.	0.	0.	0.	0.	2.535E 01	
AS79	1.000E 00	1.280E-03	0.	5.600E-02	8.990E-01	0.
			3.680E-03	7.000E-02		
0.	0.	0.	0.	0.	0.	0.
0.	6.552E 01	6.790E 00	1.776E 00	4.536E 01	0.	
0.	0.	0.	0.	0.	1.415E 00	
SE79M	1.280E-03	2.960E-03	0.	5.600E-02	0.	9.600E-02
			3.260E-04	7.000E-02		
9.600E-02	0.	0.	0.	0.	0.	0.
0.	1.789E 00	5.900E-01	1.249E-01	1.238E 00	0.	
0.	0.	0.	0.	0.	1.031E-01	
SE81M	1.000E 00	2.030E-04	0.	8.400E-03	0.	1.030E-01
			0.	1.730E-01		
1.030E-01	0.	0.	0.	0.	0.	0.
0.	2.763E 01	9.100E 00	1.937E 00	1.920E 01	0.	
0.	0.	1.137E 00	0.	0.	1.589E 00	
SE81	1.160E-03	6.410E-04	1.320E-01	1.400E-01	5.220E-01	1.500E-01
			5.390E-03	1.780E-01		
1.500E-01	0.	0.	0.	0.	0.	0.
0.	7.728E 01	8.274E 01	1.280E 01	5.328E 01	0.	
0.	0.	1.237E 01	0.	0.	4.431E 00	
SE83M	1.000E 00	10.000E-03	0.	2.900E-01	1.379E 00	2.020E-01
			5.970E-02	2.020E-01		
9.000E-03	1.600E-02	7.600E-02	0.	1.010E-01	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
SE83	1.000E 00	4.620E-04	0.	2.200E-01	5.760E-01	1.421E 00
			5.970E-02	1.720E-01		
3.200E-02	1.830E-01	1.310E-01	0.	3.120E-01	7.630E-01	0.
0.	1.245E 02	1.335E 02	2.065E 01	8.592E 01	0.	
0.	0.	1.669E 01	0.	0.	7.154E 00	
SE84	1.000E 00	3.850E-03	0.	9.200E-01	2.400E-01	3.000E-01
			2.770E-01	4.790E-01		
3.000E-01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	C.	
0.	0.	0.	0.	0.	0.	
SE85	1.000E 00	1.780E-02	0.	1.100E 00	1.610E-01	0.
			4.130E-01	5.220E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
SE87	1.000E 00	4.330E-02	0.	2.000E 00	1.100E 00	0.
			2.560E-01	2.640E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
BR83A	10.000E-03	8.370E-05	0.	2.900E-01	3.360E-01	4.000E-03
			6.230E-03	1.880E-01		
0.	0.	0.	0.	0.	0.	0.
0.	4.738E 02	0.	0.	3.278E 02	0.	
0.	0.	0.	0.	0.	2.890E 01	
BR83B	4.620E-04	8.370E-05	0.	2.200E-01	3.360E-01	4.000E-03
			0.	1.920E-01		
0.	0.	0.	0.	0.	0.	0.
0.	4.738E 02	0.	0.	3.278E 02	0.	
0.	0.	0.	0.	0.	2.890E 01	
BR84M	1.000E 00	1.920E-03	0.	1.900E-02	7.100E-01	3.276E 00
			2.000E-02	2.100E-02		
6.200E-02	8.670E-01	3.630E-01	3.190E-01	7.410E-01	1.660E-01	7.580E-01
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
BR84	3.850E-03	3.610E-04	0.	9.200E-01	1.226E 00	1.821E 00
			2.000E-02	4.990E-01		
3.500E-02	4.820E-01	2.020E-01	1.770E-01	4.120E-01	9.200E-02	4.210E-01
0.	5.544E 02	0.	0.	3.838E 02	0.	
0.	0.	0.	0.	0.	3.420E 01	
BR85	1.780E-02	3.850E-03	2.000E-01	1.100E 00	1.037E 00	0.
			1.620E-01	6.840E-01		
0.	0.	0.	0.	0.	0.	0.
0.	2.646E 01	0.	0.	1.836E 01	0.	
0.	0.	0.	0.	0.	1.635E 00	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
BR87	4.330E-02	1.260E-02	0.	2.490E 00	1.873E 00	3.780E 00
			6.910E-01	9.550E-01		
0.	0.	0.	0.	0.	0.	3.780E 00
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
BR88	1.000E 00	4.330E-02	0.	2.610E 00	3.400E-01	0.
			7.450E-01	8.490E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
BR89	1.000E 00	1.540E-01	0.	2.580E 00	0.	0.
			5.410E-01	5.670E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
KR83M	8.370E-05	1.010E-04	0.	5.100E-01	0.	4.100E-02
			1.230E-05	3.800E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
KR85M	3.850E-03	4.380E-05	0.	1.300E 00	2.830E-01	1.780E-01
			2.890E-03	6.870E-01		
1.780E-01	0.	0.	0.	0.	0.	0.
0.	7.825E 02	0.	0.	5.411E 02	0.	
0.	0.	0.	0.	0.	0.	
KR85	4.380E-05	2.070E-09	0.	2.930E-01	2.210E-01	4.000E-03
			2.890E-03	1.577E-01		
4.000E-03	0.	0.	0.	0.	0.	0.
0.	6.335E 03	0.	0.	2.454E 05	0.	
0.	0.	0.	0.	0.	0.	
KR87	1.260E-02	1.480E-04	0.	2.490E 00	1.335E 00	1.091E 00
			1.910E-01	1.145E+00		
0.	4.620E-01	0.	6.200E-02	0.	5.670E-01	0.
0.	1.212E 03	0.	0.	8.388E 02	0.	
0.	0.	0.	0.	0.	0.	
KR88	4.330E-02	6.880E-05	9.000E-01	3.510E 00	3.730E-01	1.897E 00
			5.430E-01	1.392E+00		
9.300E-02	1.870E-01	4.600E-02	2.090E-01	5.530E-01	8.090E-01	0.
0.	1.123E 03	0.	0.	1.343E 03	0.	
0.	0.	0.	0.	0.	0.	
KR89	1.540E-01	3.610E-03	2.010E 00	4.590E 00	1.389E 00	2.330E 00
			1.030E+00	1.598E+00		
0.	0.	0.	1.105E 00	0.	0.	1.225E 00
0.	4.818E 01	0.	0.	3.336E 01	0.	
0.	0.	0.	0.	0.	0.	
KR90	4.330E-01	2.100E-02	0.	5.000E 00	1.369E 00	0.
			1.218E+00	1.463E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
KR91	1.000E 00	6.930E-02	0.	3.450E 00	1.200E 00	0.
			9.990E-01	1.071E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
KR92	1.000E 00	2.310E-01	0.	1.870E 00	0.	0.
			5.330E-01	5.460E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
KR93	1.000E 00	3.460E-01	0.	4.800E-01	0.	0.
			1.830E-01	1.840E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
RB88	6.880E-05	6.420E-04	6.000E-02	3.570E 00	1.984E 00	7.480E-01
			3.790E-02	1.430E+00		
0.	1.560E-01	0.	2.300E-02	5.030E-01	0.	6.600E-02
0.	3.936E 02	0.	4.594E 01	2.725E 02	2.555E 01	
0.	0.	4.088E 01	0.	0.	2.435E 01	
RB89	3.610E-03	7.700E-04	2.000E-01	4.790E 00	5.980E-01	2.394E 00
			1.990E-01	1.797E+00		
0.	9.800E-02	1.444E 00	6.100E-02	3.060E-01	3.340E-01	1.510E-01
0.	4.482E 02	0.	4.383E 01	3.100E 02	2.908E 01	
0.	0.	3.731E 01	0.	0.	2.770E 01	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
RB90	2.100E-02	4.280E-03	7.700E-01	5.770E 00	7.500E-01	4.944E 00
			6.270E-01	2.090E+00		
0.	8.400E-02	1.300E-01	1.900E-01	1.810E-01	1.500E-01	4.210E 00
0.	6.263E 01	0.	7.954E 00	4.332E 01	4.067E 00	
0.	0.	7.224E 00	0.	0.	3.877E 00	
RB91	6.930E-02	9.625E-03	1.980E 00	5.430E 00	1.270E 00	3.000E 00
			1.346E+00	2.417E+00		
0.	0.	0.	0.	0.	0.	3.000E 00
0.	1.518E 02	0.	1.926E 01	1.049E 02	9.838E 00	
0.	0.	1.747E 01	0.	0.	9.360E 00	
RB92	2.310E-01	8.660E-03	3.430E 00	5.300E 00	3.435E 00	0.
			1.896E+00	2.440E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
RB93	3.460E-01	1.240E-01	5.620E 00	6.100E 00	1.670E 00	0.
			1.770E+00	1.954E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
SR89	7.700E-04	1.600E-07	0.	4.790E 00	5.550E-01	0.
			3.260E-03	1.800E+00		
0.	0.	0.	0.	0.	0.	0.
2.996E 05	1.405E 04	0.	0.	1.777E 05	0.	
0.	0.	0.	0.	0.	1.222E 04	
SR90	4.280E-03	7.840E-10	0.	5.770E 00	1.730E-01	0.
			3.010E-02	2.120E+00		
0.	0.	0.	0.	0.	0.	0.
1.388E 07	5.479E 03	0.	0.	2.164E 05	0.	
0.	0.	0.	0.	0.	4.780E 05	
SR91	9.625E-03	1.980E-05	3.800E-01	5.810E 00	6.240E-01	6.960E-01
			1.810E-01	2.598E+00		
0.	2.620E-01	2.800E-02	3.080E-01	9.800E-02	0.	0.
2.624E 03	5.715E 03	0.	0.	3.968E 03	0.	
0.	0.	0.	0.	0.	1.892E 02	
SR92	8.660E-03	7.400E-05	0.	5.300E 00	2.130E-01	1.274E 00
			6.870E-01	3.127E+00		
1.400E-02	2.800E-02	0.	1.232E 00	0.	0.	0.
5.110E 02	1.597E 03	0.	0.	1.183E 03	0.	
0.	0.	0.	0.	0.	5.270E 01	
SR93	1.240E-01	1.410E-03	0.	6.100E 00	1.269E 00	1.093E 00
			1.087E+00	3.641E+00		
0.	4.000E-01	4.360E-01	2.570E-01	0.	0.	0.
8.848E 01	1.102E 02	0.	0.	7.584E 01	0.	
0.	0.	0.	0.	0.	3.612E 00	
SR94	2.390E-01	8.880E-03	2.300E 00	5.200E 00	1.065E 00	9.300E-01
			2.746E+00	3.884E+00		
3.000E-02	0.	9.000E-01	0.	0.	0.	0.
1.500E 04	1.859E 01	0.	0.	1.286E 01	0.	
0.	0.	0.	0.	0.	6.120E-01	
Y90	7.840E-10	3.000E-06	0.	5.770E 00	9.230E-01	0.
			1.080E-04	2.120E+00		
0.	0.	0.	0.	0.	0.	0.
1.565E 04	1.565E 04	0.	0.	1.967E 04	0.	
0.	0.	0.	0.	0.	5.985E 02	
Y91M	1.980E-05	2.310E-04	0.	3.490E 00	0.	5.420E-01
			9.980E-04	1.559E+00		
0.	5.420E-01	0.	0.	0.	0.	0.
4.005E 00	1.543E 02	0.	0.	1.067E 02	0.	
0.	0.	0.	0.	0.	3.175E 00	
Y91 SEE FINAL ENTRY IN THIS TABULATION						
Y92	7.400E-05	5.350E-05	7.300E-01	6.030E 00	1.431E 00	3.400E-01
			2.250E-02	3.150E+00		
2.400E-02	2.400E-02	1.470E-01	3.300E-02	6.900E-02	4.300E-02	0.
1.181E 01	4.706E 02	0.	0.	3.253E 02	0.	
0.	0.	0.	0.	0.	9.705E 00	
Y93	1.410E-03	1.920E-05	0.	6.100E 00	1.170E 00	1.030E-01
			1.570E-01	3.799E+00		
1.900E-02	5.000E-03	2.600E-02	1.100E-02	4.100E-02	10.000E-04	0.
3.691E 03	8.947E 03	0.	0.	6.215E 03	0.	
0.	0.	0.	0.	0.	1.857E 02	
Y94	8.880E-03	6.080E-04	5.000E-01	5.400E 00	2.233E 00	1.160E 00
			7.000E-01	4.584E+00		
0.	0.	4.580E-01	7.020E-01	0.	0.	0.
1.941E 02	4.685E 02	0.	0.	3.243E 02	0.	
0.	0.	0.	0.	0.	9.652E 00	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
Y95	1.730E-02	1.100E-03	1.000E 00	6.200E 00	6.160E-01	9.000E-01
			1.912E+00	5.176E+00		
0.	0.	9.000E-01	0.	0.	0.	0.
7.706E 01	1.430E 02	0.	0.	9.784E 01	0.	
0.	0.	0.	0.	0.	2.932E 00	
ZR95	1.100E-03	1.230E-07	0.	6.200E 00	1.180E-01	7.310E-01
			1.230E-01	5.299E+00		
0.	7.310E-01	0.	0.	0.	0.	0.
2.861E 04	1.473E 04	3.859E 04	1.272E 04	2.061E 05	0.	
0.	0.	1.158E 04	0.	0.	8.200E 03	
ZR97	1.000E 00	1.130E-05	1.600E 00	5.900E 00	7.050E-01	1.450E-01
			1.444E+00	5.136E+00		
0.	1.200E-02	6.200E-02	7.100E-02	0.	0.	0.
1.704E 03	6.485E 03	1.278E 03	3.960E 02	4.715E 03	0.	
0.	0.	3.833E 02	0.	0.	1.410E 02	
NB95M	1.230E-07	2.140E-06	0.	1.200E-01	0.	2.350E-01
			3.030E-04	1.058E-01		
2.350E-01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
NB95	1.230E-07	2.290E-07	0.	6.200E 00	4.600E-02	7.620E-01
			3.030E-04	5.299E+00		
0.	7.620E-01	0.	0.	0.	0.	0.
8.635E 01	2.863E 03	4.114E 02	2.534E 02	4.519E 03	0.	
0.	0.	1.647E 02	0.	0.	1.382E 02	
NB97M	1.130E-05	1.160E-02	0.	5.660E 00	0.	7.500E-01
			0.000E+00	4.300E+00		
0.	7.500E-01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
NB97	1.130E-05	1.560E-04	1.900E-01	6.090E 00	4.650E-01	6.690E-01
			6.360E-02	5.200E+00		
0.	6.590E-01	10.000E-03	0.	0.	0.	0.
8.350E 01	5.563E 02	7.265E 01	3.539E 01	3.850E 02	0.	
0.	0.	2.906E 01	0.	0.	1.147E 01	
NB98	1.000E 00	2.260E-04	0.	6.400E-02	1.086E 00	2.260E 00
			3.430E-01	5.497E+00		
0.	1.392E 00	6.170E-01	1.610E-01	9.000E-02	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
NB99	2.100E-02	4.820E-03	0.	6.060E 00	1.360E 00	3.600E-01
			1.173E+00	5.765E+00		
3.600E-01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
NB100	1.000E 00	3.850E-03	0.	6.300E 00	1.451E 00	3.510E 00
			2.555E+00	5.779E+00		
3.890E-01	1.300E 00	0.	0.	4.030E-01	4.110E-01	1.007E 00
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
MO99	4.820E-03	2.890E-06	0.	6.060E 00	4.040E-01	1.190E-01
			3.520E-02	5.800E+00		
2.000E-02	9.600E-02	0.	0.	0.	0.	0.
8.200E 00	9.038E 03	1.584E 04	3.246E 03	9.528E 01	0.	
0.	0.	0.	0.	0.	5.918E 02	
MO101	1.160E-02	7.700E-04	0.	5.000E 00	4.200E-01	1.677E 00
			6.830E-01	5.989E+00		
1.510E-01	5.540E-01	4.160E-01	2.890E-01	2.670E-01	0.	0.
0.	1.373E 02	1.848E 02	2.216E 01	9.528E 01	0.	
0.	0.	0.	0.	0.	7.351E 00	
MO102	1.000E 00	1.060E-03	0.	4.100E 00	4.360E-01	0.
			1.572E+00	5.936E+00		
0.	0.	0.	0.	0.	0.	0.
0.	3.402E 01	6.796E 01	7.475E 00	2.350E 01	0.	
0.	0.	0.	0.	0.	1.820E 00	
MO105	1.000E 00	5.780E-03	0.	9.000E-01	1.740E 00	1.500E 00
			3.068E+00	3.707E+00		
0.	0.	0.	1.500E 00	0.	0.	0.
0.	9.546E 01	1.911E 02	2.112E 01	6.636E 01	0.	
0.	0.	0.	0.	0.	5.122E 00	
TC99M	2.890E-06	3.210E-05	0.	5.270E 00	0.	1.420E-01
			3.830E-05	5.044E+00		
1.420E-01	0.	0.	0.	0.	0.	0.
3.200E-02	2.470E 02	1.441E 01	5.280E-01	1.708E 02	0.	
0.	0.	0.	0.	0.	8.155E 00	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
TC101	7.700E-04	8.250E-04	0.	5.000E 00	4.790E-01	3.150E-01
			1.150E-02	6.000E+00		
2.760E-01	3.900E-02	0.	0.	0.	0.	0.
1.570E-01	8.253E 01	1.204E 01	3.360E-01	5.712E 01	0.	
0.	0.	0.	0.	0.	3.370E 00	
TC102M	10.600E-04	1.390E-01	0.	2.050E 00	7.930E-01	2.200E 00
			3.210E-02	3.000E+00		
0.	0.	0.	0.	2.200E 00	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
TC102	10.600E-04	2.570E-03	0.	2.050E 00	1.788E 00	0.
			3.210E-02	3.000E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
TC103	1.000E 00	9.620E-03	0.	3.000E 00	1.025E 00	0.
			2.550E-01	5.848E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
TC104	4.620E-03	6.420E-04	0.	1.800E 00	9.780E-01	9.020E-01
			7.280E-01	5.586E+00		
2.230E-01	6.790E-01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
TC105	5.780E-03	1.160E-03	0.	9.000E-01	6.560E-01	1.700E 00
			1.523E+00	5.230E+00		
4.250E-01	4.250E-01	0.	8.500E-01	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
TC107	1.000E 00	1.160E-02	0.	1.900E-01	2.000E 00	0.
			2.202E+00	3.142E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
RU103	9.620E-03	2.000E-07	0.	3.000E 00	6.200E-02	4.890E-01
			1.950E-03	5.850E+00		
2.000E-03	4.870E-01	0.	0.	0.	0.	0.
8.162E 02	9.900E 03	1.078E 04	0.	1.034E 05	0.	
0.	0.	0.	0.	0.	6.612E 02	
RU105	1.160E-03	4.370E-05	0.	9.000E-01	4.160E-01	6.500E-01
			7.020E-02	5.300E+00		
4.400E-02	5.700E-01	3.400E-02	2.000E-03	0.	0.	0.
6.203E 01	2.042E 03	2.506E 03	0.	1.412E 03	0.	
0.	0.	0.	0.	0.	4.339E 01	
RU106	1.000E 00	2.180E-08	0.	3.800E-01	10.000E-03	0.
			2.420E-01	4.698E+00		
0.	0.	0.	0.	0.	0.	0.
1.377E 02	3.043E 02	7.434E 02	0.	9.179E 03	0.	
0.	0.	0.	0.	0.	2.294E 01	
RU107	1.160E-02	2.750E-03	0.	1.900E-01	1.671E 00	1.380E-01
			5.460E-01	3.688E+00		
2.900E-02	6.800E-02	4.100E-02	0.	0.	0.	0.
2.417E 00	3.969E 01	8.051E 01	0.	2.736E 01	0.	
0.	0.	0.	0.	0.	8.639E-01	
RH103M	2.000E-07	2.030E-04	0.	3.000E 00	0.	4.000E-02
			5.070E-07	5.850E+00		
0.	0.	0.	0.	0.	0.	0.
6.037E-02	1.718E 01	3.167E 00	4.760E-01	1.188E 01	0.	
0.	0.	1.057E 00	0.	0.	4.935E-01	
RH105M	4.370E-05	2.310E-02	0.	1.800E-01	0.	1.290E-01
			1.210E-04	1.060E+00		
1.290E-01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
RH105	4.370E-05	5.350E-06	0.	9.000E-01	1.680E-01	3.200E-02
			1.210E-04	5.300E+00		
3.200E-02	0.	0.	0.	0.	0.	0.
1.607E 02	2.860E 03	1.371E 03	1.589E 02	2.625E 03	0.	
0.	0.	4.491E 02	0.	0.	9.646E 01	
RH106	2.180E-08	2.310E-02	0.	3.800E-01	1.411E 00	2.210E-01
			2.110E-03	4.700E+00		
0.	1.810E-01	2.700E-02	5.000E-03	3.000E-03	10.000E-04	4.000E-03
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
RH107	2.750E-03	5.250E-04	0.	1.900E-01	4.250E-01	3.280E-01
			1.180E-02	3.700E+00		
3.080E-01	2.000E-02	0.	0.	0.	0.	0.
5.092E 00	1.537E 02	4.688E 01	5.824E 00	1.063E 02	0.	
0.	0.	1.563E 01	0.	0.	4.424E 00	
RH108	2.690E-03	3.850E-02	0.	7.000E-02	1.500E 00	3.710E-01
			4.400E-02	2.700E+00		
0.	3.710E-01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
RH109	1.000E 00	2.310E-02	0.	3.000E-02	8.000E-01	1.000E-01
			1.010E-01	1.669E+00		
1.000E-01	0.	0.	0.	0.	0.	0.
2.474E 01	4.920E 02	1.983E 02	2.331E 01	3.404E 02	0.	
0.	0.	6.611E 01	0.	0.	1.414E 01	
PD109	2.310E-02	1.430E-05	0.	3.000E-02	3.600E-01	0.
			1.000E-03	1.670E+00		
0.	0.	0.	0.	0.	0.	0.
0.	2.349E 03	2.549E 03	2.503E 02	1.662E 03	0.	
0.	0.	3.128E 02	0.	0.	6.263E 01	
PD111	1.000E 00	5.260E-04	0.	1.900E-02	8.490E-01	0.
			1.000E-02	5.000E-01		
0.	0.	0.	0.	0.	0.	0.
0.	1.581E 02	1.698E 02	1.685E 01	1.093E 02	0.	
0.	0.	2.124E 01	0.	0.	4.539E 00	
PD112	1.000E 00	9.160E-06	0.	10.000E-03	7.900E-02	0.
			1.100E-02	1.500E-01		
0.	0.	0.	0.	0.	0.	0.
0.	8.102E 02	9.341E 02	9.129E 01	6.140E 02	0.	
0.	0.	1.135E 02	0.	0.	2.192E 01	
AG109M	1.430E-05	1.730E-02	0.	3.000E-02	0.	8.800E-02
			6.710E-07	1.670E+00		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
AG111M	5.260E-04	9.620E-03	0.	1.900E-02	0.	6.500E-02
			0.	5.000E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
AG111	9.620E-03	1.070E-06	0.	1.900E-02	3.590E-01	2.500E-02
			0.	5.000E-01		
2.500E-02	0.	0.	0.	0.	0.	0.
1.004E 03	8.584E 03	3.867E 03	6.013E 02	2.336E 04	0.	
0.	0.	0.	0.	0.	2.992E 02	
AG112	9.160E-06	6.820E-05	0.	10.000E-03	1.431E 00	6.780E-01
			0.	1.500E-01		
0.	2.860E-01	4.800E-02	1.380E-01	1.070E-01	4.000E-02	5.900E-02
8.143E 01	3.698E 03	5.108E 02	7.256E 01	2.558E 03	0.	
0.	0.	0.	0.	0.	7.580E 01	
AG113	8.250E-03	3.630E-05	0.	1.600E-02	5.690E-01	4.930E-01
			5.660E-04	1.100E-01		
1.500E-01	1.470E-01	1.960E-01	0.	0.	0.	0.
7.746E 01	2.121E 03	4.071E 02	5.428E 01	1.466E 03	0.	
0.	0.	0.	0.	0.	4.268E 01	
AG114	4.810E-03	1.390E-01	0.	1.400E-02	2.019E 00	5.560E-01
			2.390E-03	9.900E-02		
0.	5.560E-01	0.	0.	0.	0.	0.
1.105E 00	3.055E 01	5.992E 00	7.925E-01	2.112E 01	0.	
0.	0.	0.	0.	0.	6.426E-01	
AG115M	1.540E-02	3.460E-02	0.	9.700E-03	4.170E-01	4.320E-01
			4.000E-03	5.250E-02		
0.	4.320E-01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
AG115	3.460E-02	5.500E-04	0.	7.700E-03	1.207E 00	1.900E-02
			4.000E-03	4.250E-02		
1.900E-02	0.	0.	0.	0.	0.	0.
7.803E 00	2.117E 02	4.149E 01	5.508E 00	1.466E 02	0.	
0.	0.	0.	0.	0.	4.462E 00	
CD113M	3.630E-05	1.570E-09	0.	1.600E-02	1.810E-01	0.
			1.120E-06	1.100E-01		
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
CD115M	5.500E-04	1.870E-07	0.	7.000E-04	6.050E-01	3.600E-02
			0.	3.820E-03		
0.	10.000E-04	3.500E-02	0.	0.	0.	0.
0.	1.562E 04	2.715E 05	1.719E 02	1.686E 05	0.	
0.	0.	0.	0.	0.	5.625E 03	
CD115	5.500E-04	3.490E-06	0.	9.700E-03	3.180E-01	1.850E-01
			0.	9.117E-02		
6.000E-02	1.250E-01	0.	0.	0.	0.	0.
0.	7.283E 03	9.275E 03	6.460E 03	8.124E 03	0.	
0.	0.	0.	0.	0.	2.468E 02	
CD117M	1.050E-02	6.640E-05	0.	1.100E-02	3.480E-01	6.160E-01
			1.270E-03	8.700E-02		
5.600E-02	0.	2.540E-01	3.060E-01	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
CD117	6.640E-05	2.310E-04	0.	6.600E-03	8.100E-01	2.120E-01
			1.270E-03	5.437E-02		
0.	2.120E-01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
CD118	1.000E 00	2.310E-C4	0.	1.400E-02	2.670E-01	0.
			8.230E-03	8.600E-02		
0.	0.	0.	0.	0.	0.	0.
0.	1.021E 02	9.750E 01	6.564E 01	7.020E 01	0.	
0.	0.	0.	0.	0.	2.087E 00	
IN115M	3.490E-06	4.270E-05	0.	9.700E-03	1.600E-02	3.160E-01
			8.750E-08	9.500E-02		
3.160E-01	0.	0.	0.	0.	0.	0.
7.572E 00	5.008E 02	7.260E 01	2.887E 01	3.456E 02	0.	
0.	0.	3.625E 00	0.	3.060E 00	1.027E 01	
IN117M	2.310E-04	1.010E-04	0.	6.600E-03	5.150E-01	1.300E-01
			7.300E-06	5.437E-02		
1.020E-01	2.800E-02	0.	0.	0.	0.	0.
6.155E 01	5.651E 02	2.000E 02	6.282E 01	3.900E 02	0.	
0.	0.	1.005E 02	0.	1.456E 01	1.160E 01	
IN117	6.640E-05	2.570E-04	0.	5.800E-03	2.430E-01	7.260E-01
			7.300E-06	4.586E-02		
1.610E-01	5.650E-01	0.	0.	0.	0.	0.
1.925E 01	4.032E 02	8.770E 01	3.080E 01	2.784E 02	0.	
0.	0.	4.390E 01	0.	5.250E 00	8.300E 00	
IN118	2.310E-04	1.380E-01	0.	1.400E-02	1.851E 00	2.440E-01
			1.180E-04	8.600E-02		
0.	0.	2.440E-01	0.	0.	0.	0.
2.639E 00	2.167E 01	8.320E 00	2.572E 00	1.500E 01	0.	
0.	0.	4.170E 00	0.	6.240E-01	4.475E-01	
IN119	1.050E-03	6.420E-04	0.	1.400E-02	6.050E-01	8.150E-01
			1.000E-03	8.600E-02		
0.	8.150E-01	0.	0.	0.	0.	0.
1.997E 01	1.638E 02	6.300E 01	1.946E 01	1.134E 02	0.	
0.	0.	3.150E 00	0.	4.720E 00	3.370E 00	
IN121	1.000E 00	2.310E-02	0.	2.000E-03	1.203E 00	9.400E-01
			1.000E-02	9.200E-02		
0.	0.	9.400E-01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
SN119M	6.420E-04	3.270E-08	0.	1.400E-02	0.	2.400E-02
			1.800E-06	8.600E-02		
0.	0.	0.	0.	0.	0.	0.
1.287E 03	1.758E 03	0.	2.717E 02	4.728E 04	0.	
0.	0.	0.	0.	1.180E 02	5.775E 02	
SN121	2.310E-02	7.130E-06	0.	1.500E-02	1.130E-01	0.
			1.650E-04	9.200E-02		
0.	0.	0.	0.	0.	0.	0.
4.207E 02	1.493E 03	0.	1.644E 01	1.225E 03	0.	
0.	0.	0.	0.	1.394E 01	3.921E 01	
SN123M	6.930E-02	6.420E-08	0.	1.300E-03	5.160E-01	2.200E-02
			5.000E-03	1.100E-01		
0.	0.	2.200E-02	0.	0.	0.	0.
8.774E 04	1.342E 04	0.	2.768E 03	2.820E 05	0.	
0.	0.	0.	0.	2.351E 03	4.070E 03	
SN125M	1.000E 00	1.190E-03	0.	8.000E-03	7.890E-01	3.570E-01
			2.300E-02	1.057E-01		
3.570E-01	0.	0.	0.	0.	0.	0.
2.271E 04	2.180E 04	0.	8.827E 02	6.106E 04	0.	
0.	0.	0.	0.	7.342E 01	1.963E 03	

```
-NUCLIDE   -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                 -Y239FA(1)-Y239FA(2)
-EG(1)     -EG(2)     -EG(3)     -EG(4)     -EG(5)     -EG(6)     -EG(7)
-BONE      -G.I.      -KIDNEY    -LIVER     -LUNG      -MUSCLE
-PANCREAS  -PROSTATE  -SPLEEN    -TESTIS    -THYROID   -WHOLEBODY
SN125      1.000E 00  8.540E-07  0.         1.300E-02  8.990E-01  8.300E-02
                                 2.400E-02  1.550E-01
10.000E-04 9.000E-03  4.800E-02  2.000E-03  2.300E-02  0.         0.
 1.549E 01 8.253E 01  0.         6.765E-01  5.736E 01  0.
 0.        0.         0.         0.         5.335E-01  1.870E 00
SN127      1.000E 00  7.410E-05  0.         1.300E-01  4.300E-01  2.000E 00
                                 2.550E-01  3.670E-01
 0.        0.         0.         0.         2.000E 00  0.         0.
 3.935E 02 1.657E 03  0.         1.543E 01  1.146E 03  0.
 0.        0.         0.         0.         1.309E 01  3.740E 01
SN128      1.000E 00  2.030E-04  0.         3.700E-01  1.430E-01  0.
                                 4.040E-01  4.810E-01
 0.        0.         0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
SN130      1.000E 00  4.440E-03  0.         2.000E 00  2.590E-01  5.000E-01
                                 5.330E-01  5.520E-01
 0.        5.000E-01  0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
SB125      8.540E-07  8.140E-09  8.000E-03  2.100E-02  8.100E-02  4.510E-01
                                 2.100E-03  1.670E-01
 2.200E-02 4.090E-01  0.         0.         0.         0.         0.
 1.017E 04 1.216E 04  0.         2.157E 02  4.320E 05  0.
 0.        0.         0.         0.         1.765E 01  4.664E 03
SB126      1.000E-13  6.420E-07  0.        10.000E-04  7.370E-01  1.775E 00
                                 1.390E-02  2.800E-01
 0.        1.775E 00  0.         0.         0.         0.         0.
 1.394E 02 5.399E 03  0.         5.897E 00  3.744E 03  0.
 0.        0.         0.         0.         4.627E 00  1.174E 02
SB127      7.410E-05  2.170E-06  0.         1.300E-01  3.710E-01  5.340E-01
                                 6.150E-02  4.290E-01
 5.400E-02 4.330E-01  0.         0.         0.         0.         0.
 1.590E 03 1.474E 04  0.         4.463E 01  2.376E 04  0.
 0.        0.         0.         0.         2.703E 01  7.022E 02
SB128M     2.030E-04  2.010E-05  4.000E-02  5.000E-02  3.460E-01  2.635E 00
                                 2.180E-01  2.310E-01
 8.780E-01 6.590E-01  4.390E-01  2.190E-01  2.190E-01  1.100E-01  1.110E-01
 0.        0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
SB128      2.030E-04  1.160E-03  0.         3.600E-01  1.199E 00  5.350E-01
                                 0.         4.680E-01
 1.600E-01 3.750E-01  0.         0.         0.         0.         0.
 1.118E 02 1.462E 03  0.         2.629E 00  1.013E 03  0.
 0.        0.         0.         0.         3.315E 00  3.180E 01
SB129      1.070E-04  4.180E-05  1.000E-01  8.000E-01  6.340E-01  7.380E-01
                                 5.920E-01  1.129E+00
 0.        7.380E-01  0.         0.         0.         0.         0.
 3.472E 02 4.549E 03  0.         8.135E 00  3.144E 03  0.
 0.        0.         0.         0.         9.960E 00  9.911E 01
SB130      4.440E-03  1.630E-03  0.         2.000E 00  1.198E 00  2.650E 00
                                 1.409E+00  1.961E+00
 0.        8.500E-01  0.         1.800E 00  0.         0.         0.
 2.467E 01 3.232E 02  0.         6.079E-01  2.234E 02  0.
 0.        0.         0.         0.         7.393E-01  7.022E 00
SB131      3.400E-03  5.020E-04  1.200E 00  2.600E 00  8.510E-01  1.020E 00
                                 1.883E+00  2.203E+00
 0.        0.         1.020E 00  0.         0.         0.         0.
 3.384E 01 4.416E 02  0.         7.950E-01  3.072E 02  0.
 0.        0.         0.         0.         1.010E 00  9.646E 00
SB132      5.250E-03  5.500E-03  2.000E 00  3.300E 00  2.149E 00  1.600E 00
                                 1.763E+00  1.892E+00
 0.        0.         1.556E 00  0.         0.         4.400E-02  0.
 0.        0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
SB133      1.000E 00  2.820E-03  0.         4.000E 00  7.810E-01  2.460E 00
                                 1.164E+00  1.199E+00
 0.        0.         0.         0.         1.600E-01  2.300E 00  0.
 8.003E 00 1.046E 02  0.         1.887E-01  7.260E 01  0.
 0.        0.         0.         0.         2.401E-01  2.292E 00
SB134      1.000E 00  1.440E-02  0.         1.800E 00  2.200E 00  0.
                                 5.170E-01  5.230E-01
 0.        0.         0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
 0.        0.         0.         0.         0.         0.
```

-NUCLIDE	-LAMBDA1	-LAMBDA2	-Y235TH(1)	-Y235TH(2)	-E(BETA)	-E(GAMMA)
			-Y239FA(1)	-Y239FA(2)		
-EG(1)	-EG(2)	-EG(3)	-EG(4)	-EG(5)	-EG(6)	-EG(7)
-BONE	-G.I.	-KIDNEY	-LIVER	-LUNG	-MUSCLE	
-PANCREAS	-PROSTATE	-SPLEEN	-TESTIS	-THYROID	-WHOLEBODY	
TE125M	8.140E-09	1.380E-07	0.	6.000E-03	0.	1.450E-01
			7.000E-06	4.771E-02		
1.100E-01	0.	0.	0.	0.	0.	0.
1.360E 02	2.413E 03	0.	7.669E 02	3.204E 04	0.	
0.	0.	0.	9.956E 02	1.897E 02	4.357E 02	
TE127M	2.170E-06	7.640E-08	9.000E-03	3.500E-02	4.000E-03	8.800E-02
			1.284E-03	8.708E-02		
0.	0.	0.	0.	0.	0.	0.
6.075E 01	1.266E 03	0.	3.712E 02	2.184E 04	0.	
0.	0.	0.	4.207E 02	7.556E 01	2.460E 02	
TE127A	2.170E-06	2.070E-05	0.	1.040E-01	2.240E-01	3.000E-03
			0.	3.432E-01		
3.000E-03	0.	0.	0.	0.	0.	0.
1.109E 02	1.159E 03	0.	7.294E 01	8.040E 02	0.	
0.	0.	0.	3.690E 02	1.200E 02	3.506E 01	
TE127B	7.640E-08	2.070E-05	0.	3.400E-02	2.240E-01	3.000E-03
			0.	8.447E-02		
3.000E-03	0.	0.	0.	0.	0.	0.
1.109E 02	1.159E 03	0.	7.294E 01	8.040E 02	0.	
0.	0.	0.	3.690E 02	1.200E 02	3.506E 01	
TE129M	4.180E-05	2.430E-07	0.	3.500E-01	3.000E-02	0.
			3.500E-02	5.290E-01		
0.	0.	0.	0.	0.	0.	0.
4.988E 01	1.462E 03	0.	3.056E 02	1.301E 04	0.	
0.	0.	0.	3.454E 02	7.837E 01	2.317E 02	
TE129A	4.180E-05	1.720E-04	0.	4.500E-01	4.920E-01	1.350E-01
			3.500E-02	6.700E-01		
2.100E-02	1.020E-01	1.100E-02	0.	0.	0.	0.
4.300E 01	8.480E 02	0.	3.881E 01	5.880E 02	0.	
0.	0.	0.	1.505E 02	5.215E 01	2.614E 02	
TE129B	2.430E-07	1.720E-04	0.	3.500E-01	4.920E-01	1.350E-01
			0.	5.290E-01		
2.100E-02	1.020E-01	1.100E-02	0.	0.	0.	0.
4.300E 01	8.480E 02	0.	3.881E 01	5.880E 02	0.	
0.	0.	0.	1.505E 02	5.215E 01	2.614E 02	
TE131M	5.020E-04	6.690E-06	5.000E-02	4.400E-01	1.820E-01	1.548E 00
			1.132E+00	1.462E+00		
1.060E-01	8.380E-01	4.540E-01	4.100E-02	9.800E-02	1.100E-02	0.
6.203E 01	1.147E 04	0.	3.769E 02	9.636E 03	0.	
0.	0.	0.	4.309E 00	2.044E 02	4.005E 02	
TE131A	5.020E-04	4.620E-04	0.	2.210E 00	7.320E-01	3.960E-01
			0.	1.873E+00		
1.160E-01	1.210E-01	1.510E-01	0.	0.	0.	0.
1.374E 01	1.852E 02	0.	1.014E 01	1.283E 02	0.	
0.	0.	0.	4.657E 01	1.504E 01	5.738E 00	
TE131B	6.690E-06	4.620E-04	0.	8.800E-02	7.320E-01	3.960E-01
			0.	2.925E-01		
1.160E-01	1.210E-01	1.510E-01	0.	0.	0.	0.
1.374E 01	1.852E 02	0.	1.014E 01	1.283E 02	0.	
0.	0.	0.	4.657E 01	1.504E 01	5.738E 00	
TE132	5.500E-03	2.470E-06	1.080E 00	4.380E 00	6.100E-02	2.850E-01
			2.344E+00	4.236E+00		
2.330E-01	0.	0.	0.	0.	0.	0.
2.673E 02	4.000E 03	0.	2.981E 02	5.664E 03	0.	
0.	0.	0.	9.742E 02	2.861E 02	2.137E 02	
TE133M	2.820E-03	2.180E-04	2.020E 00	4.900E 00	4.940E-01	1.630E 00
			2.650E+00	3.513E+00		
4.300E-02	9.570E-01	6.300E-01	0.	0.	0.	0.
6.412E-01	1.380E 02	0.	3.900E 00	9.552E 01	0.	
0.	0.	0.	4.500E 00	2.205E 00	4.260E 00	
TE133A	2.820E-03	5.780E-03	6.000E-01	1.720E 00	9.640E-01	6.620E-01
			7.870E-01	1.123E+00		
3.310E-01	3.310E-01	0.	0.	0.	0.	0.
1.100E 00	2.457E 01	0.	1.056E 00	1.704E 01	0.	
0.	0.	0.	3.881E 00	1.361E 00	7.575E-01	
TE133B	2.180E-04	5.780E-03	0.	6.400E-01	9.640E-01	6.620E-01
			0.	4.567E-01		
3.310E-01	3.310E-01	0.	0.	0.	0.	0.
1.100E 00	2.457E 01	0.	1.056E 00	1.704E 01	0.	
0.	0.	0.	3.881E 00	1.361E 00	7.575E-01	
TE134	1.440E-02	2.750E-04	5.100E 00	6.900E 00	4.330E-01	1.900E-01
			3.457E+00	3.980E+00		
1.760E-01	0.	0.	0.	0.	0.	0.
5.889E 01	6.079E 02	0.	3.855E 01	4.200E 02	0.	
0.	0.	0.	1.963E 02	6.525E 01	1.875E 01	

```
-NUCLIDE  -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                -Y239FA(1)-Y239FA(2)
-EG(1)    -EG(2)     -EG(3)     -EG(4)     -EG(5)     -EG(6)    -EG(7)
-BONE     -G.I.      -KIDNEY    -LIVER     -LUNG      -MUSCLE
-PANCREAS -PROSTATE -SPLEEN     -TESTIS    -THYROID  -WHOLEBODY
TE135     1.000E 00 8.250E-03 0.         2.690E 00 1.500E 00 0.
                                2.474E+00 2.634E+00
0.        0.         0.         0.         0.         0.        0.
0.        0.         0.         0.         0.         0.
0.        0.         0.         0.         0.         0.
I131A     6.690E-06 9.900E-07 4.500E-01 8.000E-01 1.800E-01 3.960E-01
                                6.400E-02 1.234E+00
3.180E-01 7.800E-02 0.         0.         0.         0.        0.
0.        9.985E 03 0.         0.         2.832E 04 0.
0.        0.         0.         0.         9.660E 05 2.550E 03
I131B     4.620E-04 9.900E-07 0.         2.300E 00 1.800E-01 3.960E-01
                                0.         2.165E+00
3.180E-01 7.800E-02 0.         0.         0.         0.        0.
0.        9.985E 03 0.         0.         2.832E 04 0.
0.        0.         0.         0.         9.660E 05 2.550E 03
I132      2.470E-06 8.370E-05 0.         4.380E 00 5.170E-01 2.192E 00
                                3.110E-01 4.547E+00
3.000E-03 1.710E 00 4.280E-01 2.800E-02 2.300E-02 0.        0.
0.        2.136E 03 0.         0.         1.474E 03 0.
0.        0.         0.         0.         3.870E 04 1.320E 02
I133A     2.180E-04 9.260E-06 0.         4.260E 00 4.310E-01 5.150E-01
                                1.036E+00 4.090E+00
0.        5.150E-01 0.         0.         0.         0.        0.
0.        8.245E 03 0.         0.         6.240E 03 0.
0.        0.         0.         0.         2.510E 05 5.572E 02
I133B     5.780E-03 9.260E-06 0.         2.360E 00 4.310E-01 5.150E-01
                                0.         1.580E+00
0.        5.150E-01 0.         0.         0.         0.        0.
0.        8.245E 03 0.         0.         6.240E 03 0.
0.        0.         0.         0.         2.510E 05 5.572E 02
I134      2.750E-04 2.180E-04 9.000E-01 7.800E 00 6.640E-01 2.422E 00
                                2.321E+00 6.301E+00
3.200E-02 1.777E 00 3.720E-01 2.410E-01 0.         0.        0.
0.        6.439E 02 0.         0.         4.452E 02 0.
0.        0.         0.         0.         1.543E 04 3.975E 01
I135      8.250E-03 2.870E-05 3.410E 00 6.100E 00 3.160E-01 1.623E 00
                                3.664E+00 6.298E+00
0.        2.870E-01 7.890E-01 5.470E-01 0.         0.        0.
0.        4.152E 03 0.         0.         2.868E 03 0.
0.        0.         0.         0.         6.705E 04 2.565E 02
I136      1.000E 00 8.350E-03 0.         3.100E 00 1.846E 00 2.736E 00
                                4.140E+00 5.197E+00
9.800E-02 2.100E-02 1.304E 00 9.600E-02 9.600E-02 4.450E-01 6.760E-01
0.        0.         0.         0.         0.         0.
0.        0.         0.         0.         0.         0.
I137      1.000E 00 2.890E-02 0.         2.660E 00 1.400E 00 3.900E-01
                                2.975E+00 3.243E+00
3.900E-01 0.         0.         0.         0.         0.        0.
0.        0.         0.         0.         0.         0.
0.        0.         0.         0.         0.         0.
I138      1.000E 00 1.160E-01 0.         1.460E 00 8.000E-01 0.
                                1.252E+00 1.291E+00
0.        0.         0.         0.         0.         0.        0.
0.        0.         0.         0.         0.         0.
0.        0.         0.         0.         0.         0.
I139      1.000E 00 3.470E-01 0.         2.600E 00 8.000E-01 0.
                                3.270E-01 3.310E-01
0.        0.         0.         0.         0.         0.        0.
0.        0.         0.         0.         0.         0.
0.        0.         0.         0.         0.         0.
XE133M    9.260E-06 3.490E-06 0.         1.590E-01 0.        2.330E-01
                                1.380E-02 1.499E-01
2.330E-01 0.         0.         0.         0.         0.        0.
0.        2.419E 03 0.         0.         2.748E 03 0.
0.        0.         0.         0.         0.         0.
XE133     9.260E-06 1.510E-06 0.         6.620E 00 1.000E-01 8.100E-02
                                1.380E-02 5.560E+00
3.000E-03 0.         0.         0.         0.         0.        0.
0.        3.364E 03 0.         0.         6.840E 03 0.
0.        0.         0.         0.         0.         0.
XE135M    2.870E-05 7.230E-04 0.         1.830E 00 0.        5.280E-01
                                0.         1.889E+00
5.280E-01 0.         0.         0.         0.         0.        0.
0.        4.448E 01 0.         0.         3.084E 01 0.
0.        0.         0.         0.         0.         0.
```

```
 -NUCLIDE  -LAMBDA1  -LAMBDA2  -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                               -Y239FA(1)-Y239FA(2)
 -EG(1)    -EG(2)    -EG(3)    -EG(4)    -EG(5)    -EG(6)    -EG(7)
 -BONE     -G.I.     -KIDNEY   -LIVER    -LUNG     -MUSCLE
 -PANCREAS -PROSTATE -SPLEEN   -TESTIS   -THYROID  -WHOLEBODY
XE135      2.870E-05 2.120E-05 2.000E-01 6.300E 00 3.040E-01 2.410E-01
                               5.450E-01 6.843E+00
 2.230E-01 1.800E-02 0.        0.        0.        0.        0.
 0.        1.518E 03 0.        0.        1.051E 03 0.
 0.        0.        0.        0.        0.        0.
XE137      2.890E-02 2.960E-03 3.450E 00 6.000E 00 1.476E 00 0.
                               3.253E+00 6.496E+00
 0.        0.        0.        0.        0.        0.        0.
 0.        5.691E 01 0.        0.        3.948E 01 0.
 0.        0.        0.        0.        0.        0.
XE138      1.160E-01 6.790E-04 4.030E 00 5.490E 00 8.660E-01 9.000E-01
                               3.677E+00 4.968E+00
 0.        5.300E-01 0.        3.500E-01 0.        0.        0.
 0.        2.274E 02 0.        0.        1.576E 02 0.
 0.        0.        0.        0.        0.        0.
XE139      3.470E-01 1.690E-02 0.        5.400E 00 1.737E 00 9.500E-01
                               2.656E+00 2.987E+00
 9.500E-01 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
XE140      1.000E 00 4.330E-02 0.        3.800E 00 1.320E 00 0.
                               1.384E+00 1.443E+00
 0.        0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
CS136      1.000E 00 6.170E-07 0.        3.800E-01 1.070E-01 2.088E 00
                               8.300E-02 8.300E-02
 2.960E-01 8.300E-01 1.159E 00 0.        0.        0.        0.
 1.780E 03 1.595E 04 1.036E 04 8.970E 03 6.745E 04 5.701E 03
 0.        0.        5.985E 03 0.        0.        5.629E 03
CS137      2.960E-03 7.320E-10 1.500E-01 6.150E 00 1.710E-01 0.
                               3.510E-01 6.847E+00
 0.        0.        0.        0.        0.        0.        0.
 2.866E 04 4.987E 03 2.895E 04 3.813E 04 1.969E 05 1.911E 04
 0.        0.        3.358E 04 0.        0.        1.031E 04
CS138      6.790E-04 3.610E-04 2.500E-01 5.740E 00 1.099E 00 2.125E 00
                               1.103E+00 6.071E+00
 7.000E-03 1.950E-01 2.490E-01 1.029E 00 0.        3.940E-01 2.510E-01
 3.252E 01 6.980E 02 1.340E 02 8.983E 01 4.831E 02 3.896E 01
 0.        0.        6.705E 01 0.        0.        4.318E 01
CS139      1.690E-02 1.220E-03 1.070E 00 6.470E 00 1.601E 00 2.320E-01
                               2.145E+00 5.132E+00
 0.        2.500E-02 2.070E-01 0.        0.        0.        0.
 1.134E 01 1.310E 02 3.780E 01 2.331E 01 9.072E 01 7.575E 00
 0.        0.        1.890E 01 0.        0.        8.107E 00
CS140      4.330E-02 1.050E-02 2.200E 00 6.000E 00 1.949E 00 1.400E 00
                               2.988E+00 4.431E+00
 0.        4.000E-01 1.000E 00 0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
CS142      1.000E 00 3.010E-01 0.        3.200E 00 2.423E 00 1.400E 00
                               1.856E+00 1.967E+00
 0.        4.000E-01 1.000E 00 0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
BA137M     7.320E-10 4.440E-03 0.        5.850E 00 0.        6.300E-01
                               3.000E-03 6.508E+00
 0.        6.300E-01 0.        0.        0.        0.        0.
 2.502E-01 9.362E 00 3.230E-03 2.330E-03 6.511E 00 1.480E-03
 0.        0.        1.615E-03 2.704E-01 0.        2.145E-01
BA139      1.220E-03 1.360E-04 8.000E-02 6.550E 00 9.100E-01 5.000E-02
                               1.670E-01 5.299E+00
 4.600E-02 0.        0.        4.000E-03 0.        0.        0.
 3.130E 02 7.176E 02 6.377E-01 3.503E-01 4.961E 02 1.138E-01
 0.        0.        3.194E-01 1.161E 02 0.        1.622E 01
BA140      1.050E-02 6.170E-07 3.500E-01 6.350E 00 2.790E-01 2.190E-01
                               6.560E-01 5.088E+00
 1.400E-02 1.640E-01 0.        0.        0.        0.        0.
 2.142E 04 1.150E 04 2.381E 01 3.331E 01 4.800E 04 1.209E 01
 0.        0.        1.503E 01 2.907E 03 0.        1.453E 03
BA141      2.770E-02 6.420E-04 1.700E 00 6.300E 00 1.143E 00 1.740E-01
                               1.770E+00 5.250E+00
 1.060E-01 6.800E-02 0.        0.        0.        0.        0.
 9.606E 01 1.726E 02 1.827E-01 9.686E-02 1.199E 02 2.750E-02
 0.        0.        1.271E-01 1.589E 02 0.        3.921E 00
```

```
-NUCLIDE  -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                -Y239FA(1)-Y239FA(2)
-EG(1)    -EG(2)     -EG(3)     -EG(4)    -EG(5)    -EG(6)    -EG(7)
-BONE     -G.I.      -KIDNEY    -LIVER    -LUNG     -MUSCLE
-PANCREAS -PROSTATE  -SPLEEN    -TESTIS   -THYROID  -WHOLEBODY
BA142     3.010E-01 1.050E-03 2.200E 00 5.400E 00 5.670E-01 7.720E-01
                                2.954E+00 4.920E+00
3.100E-02 0.        4.170E-01 3.160E-01 0.        0.        0.
2.514E 01 4.518E 01 4.777E-02 2.524E-02 3.132E 01 7.170E-03
0.        0.        2.388E-02 9.310E 00 0.        1.020E 00
BA143     1.000E 00 5.770E-02 0.        4.470E 00 1.170E 00 0.
                                2.894E+00 3.578E+00
0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.
LA140     6.170E-07 4.810E-06 0.        6.350E 00 4.830E-01 2.468E 00
                                1.240E-02 5.100E+00
1.850E-01 5.330E-01 3.500E-02 1.457E 00 0.        1.410E-01 1.170E-01
3.657E 03 2.923E 04 0.        1.740E 03 2.807E 04 0.
0.        0.        0.        0.        0.        8.445E 02
LA141     6.420E-04 5.060E-05 1.000E-01 6.400E 00 9.580E-01 2.700E-02
                                9.950E-02 5.350E+00
0.        0.        2.700E-02 0.        0.        0.        0.
5.065E 02 1.834E 03 0.        2.273E 02 1.268E 03 0.
0.        0.        0.        0.        0.        3.800E 01
LA142     1.050E-03 1.360E-04 5.000E-01 5.900E 00 1.942E 00 1.438E 00
                                4.730E-01 5.394E+00
0.        3.300E-01 7.400E-02 1.000E-01 2.220E-01 4.880E-01 2.240E-01
1.838E 02 8.883E 02 0.        9.427E 01 6.148E 02 0.
0.        0.        0.        0.        0.        1.829E 01
LA143     5.770E-02 8.250E-04 1.530E 00 6.000E 00 1.375E 00 8.410E-01
                                1.270E+00 4.849E+00
6.200E-02 3.810E-01 3.980E-01 0.        0.        0.        0.
5.770E 01 2.010E 02 0.        2.561E 01 1.392E 02 0.
0.        0.        0.        0.        0.        4.147E 00
CE141     5.060E-05 2.430E-07 0.        6.400E 00 1.450E-01 1.020E-01
                                4.240E-04 5.350E+00
1.020E-01 0.        0.        0.        0.        0.        0.
1.370E 04 5.488E 03 1.289E 04 1.407E 04 4.764E 04 0.
0.        0.        0.        0.        0.        1.699E 03
CE143     8.250E-04 5.830E-06 0.        6.000E 00 3.710E-01 3.790E-01
                                5.120E-02 4.900E+00
1.660E-01 1.360E-01 7.700E-02 0.        0.        0.        0.
1.391E 03 8.098E 03 1.447E 03 1.693E 03 7.024E 03 0.
0.        0.        0.        0.        0.        2.107E 02
CE144     1.000E 00 2.830E-08 0.        5.620E 00 8.100E-02 3.400E-02
                                2.460E-01 4.298E+00
1.700E-02 0.        0.        0.        0.        0.        0.
5.417E 04 2.344E 03 3.905E 04 3.319E 04 6.651E 04 0.
0.        0.        0.        0.        0.        4.462E 03
CE145     1.000E 00 3.850E-03 0.        3.980E 00 5.120E-01 9.000E-01
                                6.910E-01 3.530E+00
0.        0.        9.000E-01 0.        0.        0.        0.
5.898E 00 1.884E 01 5.230E 00 5.750E 00 1.884E 01 0.
0.        0.        0.        0.        0.        5.600E-01
CE146     1.000E 00 8.250E-04 0.        3.070E 00 2.250E-01 3.000E-01
                                1.202E+00 2.748E+00
2.430E-01 0.        0.        0.        0.        0.        0.
6.525E 00 6.804E 01 7.910E 00 9.687E 00 4.728E 01 0.
0.        0.        0.        0.        0.        1.407E 00
PR143     5.830E-06 5.810E-07 3.000E-02 6.030E 00 3.150E-01 0.
                                1.530E-04 4.900E+00
0.        0.        0.        0.        0.        0.        0.
1.571E 04 7.737E 03 1.038E 04 8.997E 03 3.415E 04 0.
0.        0.        0.        0.        0.        1.112E 03
PR144     2.830E-08 6.790E-04 0.        5.620E 00 1.207E 00 2.900E-02
                                2.310E-03 4.300E+00
0.        1.100E-02 0.        7.000E-03 1.100E-02 0.        0.
5.050E 01 1.764E 02 3.369E 01 2.975E 01 1.219E 02 0.
0.        0.        0.        0.        0.        3.642E 00
PR145     3.850E-03 3.210E-05 0.        3.980E 00 6.820E-01 0.
                                1.990E-02 3.550E+00
0.        0.        0.        0.        0.        0.        0.
5.635E 02 1.954E 03 3.757E 01 3.314E 02 1.350E 03 0.
0.        0.        0.        0.        0.        4.050E 01
PR146     8.250E-04 4.620E-04 0.        3.070E 00 1.272E 00 1.075E 00
                                1.010E-01 2.849E+00
0.        7.590E-01 0.        3.160E-01 0.        0.        0.
7.660E 01 4.007E 02 5.840E 01 5.435E 01 2.776E 02 0.
0.        0.        0.        0.        0.        8.250E 00
```

```
-NUCLIDE  -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                -Y239FA(1)-Y239FA(2)
-EG(1)    -EG(2)     -EG(3)     -EG(4)    -EG(5)    -EG(6)    -EG(7)
-BONE     -G.I.      -KIDNEY    -LIVER    -LUNG     -MUSCLE
-PANCREAS -PROSTATE  -SPLEEN    -TESTIS   -THYROID  -WHOLEBODY
ND147     1.000E 00 7.280E-07 0.        2.360E 00 2.280E-01 1.960E-01
                              6.440E-03 2.250E+00
 8.000E-03 1.150E-01 0.        0.        0.        0.        0.
 9.621E 03 9.700E 03 7.669E 03 6.802E 03 3.654E 04 0.
 0.        0.        0.        0.        0.        1.170E 03
ND149     1.000E 00 1.070E-04 0.        1.130E 00 4.320E-01 4.060E-01
                              1.380E-01 1.428E+00
 2.730E-01 7.300E-02 0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.
ND151     1.000E 00 9.620E-04 0.        4.400E-01 6.290E-01 6.780E-01
                              4.490E-01 8.330E-01
 6.600E-02 1.440E-01 2.140E-01 1.530E-01 1.010E-01 0.        0.
 2.840E 01 1.928E 02 2.400E-01 2.325E 01 1.333E 02 0.
 0.        0.        0.        0.        0.        4.000E 00
PM147     7.280E-07 8.450E-09 0.        2.360E 00 6.200E-02 0.
                              9.330E-06 2.250E+00
 0.        0.        0.        0.        0.        0.        0.
 1.264E 05 1.788E 03 6.425E 04 1.701E 04 6.353E 04 0.
 0.        0.        0.        0.        0.        0.
PM149     1.070E-04 3.570E-06 0.        1.130E 00 3.610E-01 7.000E-03
                              2.000E-03 1.430E+00
 7.000E-03 0.        0.        0.        0.        0.        0.
 2.643E 03 9.173E 02 2.271E 03 6.307E 02 1.033E 04 0.
 0.        0.        0.        0.        0.        0.
PM151     9.620E-04 7.000E-06 0.        4.400E-01 3.810E-01 7.150E-01
                              5.650E-02 8.890E-01
 4.260E-01 2.890E-01 0.        0.        0.        0.        0.
 1.438E 03 8.259E 03 1.325E 03 3.771E 02 6.767E 03 0.
 0.        0.        0.        0.        0.        0.
SM151     7.000E-06 2.360E-10 0.        4.400E-01 1.900E-02 0.
                              5.780E-04 8.900E-01
 0.        0.        0.        0.        0.        0.        0.
 1.184E 05 1.087E 03 6.449E 04 2.063E 04 4.332E 04 0.
 0.        0.        0.        0.        0.        6.937E 03
SM153     1.000E 00 4.100E-06 0.        1.500E-01 2.230E-01 1.070E-01
                              1.920E-02 4.800E-01
 9.400E-02 0.        0.        0.        0.        0.        0.
 1.364E 03 4.321E 03 1.100E 03 3.256E 01 4.500E 03 0.
 0.        0.        0.        0.        0.        1.357E 02
SM155     1.000E 00 4.820E-04 0.        3.300E-02 6.080E-01 1.150E-01
                              9.500E-02 2.540E-01
 1.150E-01 0.        0.        0.        0.        0.        0.
 3.456E 01 1.770E 02 2.850E-01 3.386E 02 1.231E 02 0.
 0.        0.        0.        0.        0.        3.675E 00
SM156     1.000E 00 1.920E-05 0.        1.300E-02 3.000E-01 0.
                              1.020E-01 1.610E-01
 0.        0.        0.        0.        0.        0.        0.
 4.041E 02 1.589E 03 3.076E 02 2.094E 04 1.104E 03 0.
 0.        0.        0.        0.        0.        3.300E 01
EU155     4.820E-04 1.290E-08 0.        3.300E-02 5.700E-02 6.400E-02
                              6.000E-03 2.600E-01
 6.400E-02 0.        0.        0.        0.        0.        0.
 7.727E 04 2.530E 03 1.109E 05 2.094E 04 8.488E 04 0.
 0.        0.        0.        0.        0.        7.886E 03
EU156     1.920E-05 5.350E-0710.000E-04 1.400E-02 4.230E-01 0.
                              1.900E-02 1.800E-01
 0.        0.        0.        0.        0.        0.        0.
 2.438E 04 2.704E 04 3.633E 04 2.679E 04 1.314E 05 0.
 0.        0.        0.        0.        0.        4.307E 03
EU157     1.000E 00 1.250E-05 0.        7.800E-03 4.130E-01 4.500E-01
                              3.500E-02 1.180E-01
 0.        4.500E-01 0.        0.        0.        0.        0.
 9.099E 02 7.022E 03 1.328E 03 1.071E 03 5.034E 03 0.
 0.        0.        0.        0.        0.        1.505E 02
EU158     1.000E 00 1.920E-04 0.        2.000E-03 1.037E 00 0.
                              3.700E-02 6.700E-02
 0.        0.        0.        0.        0.        0.        0.
 1.357E 02 5.235E 02 1.504E 02 1.109E 02 3.620E 02 0.
 0.        0.        0.        0.        0.        1.075E 01
```

```
-NUCLIDE   -LAMBDA1   -LAMBDA2   -Y235TH(1)-Y235TH(2)-E(BETA)  -E(GAMMA)
                                 -Y239FA(1)-Y239FA(2)
-EG(1)     -EG(2)     -EG(3)     -EG(4)     -EG(5)     -EG(6)     -EG(7)
-BONE      -G.I.      -KIDNEY    -LIVER     -LUNG      -MUSCLE
-PANCREAS  -PROSTATE  -SPLEEN    -TESTIS    -THYROID   -WHOLEBODY
GD159      5.780E-04 1.070E-05 0.        10.000E-04 2.940E-01 5.700E-02
                                 1.000E-02 4.500E-02
 5.700E-02 0.         0.         0.         0.         0.         0.
 0.        3.015E 03  0.         0.         2.213E 03  0.
 0.        0.         0.         0.         0.         0.
Y91        .1980E-04 .1310E-06 .0           5.81       .593       .004
                                 .002       2.6
 0.        0.         .004       0.         0.         0.         0.
 2.27 E 05 1.49 E 04  0.         0.         1.97 E 05  0.
 0.        0.         0.         0.         0.         8.63 E 03
```

APPENDIX C

FPIC/U-Pu CODE OPERATING INSTRUCTIONS

The data input to the code are as follows:

Data Block 1 - Nuclide decay data and ^{235}U thermal-fission yields.

Data Block 2 - Body-organ dose conversion factors.

Data Block 3 - ^{239}Pu fast-fission yields.

Data blocks for 201 nuclides are supplied with the code package. The input to be supplied by the user is as follows:

Card A (12I6 format)

NODOSE	Number of shutdown times. Maximum of 55. If NODOSE = 51, the program will supply 51 shutdown times ranging from 10 to 2.0E+09 sec.
LAST	= 0, another case follows. = 1, no more cases to be read.
KEY	= 0, no individual nuclide dose data requested. = 1, calculate dose data for selected nuclides (see Card B). = -1, calculate dose data for all nuclides.

Card B (12I6 format) Required if KEY = 1.

NNO	Number of nuclides for which dose data is requested.
NUCNO(I) I = 1, NNO	Nuclide identification numbers. See code listing for these numbers. Nuclide numbers must be in ascending order.

Card C (6E12.5 format) Omit if NODOSE = 51.

RETIME1(I), I = 1, NODOSE	Shutdown times in sec.

Card D (6E12.5 format) (See Fig. 4)

XLPCY1	Period of short operating cycle (sec).
XLPCY2	Number of short periods.
XNPCY1	Period of long operating cycle (sec).
XNPCY2	Number of long periods.

For noncyclic operation, all numbers on Card D should be input as 1.0.

Card E (6E12.5 format)

POWER	Operating power (W).
OPTIME	Duration of constant power operation (sec).

Card F (12I6 format)

JJ	= 1, Decay powers computed for ^{235}U thermal and ^{239}Pu fast fission. = 2, for ^{239}Pu fast fission. = 3, for ^{235}U thermal fission.
NPUN	= 0, cards will be punched, one per shutdown time, in 6E12.5 format as follows: OPTIME (sec) POWER (W) Shutdown time (sec). Beta decay power (MeV/sec) Gamma decay power (MeV/sec) Total decay power (MeV/sec) = 1, no punched output.

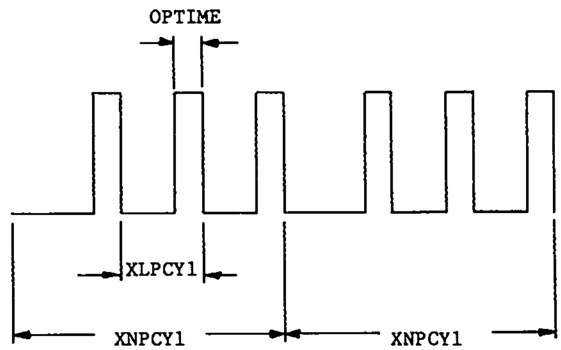

Fig. 4. Schematic of cyclic operation.