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APPLICATION OF ADJUSTED DATA IN CALCULATING FISSION-PRODUCT DECAY ENERGIES AND SPECTRA

by

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ABSTRACT

The code ADENA, which approximately calculates fission-product beta and gamma decay energies and spectra in 19 or fewer energy groups from a mixture of ^{235}U and ^{239}Pu fuels, is described. The calculation uses aggregate, adjusted data derived from a combination of several experiments and summation results based on the ENDF/B-V fission-product file. The method used to obtain these adjusted data and the method used by ADENA to calculate fission-product decay energy with an absorption correction are described, and an estimate of the uncertainty of the ADENA results is given.

Comparisons of this approximate method are made to experimental measurements, to the ANSI/ANS 5.1-1979 standard, and to other calculational methods. A listing of the complete computer code (ADENA) is contained in an appendix. Included in the listing are data statements containing the adjusted data in the form of parameters to be used in simple analytic functions. These fitted parameters can be abstracted for other uses such as in spatial neutron depletion or thermal hydraulics codes.

I. INTRODUCTION

Summation calculations of fission product decay energy based on four different fission-product data files were compared with several experiments,^{1,2,3,4,5} and the results were reported in Ref. 6. The conclusions drawn from these comparisons include

- (1) The experimental spectral data are consistent.

- (2) Aggregate beta and gamma spectral decay energies calculated from any of the four fission product files do not agree well with experiment for short irradiation and cooling times below ~ 1000 s.
- (3) It is likely that some data in ENDF/B-V (Mod 0)⁷, probably the experimental decay energies for some individual, high-Q nuclides, are deficient.

These conclusions imply that better estimates of decay spectra will result from calculations that use aggregate data derived, where possible, from experiments rather than data derived entirely from the fission-product files. However, because such experimental data are available only in the region $2.2 \text{ s} - 2 \times 10^5 \text{ s}$ for gamma decay energy and $2.2 \text{ s} - 10^4 \text{ s}$ for beta decay energy, information based on ENDF/B-V summation calculations was incorporated to extend the range of the calculated decay-energy cooling times from $10^{-4} - 10^9 \text{ s}$. The method used to prepare the adjusted data base is described in Section II.

The code ADENA uses these adjusted data to calculate fission-product decay-energy spectra from any mixture of thermally irradiated ^{235}U and ^{239}Pu fuels at user specified cooling times. A correction for neutron absorption in the fission products is included. Section III contains a description of the code, and Appendix A contains a full listing and a sample problem input and output. The spectra, but not the absorption correction, should be almost as accurate for the fissions induced by fast energy neutrons as it is for thermal neutrons.

Section IV contains the results of three applications of the code ADENA. First, the ADENA results for a finite irradiation problem including the effects of neutron absorption are compared with CINDER-10 (Ref. 8) calculations. Second, sample calculations of both the Oak Ridge and Los Alamos experiments are compared with the experiments. Third, a calculational comparison of the summed spectra with the ANSI/ANS-5.1-1979 standard⁹ is made.

Finally, Section V contains the authors' estimate of the reliability of ADENA results. Appendix B clarifies the procedure used to obtain this estimate and includes in tabular form the detailed data upon which the estimate is based.

II. PREPARATION OF ADJUSTED DATA

The adjusted data base used by ADENA is derived from a combination of experimental data and the ENDF/B-V fission-product data file. The experiments, whose results were incorporated into the data base, were conducted at Los Alamos and Oak Ridge; nuclear fuel samples were irradiated with thermal neutrons and

the decay-energy and beta-ray and/or gamma-ray spectra of the resulting fission products measured. Results of these experiments were included in formulating the ANSI/ANS-5.1 Decay Power Standard. A brief summary of the experimental range of data follows.

- o Oak Ridge spectral experiments^{1,2} in which ^{235}U and ^{239}Pu fuels were irradiated with thermal neutrons for times of 1, 10, (5 for ^{239}Pu), and 100 s, and both aggregate fission-product gamma-ray and beta-ray decay-energy spectra were measured for a range of average cooling times from 2.2 (for the 1-s irradiation time) to 12 000 s (for the 100-s irradiation time). There were similar measurements for ^{241}Pu .
- o Los Alamos calorimetric experiments^{3,4} in which ^{233}U , ^{235}U , and ^{239}Pu were irradiated with thermal neutrons for 20 000 s and total decay heat (gamma plus beta) measured for a range of cooling times from 29-190 000 s.
- o Los Alamos spectral experiments⁵ in which fuels, irradiation time, and cooling time ranges were the same as for the calorimetric experiments, but aggregate fission-product gamma-ray decay-energy spectra were measured.

The ENDF/B-V fission-product data file contains data for 877 nuclides, of which 264 have spectra, and there are 20 yield sets. These data for individual nuclides were input to the summation code CINDER-10,⁸ and the associated code system described in Refs. 10 and 11 was used to produce calculated decay energies and spectra. The aggregate experimental and summation code results were combined to produce the adjusted data base using the procedure described below.

Step 1: Use ENDF/B-V based summation results to calculate points from 10^4 s (beta) or 2×10^5 s (gamma) to 10^9 s following a fission pulse. (As noted below, calculations for shorter times were included in the detailed procedure.)

Step 2: Use the shape of the ENDF/B-V derived decay-energy curves below 2 s cooling time shifted to coincide with the experimental data having the shortest cooling times to calculate points below 2 s.

Step 3: Combine points from steps one and two with experimental data points. Use this set of combined points as input to FITPULS¹¹ to calculate a set of parametric pairs, which represents a fit for a combined adjusted equivalent pulse.

A more detailed description of the procedure outlined in these three steps follows.

ENDF/B-V Calculation - Preliminary

Methods described in Refs. 10 and 11 were used to create sets of alpha (α), lambda (λ) parameter pairs which represent least squares fits to the aggregate ENDF/B-V pulse data by fitting the data with the equation,

$$f(t) = \sum_{i=1}^n \alpha_i e^{-\lambda_i t} \quad (\text{MeV/fis-s}) \quad (1)$$

These sets of parameter pairs were obtained for beta- and gamma-ray decay, for both ^{235}U and ^{239}Pu fuels, for all decay-energy groups, over the full cooling time range of 10^{-4} - 10^9 s. The generation of these sets was a necessary preliminary step to obtaining the adjusted data base, and the sets are used in each of the three steps previously outlined.

Long Cooling Times - Step 1

The sets of parameters from the ENDF/B-V calculation were used in Eq. (1) to compute the beta- and gamma-ray decay energy at four cooling times per decade from the longest experimental cooling time (10^4 s for beta-ray decay and 2×10^5 s for gamma-ray decay) up to 10^9 s for each decay energy group for both fuels. Because of large experimental errors, ENDF/B-V data were used to calculate points from 10^3 - 10^9 s for some of the higher energy groups.

Cooling Times Less Than Two Seconds - Step 2

Because there is often a large difference between the decay energy for short cooling-times calculated from the ENDF/B-V fits and the experimentally measured values, we used the shape of the ENDF/B-V data shifted to coincide with the equivalent experimental short cooling time points. [The derivation of "equivalent experimental points" (pulse values) is discussed below.] The shift was accomplished by first plotting the ENDF/B-V fit and the equivalent experimental pulse points having a cooling time less than 10 s. Figure 1 is an example of one of these plots. The ENDF/B-V curve was then shifted manually to coincide with the equivalent experimental points, and values for cooling times of 0.01, 0.03, 0.1, 0.3, and 1.0 seconds were read off the graph. (Figure 2 shows the resulting adjusted fit for cooling times less than 10 s after the procedures described in Steps 1-3 have been completed.)

It is important to note that the equivalent experimental points plotted on Figs. 1-3 are produced from the original data in the following manner. The original experimental points are measured beta- or gamma-ray decay energies at cooling times of t seconds after an irradiation period of T seconds. In order

Fig. 1. Beta-ray fission-product decay energy for Group 5 (0.6-0.8 MeV) calculated from ENDF/B-V data and "equivalent pulse" experimental points.

Fig. 2. Beta-ray fission-product decay energy for Group 5 (0.6-0.8 MeV). Adjusted curve shows the result of shifting the ENDF/B-V curve to coincide with the "equivalent pulse" experimental points.

Fig. 3. Gamma-ray decay energy for Group 7 (1.0-1.2 MeV) showing "equivalent pulse" experimental points, ENDF/B-V fit, and adjusted fit.

to intercompare experiments with different irradiation times and to compare these experiments to calculations, it is desirable to reduce the experimental data to equivalent pulse data that are independent of irradiation time. The code FITPULS can generate a set of alphas and lambdas by fitting the original experimental data with an integration of Eq. (1) over T for a unit fission rate producing functions of the form,

$$F(T,t) = \sum_{i=1}^n \frac{\alpha_i}{\lambda_i} e^{-\lambda_i t} \left(1 - e^{-\lambda_i T} \right) \text{ (MeV/fis)} \quad (2)$$

The set of alpha, lambda parameter pairs derived by FITPULS using Eq. (2) from the combination of all experimental data points constitute the experimental pulse fit. See Appendix D of Ref. 10 for a detailed treatment of this subject. During this fitting process, the percent differences of the original experimental data points to the fitted results as calculated by Eq. (2) are computed and saved. These percent differences can be applied to the experimental pulse by evaluating Eq. (1) at the cooling times of the original experimental points and adding the percent differences to generate equivalent experimental pulse data points. Because the fitting procedure involves a nonlinear least squares algorithm, neither the experimental pulse fits nor the equivalent experimental pulse points are unique. For graphical comparisons, the equivalent experimental pulse values are an excellent representation of the experiments because deviations are emphasized. The actual fitting process of Step 3 (below) uses the original experimental data points, not the equivalent points.

Final Parameters Representing the Adjusted Data - Step 3

Points from Step 1 computed directly using the ENDF/BV pulse parameters in Eq. (1) for long cooling times, points from Step 2 derived from the shifted ENDF/BV pulse fit for short cooling times, and the original experimental data points for the middle cooling time region were combined. The combination was input along with the ENDF/BV pulse parameters to FITPULS, which produced sets of alpha, lambda parameter pairs constituting the adjusted equivalent pulse fits. FITPULS uses a nonlinear least squares procedure to fit the input to Eq. (1) (for the pulse points from Steps 1 and 2) and Eq. (2) (for the original experimental finite-irradiation data points) using the ENDF/B-V pulse parameters as the starting values for the fitting process. Thus, the adjusted

fits reflect the basic shape of the ENDF fit, as can be seen in Fig. 3, which shows the original ENDF fit, the final adjusted fit, and the equivalent pulse experimental data points for each experiment. The fitting procedure allows for weights to be assigned to the data points (experimental data or points created by the methods described in Steps 1 and 2). By looking at graphs of the equivalent experimental points and the ENDF fits, it can be determined which points should be given light weights and which should be given heavy weights. Heavy weights will force the final fit to adhere closely to those points, whereas light weights will allow the fit to wander quite far from the data points.

These adjusted fits were obtained in the 19-energy group structure given in Table I for ^{235}U beta- and gamma-ray decay-energy spectra and for ^{239}Pu beta- and gamma-ray decay-energy spectra. Note that for cooling times outside the range of the experiments, only ENDF/B-V data were used for FITPULS input; thus the adjusted fits for cooling times greater than 10^4 s for betas and 2×10^5 s for gammas are just fits to the calculated ENDF/B-V summation data. Because the experimental error at cooling times greater than 1000 s for energies greater than 4 MeV is very large for groups 17 and 18, those experimental points were ignored and the ENDF/B-V data were used instead. Thus, for these groups the adjusted fits are the ENDF/B-V fits for cooling times greater than 1000 s. There are no experimental data for group 19, therefore the adjusted fit for group 19 is based on the ENDF/B-V fit for all cooling times.

III. DESCRIPTION OF ADENA

The program ADENA was written to approximate the fission product decay-energy spectra with an absorption correction for fuel mixtures of ^{235}U and ^{239}Pu . The adjusted fits produced by the procedure given in Sec. II were incorporated into the code, which uses these parameters in Eq. (2) to calculate the fission product decay energy for a finite irradiation time without absorption. A description of the input to ADENA is given in Table II.

For many applications involving long irradiation times, a correction to the adjusted fits is needed to account for the effects of neutron absorption. (Appendix D of Ref. 10 gives the general equations to calculate absorption effects; however, the simplified method developed in Ref. 12 was used in ADENA.) Several limiting assumptions are made in order to simplify the absorption calculations. The power history must be reduced to the associated

TABLE I
ENERGY GROUP STRUCTURE

Group	E-Lo(MeV)	E-Hi(MeV)
1	0.0	0.1
2*	0.1	0.2
3	0.2	0.4
4	0.4	0.6
5	0.6	0.8
6	0.8	1.0
7	1.0	1.2
8	1.2	1.4
9	1.4	1.6
10	1.6	1.8
11	1.8	2.0
12	2.0	2.2
13	2.2	2.4
14	2.4	2.6
15	2.6	3.0
16	3.0	4.0
17	4.0	5.0
18	5.0	6.0
19	6.0	7.5

* Due to lack of experimental data, Groups 1 and 2 were combined for the beta-ray calculations.

average thermal and epithermal fluxes. The requested group structure must be a subset of the group structure given in Table I. Only the two most important chains $^{155}\text{Eu} - ^{156}\text{Eu}$ and $^{133}\text{Cs} - ^{134}\text{Cs}$ are considered; these have a net positive effect on heating and spectra. The correction is given by the equation

$$\Delta F(t, T, \phi) = \Delta N(T, \phi) \lambda w e^{-\lambda t} \quad (3)$$

where,

T is the irradiation time

t is the cooling time

ϕ is the neutron flux (thermal and epithermal)

λ is the decay constant of the second nuclide in the chain

w is the average photon decay energy for a given group for the second nuclide

$\Delta N(T, \phi)$ is the change in atom density of the nuclide resulting from its radiative capture and capture in its precursor.

TABLE II

ADENA INPUT SPECIFICATIONS^a

<u>Card</u>	<u>Variable</u>	<u>Comment</u>
1	UFRAC	Fraction of ²³⁵ U in fuel
	TFLUX	Average thermal flux (n/cm ² /s)
	ETFLUX	Average epithermal flux (n/cm ² /s)
	OTIME	Operating time (seconds) (use OTIME = 0 for pulse case)
	NGI	Number of energy groups
	NTSP	Number of cooling times
	IPLT	Plotting flag; flag = 1 for plots, = 0 for no plots
	IST	If = 1, calculate ANSI Standard, 0 otherwise
2	EI(I), I=1, NGI+1	If NGI > 0 energy bounds (MeV); energy bounds must be a subset of bounds given in Table I.
		If NGI ≤ 0, card 2 is omitted
		If NGI = 0, energy bounds of Table I are used
		If NGI = -6, the energy bounds 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 7.5 will be used
		If NGI = -12, the energy bounds 0.0, 0.4, 0.8, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0, 4.0, 5.0, 6.0, 7.5 will be used
3	TMIN, TMAX	Only if NTSP = 0 or NTSP = -1
		If NTSP = 0, results will be calculated for cooling times at each decade and half decade from TMIN to TMAX
		If NTSP = -1, results will be calculated for cooling times at each decade from TMIN to TMAX
	T(I), I=1, NTSP	Only if NTSP > 0, cooling times
4	UFG, UFB, PUFG, PUFB	Multiplication factor for increasing confi- dence limits of ADENA calculation for ²³⁵ U gamma energies, ²³⁵ U beta energies, ²³⁹ Pu gamma energies, and ²³⁹ Pu beta energies, in that order. Set = 1 for no effect

^aAll input is free field; values or commas must be
supplied for all variables.

Results are generated for each requested cooling time by group and for the sum over all groups. Beta-ray, gamma-ray, and the sum of beta- and gamma-ray decay energies are printed and plotted for each category.

The ADENA code also has the capability of calculating the decay energy after a pulse (specify OTIME = 0) and of performing calculations of the total beta plus gamma decay energy based on the ANSI/ANS-5.1-1979 Standard (specify IST = 1), as described in Table II.

IV. COMPARISONS

To check the data fits used in ADENA, three types of comparisons were made. The first comparison involved using ADENA to calculate the gammaray decay energy at three cooling times (1, 10^6 , and 10^8 s) for a ^{235}U -fueled thermal reactor with an average thermal flux of 10^{14} n/cm²/s for an operating time of 20 000 hours. The ADENA results were then compared with the results of a CINDER-10(Ref. 8) calculation of the same problem. The ADENA calculation used the adjusted data base derived from experiment and ENDF/B-V, whereas the CINDER calculation used ENDF/B-IV data. The results of both calculations are given in Table III. The biggest differences occur at the shortest cooling time, 1 s, in the lowest energy group. This observation is supported by the results of the data testing study⁶ that indicates that the calculated gamma-ray decay energies are relatively high for early cooling times and small gamma-ray energies. Maximum absorption effects in the calculations are at 10^6 s cooling time for the europium chain and 10^8 s for the cesium chain. As can be seen from the tabulations in Table III, ADENA agrees well with CINDER at these times.

The second type of comparison involved using ADENA to calculate the Oak Ridge (ORNL) and Los Alamos experiments, and plotting the calculation with the experimental data. Examples of these graphical comparisons for the ORNL 100-s irradiation experiment¹ are given in Figs. 4-6 for three cooling times (90, 950, and 11 950 s) and for the Los Alamos 5.56-h experiment³ in Figs. 7-9 for three cooling times (128, 1218, and 14 650 s). As can be seen in the figures, the calculation agrees quite well with the experiment. Note that for long cooling times and high gamma-ray energies, the experimental error is very large.

A final comparison is made with the 1979 ANSI/ANS-5.1 Standard. This standard is believed to provide the best estimate of total (beta plus gamma)

TABLE III

COMPARISON OF GAMMA-RAY ENERGY CALCULATED BY ADENA AND CINDER

Group	Energy Bounds (MeV)	Cooling Time 1 s Gamma Decay Energy (MeV/fis)		Cooling Time 10 ⁶ s Gamma Decay Energy (MeV/fis)		Cooling Time 10 ⁸ s Gamma Decay Energy (MeV/fis)	
		CINDER	ADENA	CINDER	ADENA	CINDER	ADENA
1	0.0-1.0	2.681	2.258	0.180	0.181	0.0079	0.0077
2	1.0-2.0	2.061	1.971	0.073	0.067	0.0003	0.0003
3	2.0-3.0	0.838	0.968	0.008	0.009	0.0001	0.0000
4	3.0-4.0	0.306	0.421	0.001	0.000	0.0000	0.0000
5	4.0-5.0	0.166	0.179	0.001	0.000	0.0000	0.0000
6	5.0-6.0	0.042	0.057	0.000	0.000	0.0000	0.0000
Total		6.095	5.856	0.261	0.257	0.0083	0.0081
<hr/>							
Fuel	²³⁵ U						
Thermal Flux	10 ¹⁴ n/cm ² /s						
Epithermal Flux	5 x 10 ¹⁴ n/cm ² s						
Operating Time	20 000 hr						

decay heating, but it does not provide a resolution into the beta and gamma components or spectra. The primary intent of this report is to provide a simple code that will calculate our best estimate of these components, particularly their spectra on a few-energy group basis. The total heating closely matches values from the standard, as shown in Fig. 10 for ²³⁵U and Fig. 11 for ²³⁹Pu, but is not normalized to the standard. The ADENA results are within 10% of the standard at all times. In terms of the small assigned uncertainties of the standard, the ADENA results are all within a two-sigma uncertainty of the standard for ²³⁹Pu. The uncertainties in the standard are much smaller for ²³⁵U (<2%), and 14 of the 46 points are further than 2 sigma from the standard (all are within 10%), 4 points are further than 3 sigma, and all are within 4 sigma uncertainty of the standard. Note that the standard is based on five experiments and ENDF/B-IV data, whereas our adjusted fits are based on only three experiments and ENDF/B-V data.

V. ESTIMATE OF ACCURACY OF CALCULATIONS USING THE ADENA CODE

As described in Sec. III, the user has the option of assigning values to four input parameters in ADENA, namely, UFG, UFB, PUFG, and PUFb, which will raise or lower the results of the calculation by a certain percentage and thus increase the level of confidence in the calculation. It is the intent of this

Fig. 4. Gamma-ray decay energy after a cooling time of 90 s from the Oak Ridge National Laboratory ^{235}U 100-s irradiation experiment compared with the ADENA calculation.

Fig. 5. Gamma-ray decay energy after a cooling time of 950 s from the Oak Ridge National Laboratory ^{235}U 100-s irradiation experiment compared with the ADENA calculation.

Fig. 6. Gamma-ray decay energy after a cooling time of 11 950 s from the Oak Ridge National Laboratory ^{235}U 100-s irradiation experiment compared with the ADENA calculation.

Fig. 7. Gamma-ray decay energy after a cooling time of 128 s from the Los Alamos ^{235}U 5.56-h irradiation experiment compared to the ADENA calculation.

Fig. 8. Gamma-ray decay energy after a cooling time of 1218 s from the Los Alamos ^{235}U 5.56-h irradiation experiment compared to the ADENA calculation.

Fig. 9. Gamma-ray decay energy after a cooling time of 14 650 s from the Los Alamos ^{235}U 5.56-h irradiation experiment compared to the ADENA calculation.

Fig. 10. Comparison of ANSI/
ANS-5.1-1979 standard for
thermal pulse fission of ^{235}U
to the ADENA calculation.

Fig. 11. Comparison of ANSI/
ANS-5.1-1979 standard for
thermal pulse fission of ^{239}Pu
to the ADENA calculation.

section to provide the user with some guidance in assigning values to these parameters. Overall reliability of calculations with ADENA depends upon (a) the accuracy of the adjusted spectral fits and (b) the accuracy of the neutron absorption approximation. Some indication of the accuracy of the fits is obtained by the calculation of the standard noted in Sec. IV. Note, however, that this is for the decay energy from combined beta- and gamma-ray decay for the aggregate of the fission products and summed over all energy groups.

Results given in Sec. IV show that the values calculated by ADENA are all within the 2-sigma error quoted for the ^{239}Pu standard, but that 14 were outside the small 2-sigma error quoted for ^{235}U . These 14 values are shown as a function of cooling time in Table IV. Note that 9 of the 14 values occur for cooling times of 100 s or less. We therefore suggest that for problems involving totals over energy (i.e., nonspectral) and total beta- plus gamma-decay energy, an average uncertainty value of 7.5% be assumed for cooling times of 100 s or less, and an average of 4.0% be assumed for longer cooling times.

Uncertainties assigned for spectral calculations using the adjusted fits are considerably greater, however, and are more dependent on cooling-time ranges as well as being dependent upon spectral energy ranges. A rather detailed discussion of the deviations of calculations with the adjusted fits from aggregate values from summation calculations using ENDF/B-V and the deviations of adjusted fit calculations from experimental data are given in Appendix B. On the basis of the results of the analysis in this appendix, we recommend that the uncertainties given in Table V be used over the energy and cooling-time ranges given in the table for both beta- and gamma-ray decay energies and for both ^{235}U and ^{239}Pu fuels. We further suggest that the user can easily modify this table according to his needs by referring to Appendix B.

Finally, Table III is a good example of the accuracy of the two-chain approximation that the ADENA code uses to calculate neutron absorption effects for cooling times above 10^5 s. As can be seen from the table, deviations from the summation calculations do not exceed 2% for those cooling-time ranges where the absorption correction is significant. For shorter cooling times, uncertainties in spectral values calculated with the adjusted fits are considerably greater than the deviation due to absorption effects. Consequently, as a "rule of thumb," we suggest that a minimum uncertainty of 10% be assigned in Table V for ADENA calculations with significant absorption effect, i.e., large fluence and long cooling times. Neutron absorption is discussed more fully in Refs. 10 and 12.

TABLE IV

ADENA CALCULATIONS OUTSIDE 2-SIGMA OF ^{235}U STANDARD

Cooling Time (s)	1-Sigma Uncertainty in Standard (%)	Deviation of ADENA Calculation from Standard (%)
4.0E+00	4.3	10.0
6.0E+00	3.5	8.9
8.0E+00	3.1	7.6
1.0E+01	3.2	6.7
2.0E+01	2.4	6.3
4.0E+01	2.0	8.1
6.0E+01	1.9	7.5
8.0E+01	1.9	6.5
1.0E+02	1.8	5.7
2.0E+02	1.9	4.8
4.0E+02	1.9	4.5
2.0E+03	1.8	3.9
2.0E+04	1.4	4.2
4.0E+04	1.4	3.3

TABLE V

PERCENT ACCURACY OF ADJUSTED SPECTRAL FITS

Energy Ranges (MeV)	Cooling-Time Ranges (s)			
	1.0E-02-1.0E+00	1.0E+00-1.0E+04	1.0E+04-1.0E+06	1.0E+06-1.0E+09
0.0-0.6	22.8	15.3	8.2	5.0
0.6-1.6	6.9	5.8	8.4	5.0
1.6-3.0	27.2	16.5	17.0	5.0
3.0-7.5	40.5	22.3	7.8	5.0

VI. SUMMARY

A method for creating an adjusted fission-product decay-energy data base from a combination of experimental data and the ENDF/B-V fission-product data file has been described. The code ADENA, which uses the adjusted data base in calculating fission-product decay-energy spectra (including the major effects of neutron absorption) for fuel mixtures of ^{235}U and ^{239}Pu , has also been described. The code can be used for a wide variety of reactor operational and safety related computations where aggregate fission-product decay spectra are needed. This avoids the need for the large data base and code systems¹⁰⁻¹² we have used to produce this end product, assuming the user requires only aggregate,

rather than individual nuclide, results. We have, in addition, incorporated the important experimental spectra available for short cooling times.

Several examples of the application of the ADENA code are also given, including comparison to the ANSI/ANS 5.1-1979 Standard. A section is included from which the user can obtain an indication of the reliability of ADENA calculational results.

The adjusted parameters can be abstracted from the code listing and used directly in Eqs. (1) or (2) or the more general equations in the appendix of Ref. 10 by those users requiring spectral calculations in various spatial codes.

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For two fuels, the pulse functions described in this report and the associated ADENA code are the culmination of a series of related reports and codes. The need for and general utility of such functions was originally suggested by J. Lewellen and P. Hemmig (Department of Energy). Along the way, we have enjoyed discussions contributing to our work with R. Schenter, F. Schmittroth, and F. Mann (Hanford Engineering Development Lab); A. Tobias and colleagues (Central Electricity Board, U.K.); and T. Yoshida and colleagues (Nippon Atomic Industry Group Nuclear Research Laboratory, Japan). The experimental data provided by J. K. Dickens (Oak Ridge), and J. Yarnell and E. Journey (Los Alamos) contributed vitally to this work and to earlier comparisons.

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APPENDIX A

A full listing of the computer code ADENA is contained in this appendix. The adjusted fits can be abstracted from the block data routine and used in other applications. The fits are in the order ^{235}U betas, ^{235}U gammas, ^{239}Pu betas, and ^{239}Pu gammas. For the beta fit, groups 1 and 2 have been combined; thus, in order to retrieve the fits for group 8 betas, one must abstract the seventh set of parameters. For nonspectral calculations of the total (beta plus gamma) decay energy, the fits to the standard have been included; see subroutine STNDRD.

Input and output listings of a sample problem have been included following the listing of the code. This problem calculates the decay-energy spectra in 12 groups (see Table II), at 2 cooling times (10^6 and 10^8 s), from a reactor whose operating time was 7.2×10^7 s, with a thermal flux of 10^{14} n/cm²/s, an epithermal flux of 5×10^{14} n/cm²/s, and with a fuel mixture 75% ^{235}U and 25% ^{239}Pu .

Los Alamos Identification No. LP-1434

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PROGRAM ADENA(INPUT,TAPE5=INPUT,TAPE6,OUTPUT,TAPE1)      ADEN 10
C PROGRAM TO APPROXIMATE FISSION PRODUCT DECAY ENERGY WITH ADEN 20
C ABSORPTION FOR MIXTURES OF PU-239 AND U-235.             ADEN 30
C RESULTS IN 19 GROUP GAMMA 18 GROUP BETA STRUCTURE        ADEN 40
C ABSORPTION CORRECTION FROM CS, EU CHAINS.                ADEN 50
  REAL ABCOR(2),AC(50,19,2,2),W(19,3,2),BET(19),GAM(19),TOT(19) ADEN 60
  REAL AAC(3800)                                             ADEN 70
  EQUIVALENCE (AC(1,1,1,1),AAC(1))                         ADEN 80
  COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG, ADEN 90
  2 UFB,PUFG,PUFB,IPLT,IST
  COMMON /ABSP/DC,YU,YPU,PEPXS,FEPXS,PTXS,FTXS             ADEN 100
  COMMON /FITS/XLAM(20,19,4),XALP(20,19,4),KTRM(19,4)      ADEN 110
  COMMON /FITS/XLAM(20,19,4),XALP(20,19,4),KTRM(19,4)      ADEN 120
C FITS IN ORDER U-BETA U-GAMMA PU-BETA PU-GAMMA SEE BLOCK DATA ADEN 130
C W IS THE AVERAGE DECAY ENERGY FOR SECOND                ADEN 140
C NUCLIDE BY GROUPS..                                     ADEN 150
  DATA (W(1,1,1),I=1,19)/.0180922,.0281686,.0768595,.0417469, ADEN 160
  1 .000791733,.0000108118,.618985E-7,1.84582E-6,2.28177E-8, ADEN 170
  2 10*0./                                                    ADEN 180
  DATA (W(1,1,2),I=1,19)/.000148678,0...0000980157,.141983,1.26973, ADEN 190
  1 .0700032,.0314065,.0415000,11*0./                      ADEN 200
  DATA (W(1,2,1),I=1,19)/.0390261,.0296386,.0490872,.0327957, ADEN 210
  1 .0398798,.0423082,.0407609,.0398081,.0376028,.0315247, ADEN 220
  2 .0222194,.0116397,.00297791,.0000319913,5*0./          ADEN 230
  DATA (W(1,2,2),I=1,19)/.0141238,.00160603,.000450942, ADEN 240
  1 .0169239,.0964488,.142209,.276996,.255332,0...00553968, ADEN 250
  2 .161764,.303278,.0524688,8*0./                          ADEN 260
  DATA (W(1,3,1),I=1,18)/.0191422,.0426199,.0647785,.017627, ADEN 270
  1 .00236877,.00046317,4.35695E-7,11*0./                  ADEN 280
  DATA (W(1,3,2),I=1,18)/.00749719,.00259804,.0487936,.751278, ADEN 290
  1 .822712,.171198,.204923,11*0./                          ADEN 300
  CALL FILEREP                                              ADEN 310
  IF(IPLT.EQ.1) CALL GPLOT(1HU,5HPLOTA,5)                 ADEN 320
C READ INPUT - FREE FIELD                                  ADEN 330
C CARD 1-FRACTION OF U-235 IN FUEL(UFRAC), AVERAGE THERMAL FLUX ADEN 340
C (TFLUX), AVERAGE EPITHERMAL FLUX(ETFLUX), OPERATING TIME ADEN 350
C (OTIME), NUMBER OF ENERGY GROUPS(NGI), NUMBER OF COOLING ADEN 360
C TIMES(NTSP), PLOTTING FLAG=1 FOR PLOTS; 0 OTHERWISE(IPLT), ADEN 370
C STANDARD FLAG =1 TO CALCULATE STANDARD (IST); 0 OTHERWISE ADEN 380
C USE OTIME=1 FOR BURST CASE                                ADEN 390
C CARD 2-IF NGI>0 EI(I),I=1,NGI+1, ENERGY BOUNDS          ADEN 400
C -IF NGI=0 USE STANDARD 19 GAMMA 18 BETA GROUPS            ADEN 410
C -IF NGI=-6 STANDARD 6 GROUP 0,.1,.2,.3,.4,.5,.7,5        ADEN 420
C -IF NGI=-12 BUILT IN 12GRP 0,.4,.8,1,1.4,1.8,2.2,2.6,3,4,5,7,5ADEN 430
C CARD 3-IF NTSP=0 THEN TMIN, TMAX, RESULTS WILL BE AT EACH DECADE ADEN 440
C AND HALF DECADE FROM TMIN TO TMAX                         ADEN 450
C - IF NTSP=-1 THEN TMIN, TMAX, RESULTS WILL BE AT EACH DECADE ADEN 460
C FROM TMIN TO TMAX                                         ADEN 470
C - IF NTSP>0 THEN T(1)...T(NTSP) MAXIMUM OF 50 TIMES      ADEN 480
C CARD 4-ADJUST FACTORS- PERCENT TO BE ADDED TO U,PU DECAY ENERGY ADEN 490
C (BETA,GAMMA FOR EACH) UFG,UFB,PUFG,PUFB                 ADEN 500
  CALL READSUB                                              ADEN 510
C ACCUMULATE ABSORPTION CORRECTION                         ADEN 520
C CONSIDER ONLY CS 133-134 AND EU 155-156 CHAINS           ADEN 530
C USE AC(I,J,K,L) I=COOLING TIME, J=GROUP, K=FUEL, L=BETA OR GAMMA ADEN 540
  NG=19                                                     ADEN 550
  NBG=2                                                      ADEN 560
  NFUEL=2                                                    ADEN 570
  NCHN=2                                                     ADEN 580
  DO 30 I=1,3800                                           ADEN 590
  30 AAC(I)=0.                                               ADEN 600
C USE PULSE EONS IF OTIME=0.                                ADEN 610
  IF(OTIME.EQ.0.) GO TO 101                                ADEN 620
C ABSORPTION CORRECTIONS RETURNED IN ABCOR(1) FOR URANIUM ABCOR(2) FOR ADEN 630
C PLUTONIUM                                                 ADEN 640

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DO 100 N=1,NCHN	ADEN 650
CALL EVAL(N,ABCR)	ADEN 660
C LOOP OVER TIME STEPS (I) AND GROUPS (J) TO GET CORRECTIONS	ADEN 670
C K INDEX TO NUMBER OF FUELS	ADEN 680
C L INDEX TO BETA OR GAMMA CORRECTION	ADEN 690
DO 90 L=1,NBG	ADEN 700
DO 90 K=1,NFUEL	ADEN 710
DO 90 I=1,NTSP	ADEN 720
DO 90 J=1,NG	ADEN 730
90 AC(I,J,K,L)=AC(I,J,K,L)+ABCR(K)*DC*EXP(-DC*T(I))*W(J,N,L)	ADEN 740
100 CONTINUE	ADEN 750
C CHECK FOR STANDARD CALCULATION	ADEN 760
101 IF(IST.EQ.1) CALL STNDRD(AC)	ADEN 770
C FINAL ACCUMULATION IS BY COOLING TIME	ADEN 780
C FOR EACH TIME CALCULATED BETA, GAMMA AND TOTAL DECAY ENERGY FOR	ADEN 790
C EACH GROUP	ADEN 800
C TAKE APPROPRIATE FRACTION FOR EACH FUEL AND SUM	ADEN 810
DO 200 I=1,NTSP	ADEN 820
BTOT=GTOT=STOT=0.	ADEN 830
DO 150 J=1,NG	ADEN 840
BET(J)=0.	ADEN 850
GAM(J)=0.	ADEN 860
TOT(J)=0.	ADEN 870
C BETA INDICES ARE 1 FOR URANIUM AND 3 FOR PLUTONIUM	ADEN 880
IF(J.EQ.19) GO TO 190	ADEN 890
KU=KTRM(J,1)	ADEN 900
KPU=KTRM(J,3)	ADEN 910
C U-BETAS	ADEN 920
DO 110 K=1,KU	ADEN 930
XA=XALP(K,J,1)	ADEN 940
XL=XLAM(K,J,1)	ADEN 950
IF(OTIME.NE.O.) BET(J)=BET(J)+XA/XL*EXP(-XL*T(I))*(1-EXP(-XL	ADEN 960
1 *OTIME))	ADEN 970
IF(OTIME.EQ.O.) BET(J)=BET(J)+XA*EXP(-XL*T(I))	ADEN 980
110 CONTINUE	ADEN 990
BET(J)=BET(J)+AC(I,J,1,1)	ADEN1000
IF(UFB.LE.O.) UFB=1.	ADEN1010
BET(J)=BET(J)+UFB	ADEN1020
C PU-BETAS	ADEN1030
TEMP=0.	ADEN1040
DO 120 K=1,KPU	ADEN1050
XA=XALP(K,J,3)	ADEN1060
XL=XLAM(K,J,3)	ADEN1070
IF(OTIME.NE.O.) TEMP=TEMP+XA/XL*EXP(-XL*T(I))*(1-EXP(-XL*OTIME))	ADEN1080
IF(OTIME.EQ.O.) TEMP=TEMP+XA*EXP(-XL*T(I))	ADEN1090
120 CONTINUE	ADEN1100
TEMP=TEMP+AC(I,J,2,1)	ADEN1110
IF(PUFB.LE.O.) PUFB=1.	ADEN1120
TEMP=TEMP+PUFB	ADEN1130
C GET FRACTIONS	ADEN1140
BET(J)=UFRAC*BET(J)+(1-UFRAC)*TEMP	ADEN1150
IF(BET(J).LT.1.0E-10) BET(J)=0.0	ADEN1160
C GAMMAS INDICES ARE 2,4	ADEN1170
190 KU=KTRM(J,2)	ADEN1180
KPU=KTRM(J,4)	ADEN1190
C U-GAMMAS	ADEN1200
DO 130 K=1,KU	ADEN1210
XA=XALP(K,J,2)	ADEN1220
XL=XLAM(K,J,2)	ADEN1230
IF(OTIME.NE.O.) GAM(J)=GAM(J)+XA/XL*EXP(-XL*T(I))*(1-EXP(-XL	ADEN1240
1 *OTIME))	ADEN1250
IF(OTIME.EQ.O.) GAM(J)=GAM(J)+XA*EXP(-XL*T(I))	ADEN1260
130 CONTINUE	ADEN1270
GAM(J)=GAM(J)+AC(I,J,1,2)	ADEN1280

DATA E/O...1..2..4..6..8..1..1.2,1.4,1.6,1.8,2.,2.2,2.4,	REGR 50
1 2.6,3.,4.,5.,6.,7.5/	REGR 60
DATA E1/O...1..2..3..4..5..7.5/	REGR 70
DATA E2/O...4..8..1..1.4,1.8,2.2,2.6,3..4..5..6..7.5/	REGR 80
C SHIFT BETA GROUPS DOWN SO GROUP 1 IS EMPTY	REGR 90
DO 2 I=1,18	REGR 100
BET(19-I+1)=BET(19-I)	REGR 110
BET(1)=0.	REGR 120
C STANDARD 19 GROUPS	REGR 130
IF(NGI.NE.19) GO TO 5	REGR 140
DO 3 I=1,20	REGR 150
3 EI(I)=E(I)	REGR 160
RETURN	REGR 170
C LOOK FOR STANDARD 6 AND 12 GROUPS	REGR 180
5 IF(NGI.GT.0) GO TO 9	REGR 190
IF(NGI.NE.-6) GO TO 7	REGR 200
NGI=6	REGR 210
DO 6 I=1,7	REGR 220
6 EI(I)=E1(I)	REGR 230
GO TO 9	REGR 240
7 NGI=12	REGR 250
DO 8 I=1,13	REGR 260
8 EI(I)=E2(I)	REGR 270
9 NG=20	REGR 280
JSTART=1	REGR 290
DO 100 I=1,NGI	REGR 300
DO 10 J=JSTART,NG	REGR 310
C FIND HOW MANY GROUPS TO COMBINE	REGR 320
IF(EI(I+1).EQ.E(J)) GO TO 20	REGR 330
10 CONTINUE	REGR 340
WRITE(6,15)	REGR 350
15 FORMAT (" ILLEGAL ENERGY BOUNDS SPECIFIED")	REGR 360
STOP	REGR 370
20 T1=0.	REGR 380
T2=0.	REGR 390
T3=0.	REGR 400
JEND=J-1	REGR 410
DO 30 K=JSTART,JEND	REGR 420
T1=T1+BET(K)	REGR 430
T2=T2+GAM(K)	REGR 440
30 T3=T3+TOT(K)	REGR 450
BET(I)=T1	REGR 460
GAM(I)=T2	REGR 470
TOT(I)=T3	REGR 480
JSTART=J	REGR 490
100 CONTINUE	REGR 500
RETURN	REGR 510
END	REGR 520
SUBROUTINE READSUB	READ 10
COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG,	READ 20
2 UFB,PUFG,PUFB,IPLT,IST	READ 30
READ *,UFRAC,TFLUX,ETFLUX,OTIME,NGI,NTSP,IPLT,IST	READ 40
NGI=NGI+1	READ 50
IF(NGI.LT.21) GO TO 10	READ 60
WRITE(6,8)	READ 70
8 FORMAT(" MAX OF 20 GROUPS")	READ 80
STOP	READ 90
10 IF(NGI.GT.0) READ *,(EI(I),I=1,NGI)	READ 100
IF(NGI.EQ.0) NGI=19	READ 110
IF(NTSP.GT.0) GO TO 30	READ 120
READ *,TMIN,TMAX	READ 130
IF(TMIN.NE.TMAX) GO TO 15	READ 140
NTSP=1	READ 150
T(1)=TMIN	READ 160

GO TO 40	READ 170
15 L=IFIX(ALOG10(TMIN))	READ 180
IF(L.LT.0) L=L-1	READ 190
M=IFIX(ALOG10(TMAX))+.99)	READ 200
IF(NTSP.EQ.-1) GO TO 20	READ 210
NTSP=2*(M-L)+1	READ 220
J=1	READ 230
DO 18 I=1,NTSP,2	READ 240
T(I)=10.**((L+J-1)	READ 250
T(I+1)=5.*T(I)	READ 260
J=J+1	READ 270
18 CONTINUE	READ 280
GO TO 40	READ 290
20 NTSP=(M-L)+1	READ 300
DO 22 I=1,NTSP	READ 310
22 T(I)=10.**((L+I-1)	READ 320
GO TO 40	READ 330
30 IF(NTSP.LE.50) GO TO 35	READ 340
WRITE(6,32)	READ 350
32 FORMAT(" MAX OF 50 TIME STEPS")	READ 360
STOP	READ 370
35 READ *,(T(I),I=1,NTSP)	READ 380
40 READ *,UFG,UFB,PUFG,PUFB	READ 390
RETURN	READ 400
END	READ 410
SUBROUTINE EVAL(NCID,ABCOR)	EVAL 10
COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG,	EVAL 20
2 UFB,PUFG,PUFB,IPLT,IST	EVAL 30
COMMON /ABSP/DC,YU,YPU,PEPXS,FEPXS,PTXS,FTXS	EVAL 40
REAL ABCOR (2),K	EVAL 50
C NCID- NUCLIDE ID 1 FOR CS 2 FOR EU	EVAL 60
C DC DECAY CONSTANT	EVAL 70
C YU CUMULATIVE YIELD FRACTION FROM THERMAL FISSION U-235	EVAL 80
C YPU CUMULATIVE YIELD FRACTION FROM THERMAL FISSION PU-239	EVAL 90
C PEPXS(N,GAM) XS OF PRECURSOR EPITHERMAL	EVAL 100
C FEPXS(N,GAM) XS OF SECOND NUCLIDE	EVAL 110
C PTXS(N,GAM) XS OF PRECURSOR THERMAL	EVAL 120
C FTXS(N,GAM) XS OF SECOND NUCLIDE	EVAL 130
C K CONSTANT	EVAL 140
C EVALUATE ADDITIONAL ATOM DENSITY OF NUCLIDE 2 RESULTING	EVAL 150
C FROM RADIATIVE CAPTURE IN NUCLIDE 1.	EVAL 160
C THIS TERM IS INDEPENDENT OF GROUP OR COOLING TIME.	EVAL 170
C ABCOR(1) FOR U ABCOR(2) FOR PU	EVAL 180
C $Y \cdot A \cdot K / (1 / (A \cdot B) - (EXP(-A \cdot OTIME) / (A \cdot (B - A))) + (EXP(-B \cdot OTIME) / (B \cdot (B - A))))$	EVAL 190
C $A = PTXS \cdot TFLUX + PEPXS \cdot ETFLUX$	EVAL 200
C $B = DC + FTXS \cdot TFLUX + FEPXS \cdot ETFLUX$	EVAL 210
C K=1.0	EVAL 220
IF(NCID.EQ.1) CALL CSCHN	EVAL 230
IF(NCID.EQ.2) CALL EUCHN	EVAL 240
A=(PTXS*TFLUX+PEPXS*ETFLUX)*1.E-24	EVAL 250
B=DC+(FTXS*TFLUX+FEPXS*ETFLUX)*1.E-24	EVAL 260
ABCOR(1)=A*K*(1/(A*B)-(EXP(-A*OTIME)/(A*(B-A)))+	EVAL 270
1 (EXP(-B*OTIME)/(B*(B-A))))	EVAL 280
ABCOR(2)=ABCOR(1)*YPU	EVAL 290
ABCOR(1)=ABCOR(1)*YU	EVAL 300
RETURN	EVAL 310
END	EVAL 320
SUBROUTINE CSCHN	CSCH 10
COMMON /ABSP/X(7)	CSCH 20
REAL AR(7)	CSCH 30
DATA AR/1.06523E-8,.06779,0.06957,34.12,20.454,30.162,140.67/	CSCH 40
C FILL ABSP COMMON WITH VALUES FOR CS CHAIN	CSCH 50
DO 10 I=1,7	CSCH 60
10 X(I)=AR(I)	CSCH 70

RETURN	CSCH 80
END	CSCH 90
SUBROUTINE EUCHN	EUCH 10
COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG,	EUCH 20
2 UFB,PUFG,PUFB,IPLT,IST	EUCH 30
COMMON /ABSP/X(7)	EUCH 40
C FILL IN ABSP COMMON WITH VALUES FOR EU CHAIN	EUCH 50
REAL AR(7)	EUCH 60
DATA AR/5.28152E-7,.00033,.00170,153.59,129.52,4059.8,484.94/	EUCH 70
DO 10 I=1,7	EUCH 80
10 X(I)=AR(I)	EUCH 90
C CORRECT CUMULATIVE YIELD	EUCH 100
C F IS FLUENCE	EUCH 110
F=TFLUX*OTIME*1.E-21	EUCH 120
FLOG=ALOG(F)	EUCH 130
IF(F.GT.3.0) GO TO 20	EUCH 140
Y=EXP(1.688*FLOG-6.565)	EUCH 150
GO TO 30	EUCH 160
20 Y=EXP(-0.1827*FLOG**2+1.47*FLOG-6.105)	EUCH 170
30 X(2)=X(2)+Y	EUCH 180
X(3)=X(3)+Y	EUCH 190
RETURN	EUCH 200
END	EUCH 210
SUBROUTINE PLOTIT(DT,NT,I)	PLOT 10
REAL X(50),Y(50),DT(2)	PLOT 20
INTEGER XL(2),YL(5),TL(5)	PLOT 30
COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG,	PLOT 40
2 UFB,PUFG,PUFB,IPLT,IST	PLOT 50
C MAKE PLOTS OF DECAY ENERGY /BIN VS ENERGY FOR EACH COOLING TIME -	PLOT 60
C NT=1 FOR TOTAL BETA +GAMMA	PLOT 70
C NT=2 FOR BETA PLOT	PLOT 80
C NT=3 FOR GAMMA PLOT	PLOT 90
DATA XL,YL/10H<ENERGY> (.10H<E>V)\$.10H<ECAY >E<,	PLOT 100
1 10H<ENERGY PER .10H>F<SSION/, 10H>B<IN >W<I, 10H<DTH\$	PLOT 110
IF(NT.NE.1) GO TO 15	PLOT 120
TL(1)=10H T<OTAL> E	PLOT 130
TL(2)=10H<ENERGY FOR	PLOT 140
TL(3)=10H >C<OOLING	PLOT 150
TL(4)=10H> T<IME	PLOT 160
ENCODE(9,10,TL(5)) T(I)	PLOT 170
10 FORMAT(1PE9.3)	PLOT 180
15 IF(NT.EQ.2) TL(1)=10H B<ETA >E	PLOT 190
IF(NT.EQ.3) TL(1)=10H G<AMMA >E	PLOT 200
NP=NGI+2	PLOT 210
X(1)=EI(1)	PLOT 220
K=2	PLOT 230
DO 20 J=2,NP,2	PLOT 240
X(J)=EI(K)	PLOT 250
X(J+1)=X(J)	PLOT 260
20 K=K+1	PLOT 270
K=1	PLOT 280
DO 30 J=1,NP,2	PLOT 290
Y(J)=DT(K)/(EI(K+1)-EI(K))	PLOT 300
IF(Y(J).LE.0.0) Y(J)=1.E-10	PLOT 310
Y(J+1)=Y(J)	PLOT 320
30 K=K+1	PLOT 330
CALL SETUP(X,Y,NP,TL,50,XL,100,YL,100,2.0,0.2)	PLOT 340
CALL ENDPL(0)	PLOT 350
RETURN	PLOT 360
END	PLOT 370
SUBROUTINE STNDRD(AC)	STND 10
C CALCULATE TOTAL DECAY HEAT USING ANSI/ANS-5.1 STANDARD	STND 20
COMMON /VAR/NGI,EI(20),NTSP,T(50),UFRAC,TFLUX,ETFLUX,OTIME,UFG,	STND 30
1 UFB,PUFG,PUFB,IPLT	STND 40

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      REAL STL(23,2),STA(23,2),ST(50),AC(50,19,2,2)
C U-235 ALPHAS
  DATA (STA(I,1),I=1,23)/.65057,.51264,.24384,.13850,.055440,.022225
  X,3.3088E-3,9.3015E-4,8.0943E-4,1.9567E-4,3.2535E-5,7.5595E-6,
  X 2.5232E-6,4.9948E-7,1.8531E-7,2.6608E-8,2.2398E-9,8.1641E-12,
  X 8.7797E-11,2.5131E-14,3.2176E-16,4.5038E-17,7.4791E-17/
C U-235 LAMBDA S
  DATA (STL(I,1),I=1,23)/22.138,.51587,.19594,.10314,.033656,.011681
  X,.0035870,.0013930,6.2630E-4,1.8906E-4,5.4988E-5,2.0958E-5,
  X 1.001E-5,2.5438E-6,6.6361E-7,1.2290E-7,2.7213E-8,4.3714E-9,
  X 7.5780E-10,2.4786E-10,
  X 2.2384E-13,2.46E-14,1.5699E-14/
C PU-239 ALPHAS
  DATA (STA(I,2),I=1,23)/.2083,.3853,.2213,.09460,.03531,.02292,
  X .003946,.001317,7.052E-4,1.432E-4,1.765E-5,7.347E-6,
  X 1.747E-6,5.481E-7,1.671E-7,2.112E-8,2.996E-9,5.107E-11,5.730E-11,
  X 4.138E-14,1.088E-15,2.454E-17,7.557E-17/
C PU-239 LAMBDA S
  DATA (STL(I,2),I=1,23)/10.02,.6433,.2186,.1004,.03728,.01435,
  X .004549,.001328,5.356E-4,1.73E-4,4.881E-5,2.006E-5,
  X 8.319E-6,2.358E-6,6.450E-7,1.278E-7,2.466E-8,9.378E-9,
  X 7.45E-10,2.426E-10,2.21E-13,2.64E-14,1.38E-14/
C STANDARD FOR TOTALS ONLY
  DO 100 I=1,NTSP
    ST(I)=0.
    DO 90 J=1,2
      S=0.
C LOOP THRU URANIUM THEN PLUTONIUM CALC
C SEE IF BURST OR FINITE IRRADIATION CALC
    IF(OTIME.NE.O.) GO TO 20
    DO 10 K=1,23
      10 S=S+STA(K,J)*EXP(-STL(K,J)*T(I))
      GO TO 80
    DO 22 K=1,23
      22 S=S+STA(K,J)/STL(K,J)*EXP(-STL(K,J)*T(I))*((1-EXP(-STL(K,J)*OTIME))
C ADD IN ALL ABSORPTION CORRECTIONS
      DO 30 K=1,2
        DO 30 L=1,19
          30 S=S+AC(I,L,J,K)
C FIGURE PER CENT FOR U AND PU
      80 IF(J.EQ.1) ST(I)=UFRAC*S
        IF(J.EQ.2) ST(I)=ST(I)+(1-UFRAC)*S
      90 CONTINUE
      100 CONTINUE
C PRINT RESULTS
      TEMP1=UFRAC*100.
      TEMP=100.-TEMP1
      WRITE(6,150)
150 FORMAT(1H1,T20,"CALCULATION OF ANSI/ANS-5.1 STANDARD")
      WRITE(6,152) TEMP1,TEMP,TFLUX,ETFLUX,OTIME
152 FORMAT(T30,"PERCENT U-235",T50,1PE11.4/
1 T30,"PERCENT PU-239",T50,1PE11.4/
2 T30,"THERMAL FLUX",T50,1PE11.4," N/CM**2-S"/
3 T30,"EPITHERMAL FLUX",T50,1PE11.4," N/CM**2-S"/
4 T30,"OPERATING TIME",T50,1PE11.4," SECONDS")
      WRITE(6,154)
154 FORMAT(//T10,"COOLING TIME",T40,"TOTAL DECAY ENERGY"/
1 T15,"(SEC)",T45,"(MEV/FIS)")
      WRITE(6,156) (T(I),ST(I),I=1,NTSP)
156 FORMAT (T12,1PE12.5,T42,1PE12.5)
      STOP
      RETURN
      END
      BLOCK DATA

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COMMON /FITS/ XLAM(20,19,4),XALP(20,19,4),KTRM(19,4)
C FITS FOR U-235 BETAS
DATA (XALP(K, 1,1),K=1,20)/
X .6434E-11, .1913E-10, .1578E-09, .2530E-08, .1708E-07, .4206E-07, DATA 20
X .1834E-06, .5005E-06, .2179E-05, .8087E-05, .2306E-04, .9554E-04, DATA 25
X .5491E-03, .1982E-02, .1696E-02, .6758E-03, .6054E-03, .2326E-03, DATA 30
XO, .0, / DATA 40
DATA (XLAM(K, 1,1),K=1,20)/
X .7896E-09, .9474E-08, .3256E-07, .1501E-06, .9199E-06, .3307E-05, DATA 80
X .1780E-04, .7042E-04, .1454E-03, .4018E-03, .1345E-02, .7228E-02, DATA 90
X .3395E-01, .1833E+00, .6551E+00, .8562E+00, .8475E+01, .4550E+01, DATA 100
XO, .0, / DATA 110
DATA (XALP(K, 2,1),K=1,20)/
X .1062E-10, .1890E-11, .6351E-10, .2015E-08, .1576E-07, .5459E-07, DATA 120
X .6061E-06, .9710E-06, .3984E-05, .1727E-04, .5401E-04, .2774E-03, DATA 130
X .8341E-03, .9005E-03, .5944E-02, .2499E-01, .2153E-01, .1110E-01, DATA 140
XO, .1126E-01, .0, / DATA 150
DATA (XLAM(K, 2,1),K=1,20)/
X .7807E-09, .1148E-07, .3184E-07, .1585E-06, .6529E-06, .3463E-05, DATA 160
X .1731E-04, .6245E-04, .1701E-03, .4936E-03, .1393E-02, .9581E-02, DATA 170
X .3740E-01, .1121E+00, .4593E+00, .7693E+00, .8770E+00, .1010E+02, DATA 180
X .9788E+01, .0, / DATA 190
DATA (XALP(K, 3,1),K=1,20)/
X .4750E-11, .2357E-11, .7888E-10, .2391E-08, .1854E-07, .8220E-07, DATA 200
X .6783E-06, .1340E-05, .9950E-05, .6032E-04, .3861E-03, .1226E-02, DATA 210
X .2435E-02, .2601E-02, .5654E-02, .5239E-02, .8991E-02, .1611E-05, DATA 220
XO, .0, / DATA 230
DATA (XLAM(K, 3,1),K=1,20)/
X .7805E-09, .1191E-07, .3140E-07, .1698E-06, .7808E-06, .4453E-05, DATA 240
X .1624E-04, .6349E-04, .1951E-03, .9275E-03, .7555E-02, .3455E-01, DATA 250
X .1381E+00, .3703E+00, .1792E+01, .5809E+01, .3458E+01, .1178E-03, DATA 260
XO, .0, / DATA 270
DATA (XALP(K, 4,1),K=1,20)/
X .4883E-11, .1903E-10, .9872E-10, .4300E-08, .1432E-07, .1350E-06, DATA 280
X .9369E-06, .5395E-05, .7592E-04, .1308E-02, .2671E-02, .9315E-02, DATA 290
X .7551E-03, .7696E-02, .9081E-02, .5847E-03, .7231E-04, .8844E-04, DATA 300
XO, .1824E-08, .0, / DATA 310
DATA (XLAM(K, 4,1),K=1,20)/
X .7499E-09, .2138E-07, .3127E-07, .1626E-06, .7559E-06, .5469E-05, DATA 320
X .2151E-04, .1349E-03, .5565E-03, .9635E-02, .4599E-01, .3322E+00, DATA 330
X .1206E+02, .8495E+00, .1442E+01, .9493E-02, .6678E-03, .1281E-02, DATA 340
X .1742E-06, .0, / DATA 350
DATA (XALP(K, 5,1),K=1,20)/
X .6292E-11, .1042E-09, .6666E-10, .2504E-08, .1152E-07, .6957E-06, DATA 360
X .1044E-04, .6635E-04, .1760E-01, .2071E-01, .2346E-01, .1872E-01, DATA 370
X .3231E-02, .6294E-02, .1352E-01, .5361E-06, .1231E-05, .0, DATA 380
XO, .0, / DATA 390
DATA (XLAM(K, 5,1),K=1,20)/
X .7685E-09, .2614E-07, .3809E-07, .1591E-06, .1020E-05, .8643E-05, DATA 400
X .1924E-03, .9142E-03, .1071E-01, .4203E+01, .3437E+01, .1116E-01, DATA 410
X .1991E-01, .1267E+00, .1096E+01, .9227E-05, .3095E-04, .0, DATA 420
XO, .0, / DATA 430
DATA (XALP(K, 6,1),K=1,20)/
X .7112E-11, .1540E-09, .6938E-10, .2156E-08, .5464E-08, .6190E-07, DATA 440
X .4927E-06, .2253E-05, .1857E-04, .6168E-04, .2965E-03, .1574E-02, DATA 450
X .3578E+00, .3686E+00, .2491E-01, .7847E-02, .2409E-02, .4072E-09, DATA 460
XO, .0, / DATA 470
DATA (XLAM(K, 6,1),K=1,20)/
X .7706E-09, .2641E-07, .4577E-07, .1623E-06, .9591E-06, .7049E-05, DATA 480
X .2044E-04, .6548E-04, .3281E-03, .1229E-02, .6261E-02, .1967E-01, DATA 490
X .1663E+00, .1708E+00, .2903E+00, .3439E+01, .1017E+02, .1777E-06, DATA 500
XO, .0, / DATA 510
DATA (XALP(K, 7,1),K=1,20)/
X .7264E-11, .1605E-09, .8736E-10, .8811E-09, .3714E-08, .1754E-06, DATA 520

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X .1339E-05, .2520E-05, .1466E-04, .4227E-04, .1311E-03, .8081E-03, DATA 650
X .1912E-02, .5576E-02, .3570E-02, .2204E-01, .1461E-01, .8132E-02, DATA 660
X .4068E-10, 0, DATA 670
DATA (XLAM(K, 7, 1), K=1, 20)/ DATA 680
X .7709E-09, .2619E-07, .3811E-07, .1811E-06, .1336E-05, .1290E-04, DATA 690
X .3986E-04, .1399E-03, .3666E-03, .1039E-02, .4132E-02, .1239E-01, DATA 700
X .3473E-01, .1258E+00, .1675E+00, .9831E+00, .1783E+01, .4127E+01, DATA 710
X .2837E-05, 0, DATA 720
DATA (XALP(K, 8, 1), K=1, 20)/ DATA 730
X .6463E-11, .1825E-09, .8885E-10, .3097E-09, .8137E-09, .2905E-08, DATA 740
X .1905E-08, .1107E-05, .1110E-05, .1731E-04, .4208E-04, .9869E-04, DATA 750
X .8968E-03, .2568E-02, .5091E-02, .1612E-01, .3812E-01, .3097E-01, DATA 760
XO, 0, DATA 770
DATA (XLAM(K, 8, 1), K=1, 20)/ DATA 780
X .7583E-09, .2675E-07, .3901E-07, .3983E-06, .9840E-06, .3216E-05, DATA 790
X .1486E-04, .4059E-04, .8726E-04, .3789E-03, .1079E-02, .3565E-02, DATA 800
X .1219E-01, .4522E-01, .1086E+00, .3837E+00, .3853E+01, .4879E+01, DATA 810
XO, 0, DATA 820
DATA (XALP(K, 9, 1), K=1, 20)/ DATA 830
X .4849E-11, .2136E-09, .6448E-10, .1028E-08, .6465E-07, .1052E-05, DATA 840
X .2872E-05, .2114E-02, .1843E-01, .7584E-02, .2210E-01, .2356E-02, DATA 850
X .3988E-03, .1578E-02, .1751E-10, 0, 0, 0, DATA 860
XO, 0, DATA 870
DATA (XLAM(K, 9, 1), K=1, 20)/ DATA 880
X .7314E-09, .2655E-07, .5161E-07, .1138E-05, .1148E-04, .3500E-04, DATA 890
X .1536E-03, .1078E-02, .1263E+00, .1502E+00, .7820E+00, .1131E-02, DATA 900
X .1823E-02, .1764E-01, .4980E-07, 0, 0, 0, DATA 910
XO, 0, DATA 920
DATA (XALP(K, 10, 1), K=1, 20)/ DATA 930
X .2949E-11, .1980E-09, .6559E-10, .5338E-09, .8019E-07, .1207E-05, DATA 940
X .2281E-04, .5828E-04, .4859E-03, .9572E-02, .1438E-01, .2216E-01, DATA 950
X .6902E-02, .9159E-07, .2522E-10, 0, 0, 0, DATA 960
XO, 0, DATA 970
DATA (XLAM(K, 10, 1), K=1, 20)/ DATA 980
X .7714E-09, .2751E-07, .3731E-07, .1322E-05, .1422E-04, .4057E-04, DATA 990
X .4868E-03, .1670E-02, .8908E-02, .4377E-01, .1733E+00, .1193E+01, DATA 1000
X .4579E-01, .2355E-02, .4412E-07, 0, 0, 0, DATA 1010
XO, 0, DATA 1020
DATA (XALP(K, 11, 1), K=1, 20)/ DATA 1030
X .1020E-11, .1452E-09, .7995E-10, .2193E-09, .2169E-06, .1707E-05, DATA 1040
X .2067E-04, .7755E-04, .6905E-03, .2517E-02, .1233E-01, .2177E-01, DATA 1050
X .4179E-02, .1870E-03, .8830E-06, .1946E-10, 0, 0, DATA 1060
XO, 0, DATA 1070
DATA (XLAM(K, 11, 1), K=1, 20)/ DATA 1080
X .7529E-09, .2621E-07, .3554E-07, .2239E-05, .2054E-04, .5446E-04, DATA 1090
X .5119E-03, .2029E-02, .1264E-01, .4546E-01, .1633E+00, .7341E+00, DATA 1100
X .8797E+01, .6310E-01, .6605E-04, .3456E-07, 0, 0, DATA 1110
XO, 0, DATA 1120
DATA (XALP(K, 12, 1), K=1, 20)/ DATA 1130
X .1903E-12, .1072E-09, .5483E-10, .1553E-09, .1454E-06, .1201E-05, DATA 1140
X .1695E-04, .5651E-04, .3952E-03, .4120E-02, .7799E-02, .1116E-01, DATA 1150
X .2257E-01, .2236E-02, .1368E-05, .6888E-11, 0, 0, DATA 1160
XO, 0, DATA 1170
DATA (XLAM(K, 12, 1), K=1, 20)/ DATA 1180
X .7383E-09, .2529E-07, .3435E-07, .2998E-05, .2031E-04, .5467E-04, DATA 1190
X .4681E-03, .1594E-02, .9282E-02, .4844E-01, .1677E+00, .2477E+00, DATA 1200
X .1378E+01, .8750E-01, .1320E-03, .2175E-07, 0, 0, DATA 1210
XO, 0, DATA 1220
DATA (XALP(K, 13, 1), K=1, 20)/ DATA 1230
X .1537E-12, .8363E-10, .2375E-10, .4104E-07, .6387E-06, .2477E-04, DATA 1240
X .1345E-02, .7314E-03, .4027E-02, .3552E-01, .2066E-01, .2439E-01, DATA 1250
X .1287E-02, .6659E-11, .7127E-10, 0, 0, 0, DATA 1260
XO, 0, DATA 1270
DATA (XLAM(K, 13, 1), K=1, 20)/ DATA 1280

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X .7277E-09, .2623E-07, .4445E-07, .1752E-04, .4300E-04, .6432E-03, DATA1290
X .3340E-02, .1420E-01, .6944E-01, .2643E+00, .2914E+00, .1245E+01, DATA1300
X .3420E-02, .4485E-07, .2409E-05, 0, 0, 0, DATA1310
XO, 0, /, DATA1320
DATA (XALP(K, 14, 1), K=1, 20)/, DATA1330
X .2727E-12, .4138E-10, .1706E-10, .1045E-10, .1495E-09, .1240E-07, DATA1340
X .1340E-05, .2917E-04, .5145E-04, .4355E-03, .1236E-01, .4517E-01, DATA1350
X .4570E-01, .2425E-01, .2114E-01, .2968E-01, .4287E-06, 0, DATA1360
XO, 0, /, DATA1370
DATA (XLAM(K, 14, 1), K=1, 20)/, DATA1380
X .7243E-09, .2441E-07, .3570E-07, .2328E-06, .3553E-05, .1636E-04, DATA1390
X .4797E-04, .5905E-03, .1357E-02, .6814E-02, .4479E-01, .6053E+00, DATA1400
X .3446E+01, .4152E+01, .6306E-01, .1055E+00, .8224E-04, 0, DATA1410
XO, 0, /, DATA1420
DATA (XALP(K, 15, 1), K=1, 20)/, DATA1430
X .4153E-12, .3579E-11, .1346E-11, .1425E-10, .3418E-09, .8996E-06, DATA1440
X .2150E-05, .4837E-04, .9929E-04, .3157E-03, .2987E-02, .3174E-01, DATA1450
X .1002E+00, .4835E-03, .3577E-01, .9453E-01, .1804E-05, 0, DATA1460
XO, 0, /, DATA1470
DATA (XLAM(K, 15, 1), K=1, 20)/, DATA1480
X .7098E-09, .2083E-07, .6657E-07, .2455E-06, .5361E-05, .3918E-04, DATA1490
X .5184E-04, .6238E-03, .1948E-02, .6540E-02, .2109E-01, .1171E+00, DATA1500
X .4571E+00, .3940E+01, .4790E+00, .1663E+01, .4392E-04, 0, DATA1510
XO, 0, /, DATA1520
DATA (XALP(K, 16, 1), K=1, 20)/, DATA1530
X .1360E-12, .2872E-11, .3918E-09, .1941E-06, .5200E-05, .4277E-04, DATA1540
X .3132E-03, .1951E+00, .4793E+00, .3067E+00, .7505E-01, .4923E-01, DATA1550
X .2039E-01, .8067E-12, .5015E-11, 0, 0, 0, DATA1560
XO, 0, /, DATA1570
DATA (XLAM(K, 16, 1), K=1, 20)/, DATA1580
X .7006E-09, .2105E-06, .9443E-05, .4775E-04, .5230E-03, .3298E-02, DATA1590
X .9846E-02, .7072E-01, .7851E-01, .8639E-01, .6381E+00, .1712E+01, DATA1600
X .7458E+00, .4439E-06, .1375E-05, 0, 0, 0, DATA1610
XO, 0, /, DATA1620
DATA (XALP(K, 17, 1), K=1, 20)/, DATA1630
X .3393E-13, .5026E-13, .1891E-12, .1251E-09, .7343E-09, .2219E-07, DATA1640
X .1196E-05, .2789E-04, .1550E-03, .1477E-01, .2050E-01, .1423E-01, DATA1650
X .2480E-01, .1599E-01, .5153E-08, 0, 0, 0, DATA1660
XO, 0, /, DATA1670
DATA (XLAM(K, 17, 1), K=1, 20)/, DATA1680
X .6959E-09, .2317E-06, .1891E-05, .1121E-04, .3562E-04, .7610E-04, DATA1690
X .4750E-02, .4628E-02, .2096E-01, .1399E+00, .6032E+00, .5545E+00, DATA1700
X .2415E+01, .3674E+01, .7165E-04, 0, 0, 0, DATA1710
XO, 0, /, DATA1720
DATA (XALP(K, 18, 1), K=1, 20)/, DATA1730
X 1.90934E-15, 5.36465E-14, 2.33181E-11, 2.77998E-10, 4.54551E-8, DATA1740
X 1.93885E-6, 8.71837E-5, 2.22677E-3, 5.98149E-3, 8.85817E-3, DATA1750
X 1.61727E-3, -2.36961E-10, -4.45492E-14, 7*0, /, DATA1760
DATA (XLAM(K, 18, 1), K=1, 20)/, DATA1770
X 7.06343E-10, 8.33849E-7, 1.16847E-5, 6.74779E-5, 1.36779E-3, DATA1780
X 4.87554E-3, 2.05905E-2, 7.64181E-2, 1.98977E-1, 1.04123, DATA1790
X 5.21095, 7.60620E-5, 9.28661E-7, 7*0, /, DATA1800
DATA (XALP(K, 19, 1), K=1, 20)/, DATA1810
XO, 0, 0, 0, 0, 0, DATA1820
XO, 0, 0, 0, 0, 0, DATA1830
XO, 0, 0, 0, 0, 0, DATA1840
XO, 0, /, DATA1850
DATA (XLAM(K, 19, 1), K=1, 20)/, DATA1860
XO, 0, 0, 0, 0, 0, DATA1870
XO, 0, 0, 0, 0, 0, DATA1880
XO, 0, 0, 0, 0, 0, DATA1890
XO, 0, /, DATA1900
C FITS FOR U-235 GAMMAS GROUPS 1 THROUGH 19
DATA (XALP(K, 1, 2), K=1, 20)/, DATA1905
DATA1910

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X .1228E-12, .4447E-12, .9405E-11, .3022E-09, .6528E-08, .3318E-07, DATA1920
X .9476E-06, .7533E-05, .6507E-04, .4818E-03, .8863E-03, .2132E-03, DATA1930
X-.3858E-05, .3226E-07, .4742E-07, O., O., O., DATA1940
XO. O. / DATA1950
DATA (XLAM(K, 1,2),K=1,20)/ DATA1960
X .8579E-09, .1275E-07, .3172E-07, .3403E-06, .1314E-05, .5054E-05, DATA1970
X .3283E-03, .1426E-02, .1041E-01, .4514E-01, .3187E+00, .4561E-01, DATA1980
X .1425E-02, .6742E-05, .3695E-04, O., O., O., DATA1990
XO. O. / DATA2000
DATA (XALP(K, 2,2),K=1,20)/ DATA2010
X .4090E-13, .2485E-11, .2304E-10, .1295E-08, .2774E-07, .4529E-07, DATA2020
X .6728E-06, .5744E-05, .9158E-05, .1127E-04, .1192E-03, .7323E-03, DATA2030
X .1619E-02, .9440E-02, .2279E-03, .4288E-08, O., O., DATA2040
XO. O. / DATA2050
DATA (XLAM(K, 2,2),K=1,20)/ DATA2060
X .4802E-08, .2080E-07, .3117E-07, .2722E-06, .2963E-05, .1461E-04, DATA2070
X .9231E-04, .4102E-03, .1158E-02, .3266E-02, .1323E-01, .4193E-01, DATA2080
X .1259E+00, .7269E+00, .1045E+02, .4334E-05, O., O., DATA2090
XO. O. / DATA2100
DATA (XALP(K, 3,2),K=1,20)/ DATA2110
X .4262E-14, .1991E-13, .3188E-15, .6465E-11, .5067E-08, .1193E-07, DATA2120
X .5075E-07, .1227E-06, .1918E-06, .1984E-04, .5503E-04, .1187E-03, DATA2130
X .9778E-03, .3131E-02, .1475E-01, .2059E-03, .7574E-02, .1270E-01, DATA2140
XO. O. / DATA2150
DATA (XLAM(K, 3,2),K=1,20)/ DATA2160
X .6144E-08, .9623E-08, .1542E-06, .1262E-06, .6485E-06, .1179E-05, DATA2170
X .3726E-05, .2662E-04, .1312E-04, .3288E-03, .1102E-02, .7011E-02, DATA2180
X .1899E-01, .9157E-01, .3912E+00, .1463E+02, .4043E+00, .1026E+01, DATA2190
XO. O. / DATA2200
DATA (XALP(K, 4,2),K=1,20)/ DATA2210
X .2064E-13, .8636E-12, .9578E-11, .3139E-08, .3769E-07, .5032E-06, DATA2220
X .1039E-05, .2068E-04, .8651E-04, .1204E-02, .7462E-02, .1001E+00, DATA2230
X-.8124E-01, .1455E+00, .1232E+00, .1243E-07, O., O., DATA2240
XO. O. / DATA2250
DATA (XLAM(K, 4,2),K=1,20)/ DATA2260
X .2121E-08, .9932E-08, .2363E-07, .2110E-06, .7255E-06, .1045E-04, DATA2270
X .4414E-04, .2598E-03, .1443E-02, .1353E-01, .7951E-01, .4185E+00, DATA2280
X .4654E+00, .2092E+01, .2209E+01, .7486E-06, O., O., DATA2290
XO. O. / DATA2300
DATA (XALP(K, 5,2),K=1,20)/ DATA2310
X .2574E-10, .7418E-11, .2867E-10, .1984E-07, .2611E-06, .1350E-05, DATA2320
X .1972E-04, .7089E-04, .3109E-03, .2301E-02, .8318E-02, .1851E+01, DATA2330
X-.1906E+01, .1591E+00, .6489E-01, .1156E-07, O., O., DATA2340
XO. O. / DATA2350
DATA (XLAM(K, 5,2),K=1,20)/ DATA2360
X .7376E-09, .1713E-07, .4871E-07, .1228E-06, .2894E-05, .1485E-04, DATA2370
X .1964E-03, .1152E-02, .4265E-02, .2561E-01, .1481E+00, .1395E+01, DATA2380
X .1437E+01, .3249E+01, .4622E+01, .1979E-06, O., O., DATA2390
XO. O. / DATA2400
DATA (XALP(K, 6,2),K=1,20)/ DATA2410
X .1259E-16, .2938E-12, .9255E-13, .7414E-08, .1273E-07, .4374E-07, DATA2420
X .1052E-05, .2150E-04, .2559E-04, .2235E-03, .8837E-03, .3410E-02, DATA2430
X .1101E-01, .4631E-01, .2531E-01, O., O., O., DATA2440
XO. O. / DATA2450
DATA (XLAM(K, 6,2),K=1,20)/ DATA2460
X .5695E-09, .2122E-07, .3302E-07, .5605E-06, .8313E-06, .4035E-05, DATA2470
X .3179E-04, .1608E-03, .2116E-03, .1521E-02, .1108E-01, .4970E-01, DATA2480
X .2147E+00, .9452E+00, .4542E+01, O., O., O., DATA2490
XO. O. / DATA2500
DATA (XALP(K, 7,2),K=1,20)/ DATA2510
X .9554E-17, .1803E-11, .2164E-13, .1910E-10, .3362E-09, .1093E-07, DATA2520
X .2442E-06, .7977E-06, .1458E-04, .1037E-03, .3971E-03, .2181E-02, DATA2530
X .5714E-02, .1870E-01, .3736E-01, .6221E-01, .4891E-01, O., DATA2540
XO. O. / DATA2550

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DATA (XLAM(K, 7,2),K=1,20)/
X .7047E-09, .2167E-07, .2207E-07, .3623E-06, .8302E-06, .2815E-05, DATA2560
X .1497E-04, .2924E-04, .1891E-03, .1162E-02, .6912E-02, .2700E-01, DATA2570
X .1068E+00, .4804E+00, .1129E+01, .2848E+01, .4440E+01, 0, DATA2580
XO, 0, DATA2590
DATA (XALP(K, 8,2),K=1,20)/
X .2433E-16, .3457E-13, .1720E-12, .3215E-10, .3094E-08, .2218E-07, DATA2600
X .8842E-07, .3442E-05, .1351E-04, .1040E-03, .2014E-02, .7000E-02, DATA2610
X .1128E+00, .3390E-01, .5434E+00, .5846E+00, .1887E-03, 0, DATA2620
XO, 0, DATA2630
DATA (XLAM(K, 8,2),K=1,20)/
X .1824E-08, .2029E-07, .3403E-07, .1420E-06, .1775E-05, .2891E-05, DATA2640
X .1268E-04, .5066E-04, .2003E-03, .1186E-02, .1179E-01, .9864E-01, DATA2650
X .8032E+00, .7183E+00, .2027E+01, .1897E+01, .1082E-01, 0, DATA2660
XO, 0, DATA2670
DATA (XALP(K, 9,2),K=1,20)/
X .2657E-17, .4743E-11, .2442E-11, .1499E-06, .1019E-04, .1913E-03, DATA2680
X .1784E-02, .8929E-02, .1433E-01, .6409E-02, .8391E-02, .2153E-03, DATA2690
X .1150E-03, .2028E-06, .1274E-06, .1911E-06, .7048E-06, 0, DATA2700
XO, 0, DATA2710
DATA (XLAM(K, 9,2),K=1,20)/
X .4328E-09, .2620E-07, .3741E-07, .6916E-06, .1507E-03, .6732E-03, DATA2720
X .1162E-01, .2082E+00, .1520E+01, .3379E-01, .3717E-01, .8070E-03, DATA2730
X .1756E-02, .8980E-06, .1065E-05, .8004E-05, .2568E-04, 0, DATA2740
XO, 0, DATA2750
DATA (XALP(K, 10,2),K=1,20)/
X .2671E-18, .1056E-12, .4417E-13, .1072E-11, .1159E-08, .1388E-08, DATA2760
X .4823E-06, .3281E-05, .1291E-04, .4864E-03, .3784E-02, .1598E-01, DATA2770
X .1040E+00, .1049E+00, .2317E-05, .4039E-03, .5889E-03, .2100E-02, DATA2780
XO, 0, DATA2790
DATA (XLAM(K, 10,2),K=1,20)/
X .6182E-10, .2175E-07, .2117E-06, .8332E-06, .2418E-05, .5228E-05, DATA2800
X .2323E-04, .1063E-03, .4402E-03, .1501E-02, .1246E+00, .4091E+00, DATA2810
X .1520E+01, .1693E+01, .4745E+02, .1485E-02, .1012E-01, .3991E-01, DATA2820
XO, 0, DATA2830
DATA (XALP(K, 11,2),K=1,20)/
X .2024E-18, .5844E-13, .6540E-10, .1507E-08, .2069E-08, .2169E-07, DATA2840
X .2723E-06, .2706E-05, .1521E-04, .5338E-04, .1569E-03, .6287E-03, DATA2850
X .1160E-02, .6638E-02, .1869E-01, .2948E-01, 0, 0, DATA2860
XO, 0, DATA2870
DATA (XLAM(K, 11,2),K=1,20)/
X .9974E-10, .2208E-07, .5904E-06, .2846E-05, .2872E-05, .2110E-04, DATA2880
X .2734E-04, .1085E-03, .4563E-03, .1452E-02, .6788E-02, .1403E-01, DATA2890
X .3474E-01, .1469E+00, .6451E+00, .1739E+01, 0, 0, DATA2900
XO, 0, DATA2910
DATA (XALP(K, 12,2),K=1,20)/
X .2671E-12, .3418E-10, .2562E-08, .3248E-09, .3678E-06, .2663E-05, DATA2920
X .2568E-04, .8103E-04, .1192E-02, .4033E-02, .8527E-02, .1476E+00, DATA2930
X .1415E+00, .1026E-10, 0, 0, 0, 0, DATA2940
XO, 0, DATA2950
DATA (XLAM(K, 12,2),K=1,20)/
X .2274E-07, .2879E-07, .2204E-05, .2203E-05, .4780E-04, .1152E-03, DATA2960
X .4940E-03, .2200E-02, .1736E-01, .9531E-01, .3754E+00, .4271E+01, DATA2970
X .4296E+01, .2996E-07, 0, 0, 0, 0, DATA2980
XO, 0, DATA2990
DATA (XALP(K, 13,2),K=1,20)/
X .8784E-13, .1050E-16, .1016E-15, .4116E-11, .9380E-09, .4627E-09, DATA3000
X .1670E-06, .2679E-05, .1391E-04, .6762E-04, .1035E-02, .5141E-02, DATA3010
X .1035E+00, .2308E-01, .1034E+00, 0, 0, 0, DATA3020
XO, 0, DATA3030
DATA (XLAM(K, 13,2),K=1,20)/
X .2174E-07, .1889E-07, .3614E-06, .4137E-06, .6352E-06, .2476E-05, DATA3040
X .4117E-04, .8088E-04, .3708E-03, .2403E-02, .1483E-01, .1085E+00, DATA3050
X .1296E+01, .3206E+01, .1609E+01, 0, 0, 0, DATA3060

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XO. DATA (XALP(K,14,2),K=1,20)/ DATA3200
X .4550E-13, .2863E-14, .3774E-09, .4319E-08, .4902E-06, .2073E-05, DATA3210
X .5159E-04, .1950E-03, .1111E-02, .3164E-02, .6179E-02, .1502E-04, DATA3220
X -.3800E-04, -.2081E-08, 0., 0., 0., 0., DATA3230
XO. DATA (XALP(K,15,2),K=1,20)/ DATA3240
X .2174E-07, .8104E-07, .9897E-06, .6300E-06, .5834E-04, .9839E-04, DATA3250
X .6065E-03, .4739E-02, .2031E-01, .9459E-01, .3370E+00, .1394E+02, DATA3260
X .6874E-03, .2182E-05, 0., 0., 0., 0., DATA3270
XO. DATA (XALP(K,16,2),K=1,20)/ DATA3280
X .2495E-13, .7280E-14, .7767E-10, .3281E-06, .3060E-05, .7557E-05, DATA3290
X .1161E-03, .1366E-02, .3349E-02, .1577E-01, .1207E-02, -.3044E-01, DATA3300
X .3383E-01, -.5577E-04, 0., 0., 0., 0., DATA3310
XO. DATA (XALP(K,17,2),K=1,20)/ DATA3320
X .2173E-07, .2794E-07, .6198E-06, .5951E-04, .2018E-03, .3211E-03, DATA3330
X .2357E-02, .1367E-01, .5757E-01, .2826E+00, .4177E+01, .1392E+01, DATA3340
X .1657E+01, .3513E+01, 0., 0., 0., 0., DATA3350
XO. DATA (XALP(K,18,2),K=1,20)/ DATA3360
X .6504E-14, .2.869E-18, .5.395E-13, .4.068E-11, .2.719E-07, .3.819E-06, DATA3370
X 5.467E-05, .2.832E-05, .1.781E-03, .5.359E-03, .1.624E-02, .2.948E-02, DATA3380
X -1.603E-02, .7.184E-03, -.2.691E-12, -.3.153E-11, 0., 0., DATA3390
XO. DATA (XALP(K,19,2),K=1,20)/ DATA3400
X .2173E-07, .2.188E-08, .4.266E-07, .6.412E-07, .7.441E-05, .1.887E-04, DATA3410
X 1.244E-03, .1.767E-03, .1.124E-02, .5.813E-02, .1.825E-01, .6.914E-01, DATA3420
X 1.777E+00, .4.474E+00, .6.246E-07, .3.729E-06, 0., 0., DATA3430
XO. DATA (XALP(K,20,2),K=1,20)/ DATA3440
X 2.168E-19, .6.995E-09, .2.267E-08, .1.791E-07, .5.588E-05, .2.432E-04, DATA3450
X 1.063E-03, .6.520E-03, .2.135E-02, .3.497E-03, -.1.341E-03, -.6.313E-09, DATA3460
X 8.807E-03, -.9.967E-03, 0., 0., 0., 0., DATA3470
XO. DATA (XALP(K,21,2),K=1,20)/ DATA3480
X 4.141E-06, .6.319E-05, .7.671E-05, .4.034E-04, .3.650E-03, .5.320E-03, DATA3490
X 1.907E-02, .9.780E-02, .5.200E-01, .1.119E+01, .1.931E-01, .3.985E-04, DATA3500
X 9.947E-02, .9.387E-02, 0., 0., 0., 0., DATA3510
XO. DATA (XALP(K,22,2),K=1,20)/ DATA3520
X 8.816E-20, .2.179E-15, .2.465E-13, .1.821E-07, .3.242E-05, .2.858E-04, DATA3530
X 2.039E-01, -.2.012E-01, .4.292E-03, -.2.908E-03, .9.703E-04, -.5.322E-04, DATA3540
X -6.367E-20, .2.267E-03, -.1.939E-03, .1.000E-20, 0., 0., DATA3550
XO. DATA (XALP(K,23,2),K=1,20)/ DATA3560
X 5.758E-06, .2.011E-04, .6.372E-04, .2.754E-03, .5.036E-03, .1.138E-02, DATA3570
X 2.014E-01, .2.022E-01, .4.014E-01, .4.045E-01, .1.201E+00, .1.824E+00, DATA3580
X 7.043E-06, .4.107E-02, .4.044E-02, .1.000E-05, 0., 0., DATA3590
XO. DATA (XALP(K,24,2),K=1,20)/ DATA3600
X 3.44840E-21, .8.39004E-21, .3.62256E-19, .4.63223E-17, .4.49234E-9, DATA3610
X 1.07130E-5, .1.31924E-5, .2.51500E-4, -.1.57334E-4, .8.27934E-5, DATA3620
X -1.63836E-5, -.9.44376E-21, 8*0., DATA3630
XO. DATA (XALP(K,25,2),K=1,20)/ DATA3640
X 4.26783E-6, .2.10226E-5, .2.05656E-4, .6.05335E-4, .5.32009E-3, DATA3650
X 8.59635E-3, .1.35035E-2, .187459, .325807, .956266, .1.13647, DATA3660
X 2.15828E-5, 8*0., DATA3670
C FITS FOR PU-239 BETAS GROUPS 1 AND 2 COMBINED INTO 1 DATA3680
XO. DATA (XALP(K,1,3),K=1,20)/ DATA3690
X .5119E-11, .5897E-10, .7550E-09, .3890E-08, .3120E-07, .8983E-07, DATA3700
X .2280E-06, .4645E-05, .2900E-04, .4929E-04, .2540E-03, .8475E-03, DATA3710
X .4021E-04, .3211E-04, .3215E-05, 0., 0., 0., DATA3720

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XO. ,O. / DATA3830
DATA (XLAM(K, 1,3),K=1,20)/ DATA3840
X .8882E-09, .1583E-07, .8552E-07, .2910E-06, .1431E-05, .6194E-05, DATA3850
X .2573E-04, .1800E-03, .8218E-03, .4258E-02, .1513E-01, .8165E-01, DATA3860
X .1433E+00, .4597E+00, .9689E+01, O. ,O. ,O. DATA3870
XO. ,O. / DATA3880
DATA (XALP(K, 2,3),K=1,20)/ DATA3890
X .6815E-11, .5074E-10, .8639E-09, .6740E-08, .2546E-07, .2057E-06, DATA3900
X .1088E-05, .7335E-05, .6070E-04, .1277E-03, .5421E-03, .1033E-02, DATA3910
X .8253E-03, .5389E-03, .6076E-04, O. ,O. ,O. DATA3920
XO. ,O. / DATA3930
DATA (XLAM(K, 2,3),K=1,20)/ DATA3940
X .7591E-09, .2618E-07, .1405E-06, .4525E-06, .1392E-05, .7443E-05, DATA3950
X .3189E-04, .1980E-03, .8686E-03, .5066E-02, .1791E-01, .5746E-01, DATA3960
X .2753E+00, .9173E+00, .4599E+01, O. ,O. ,O. DATA3970
XO. ,O. / DATA3980
DATA (XALP(K, 3,3),K=1,20)/ DATA3990
X .2331E-11, .6773E-10, .4448E-09, .6469E-08, .2265E-07, .1876E-06, DATA4000
X .9492E-06, .2378E-05, .2535E-04, .8596E-04, .4259E-03, .1130E-02, DATA4010
X .1605E-02, .2016E-02, .4068E-03, O. ,O. ,O. DATA4020
XO. ,O. / DATA4030
DATA (XLAM(K, 3,3),K=1,20)/ DATA4040
X .7847E-09, .2413E-07, .1174E-06, .4460E-06, .1391E-05, .7015E-05, DATA4050
X .2461E-04, .1012E-03, .3937E-03, .1494E-02, .8519E-02, .3219E-01, DATA4060
X .8691E-01, .5182E+00, .2517E+01, O. ,O. ,O. DATA4070
XO. ,O. / DATA4080
DATA (XALP(K, 4,3),K=1,20)/ DATA4090
X .2049E-11, .1108E-09, .5264E-09, .4655E-08, .2002E-07, .1850E-06, DATA4100
X .8825E-06, .3569E-05, .3391E-04, .6498E-04, .4854E-03, .1538E-02, DATA4110
X .3867E-02, .1255E-02, .7133E-05, O. ,O. ,O. DATA4120
XO. ,O. / DATA4130
DATA (XLAM(K, 4,3),K=1,20)/ DATA4140
X .7507E-09, .2418E-07, .1156E-06, .4219E-06, .1460E-05, .7192E-05, DATA4150
X .2458E-04, .1158E-03, .4870E-03, .1587E-02, .7846E-02, .2731E-01, DATA4160
X .1339E+00, .3199E+00, .6246E+00, O. ,O. ,O. DATA4170
XO. ,O. / DATA4180
DATA (XALP(K, 5,3),K=1,20)/ DATA4190
X .2439E-11, .1568E-09, .4441E-09, .2337E-08, .1279E-07, .1047E-06, DATA4200
X .4656E-06, .2064E-05, .2006E-04, .7338E-04, .5369E-03, .1655E-02, DATA4210
X .2997E-02, .6525E-02, .1815E-02, O. ,O. ,O. DATA4220
XO. ,O. / DATA4230
DATA (XLAM(K, 5,3),K=1,20)/ DATA4240
X .7504E-09, .2410E-07, .1074E-06, .3520E-06, .1432E-05, .6781E-05, DATA4250
X .1957E-04, .7239E-04, .3514E-03, .1307E-02, .7554E-02, .2869E-01, DATA4260
X .1045E+00, .4012E+00, .1983E+01, O. ,O. ,O. DATA4270
XO. ,O. / DATA4280
DATA (XALP(K, 6,3),K=1,20)/ DATA4290
X .2630E-11, .2006E-09, .2809E-09, .1345E-08, .6247E-08, .4608E-07, DATA4300
X .3230E-06, .1579E-05, .1667E-04, .6838E-04, .5111E-03, .1826E-02, DATA4310
X .3938E-02, .6417E-02, .1507E-02, O. ,O. ,O. DATA4320
XO. ,O. / DATA4330
DATA (XLAM(K, 6,3),K=1,20)/ DATA4340
X .7524E-09, .2402E-07, .9519E-07, .3138E-06, .1343E-05, .6853E-05, DATA4350
X .1819E-04, .6169E-04, .3381E-03, .1311E-02, .7685E-02, .2827E-01, DATA4360
X .1140E+00, .4672E+00, .2453E+01, O. ,O. ,O. DATA4370
XO. ,O. / DATA4380
DATA (XALP(K, 7,3),K=1,20)/ DATA4390
X .2669E-11, .2368E-09, .1117E-09, .6499E-09, .3244E-08, .2113E-07, DATA4400
X .2830E-06, .1318E-05, .1476E-04, .6597E-04, .4800E-03, .1977E-02, DATA4410
X .5113E-02, .8198E-02, .1718E-02, O. ,O. ,O. DATA4420
XO. ,O. / DATA4430
DATA (XLAM(K, 7,3),K=1,20)/ DATA4440
X .7529E-09, .2395E-07, .7533E-07, .3016E-06, .1357E-05, .6895E-05, DATA4450
X .1905E-04, .5995E-04, .3314E-03, .1306E-02, .7605E-02, .2859E-01, DATA4460

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X .1199E+00, .4470E+00, .3161E+01, 0, 0, 0, DATA4470
XO, 0, DATA4480
DATA (XALP(K, 8, 3), K=1, 20)/ DATA4490
X .2420E-11, .2604E-09, .3715E-10, .3381E-09, .1968E-08, .1364E-07, DATA4500
X .2439E-06, .1116E-05, .1347E-04, .6335E-04, .4102E-03, .1905E-02, DATA4510
X .7426E-02, .1102E-01, .2431E-02, 0, 0, 0, DATA4520
XO, 0, DATA4530
DATA (XLAM(K, 8, 3), K=1, 20)/ DATA4540
X .7532E-09, .2386E-07, .5222E-07, .3842E-06, .1474E-05, .7069E-05, DATA4550
X .1943E-04, .5450E-04, .3417E-03, .1313E-02, .7243E-02, .2757E-01, DATA4560
X .1317E+00, .5374E+00, .1742E+01, 0, 0, 0, DATA4570
XO, 0, DATA4580
DATA (XALP(K, 9, 3), K=1, 20)/ DATA4590
X .1878E-11, .2680E-09, .3369E-10, .1866E-09, .1196E-08, .6570E-08, DATA4600
X .1778E-06, .8040E-06, .1244E-04, .6067E-04, .3749E-03, .1892E-02, DATA4610
X .7177E-02, .1117E-01, .2441E-02, 0, 0, 0, DATA4620
XO, 0, DATA4630
DATA (XLAM(K, 9, 3), K=1, 20)/ DATA4640
X .7537E-09, .2377E-07, .5089E-07, .4034E-06, .1600E-05, .6887E-05, DATA4650
X .1972E-04, .4704E-04, .3563E-03, .1310E-02, .7270E-02, .2882E-01, DATA4660
X .1275E+00, .4606E+00, .2457E+01, 0, 0, 0, DATA4670
XO, 0, DATA4680
DATA (XALP(K, 10, 3), K=1, 20)/ DATA4690
X .1158E-11, .2582E-09, .3229E-10, .9044E-10, .5239E-09, .3076E-08, DATA4700
X .1804E-06, .6059E-06, .1017E-04, .5633E-04, .3146E-03, .1642E-02, DATA4710
X .7810E-02, .1161E-01, .4786E-02, 0, 0, 0, DATA4720
XO, 0, DATA4730
DATA (XLAM(K, 10, 3), K=1, 20)/ DATA4740
X .7549E-09, .2362E-07, .4904E-07, .3593E-06, .1570E-05, .6889E-05, DATA4750
X .2091E-04, .4810E-04, .3897E-03, .1238E-02, .7345E-02, .2806E-01, DATA4760
X .1257E+00, .4593E+00, .4158E+01, 0, 0, 0, DATA4770
XO, 0, DATA4780
DATA (XALP(K, 11, 3), K=1, 20)/ DATA4790
X .4893E-12, .2324E-09, .2848E-10, .3249E-10, .1059E-09, .2470E-08, DATA4800
X .1398E-06, .4286E-06, .9132E-05, .5456E-04, .2526E-03, .1547E-02, DATA4810
X .8177E-02, .1284E-01, .4237E-02, 0, 0, 0, DATA4820
XO, 0, DATA4830
DATA (XLAM(K, 11, 3), K=1, 20)/ DATA4840
X .7587E-09, .2344E-07, .4668E-07, .2829E-06, .1664E-05, .8128E-05, DATA4850
X .2152E-04, .4695E-04, .4246E-03, .1236E-02, .7192E-02, .2789E-01, DATA4860
X .1323E+00, .4483E+00, .4122E+01, 0, 0, 0, DATA4870
XO, 0, DATA4880
DATA (XALP(K, 12, 3), K=1, 20)/ DATA4890
X .1915E-12, .1950E-09, .2300E-10, .2236E-10, .2488E-09, .3744E-07, DATA4900
X .3702E-08, .8964E-05, .5010E-04, .1958E-03, .1476E-02, .7887E-02, DATA4910
X .1339E-01, .4395E-02, 0, 0, 0, 0, DATA4920
XO, 0, DATA4930
DATA (XLAM(K, 12, 3), K=1, 20)/ DATA4940
X .7652E-09, .2320E-07, .5096E-07, .3528E-06, .3786E-05, .1540E-04, DATA4950
X .3900E-04, .4844E-03, .1274E-02, .6800E-02, .2764E-01, .1371E+00, DATA4960
X .4143E+00, .3473E+01, 0, 0, 0, 0, DATA4970
XO, 0, DATA4980
DATA (XALP(K, 13, 3), K=1, 20)/ DATA4990
X .1704E-12, .1474E-09, .1561E-10, .1592E-10, .1887E-09, .2041E-07, DATA5000
X .3010E-06, .9338E-05, .4301E-04, .1146E-03, .1512E-02, .7586E-02, DATA5010
X .1418E-01, .4085E-02, 0, 0, 0, 0, DATA5020
XO, 0, DATA5030
DATA (XLAM(K, 13, 3), K=1, 20)/ DATA5040
X .7606E-09, .2289E-07, .4910E-07, .2551E-06, .4225E-05, .1492E-04, DATA5050
X .4040E-04, .5009E-03, .1338E-02, .5592E-02, .2749E-01, .1422E+00, DATA5060
X .4899E+00, .3028E+01, 0, 0, 0, 0, DATA5070
XO, 0, DATA5080
DATA (XALP(K, 14, 3), K=1, 20)/ DATA5090
X .3008E-12, .1551E-09, .1037E-10, .2433E-10, .2786E-09, .9032E-08, DATA5100

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X .4663E-06, .1672E-04, .6538E-04, .2303E-03, .2097E-02, .1452E-01, DATA5110
X .2618E-01, .9535E-02, .0, .0, .0, .0, DATA5120
XO, .0, /, DATA5130
DATA (XLAM(K, 14, 3), K=1, 20)/, DATA5140
X .7514E-09, .2224E-07, .4785E-07, .2477E-06, .4257E-05, .1270E-04, DATA5150
X .4199E-04, .5579E-03, .1284E-02, .6216E-02, .2640E-01, .1376E+00, DATA5160
X .4918E+00, .3000E+01, .0, .0, .0, .0, DATA5170
XO, .0, /, DATA5180
DATA (XALP(K, 15, 3), K=1, 20)/, DATA5190
X .4543E-12, .3983E-10, .8334E-11, .2808E-10, .1169E-09, .6576E-08, DATA5200
X .5397E-06, .2329E-04, .8706E-04, .4345E-03, .3394E-02, .3286E-01, DATA5210
X .5802E-01, .1363E-01, .0, .0, .0, .0, DATA5220
XO, .0, /, DATA5230
DATA (XLAM(K, 15, 3), K=1, 20)/, DATA5240
X .7371E-09, .2121E-07, .9686E-07, .2722E-06, .3451E-05, .1211E-04, DATA5250
X .5192E-04, .5555E-03, .1414E-02, .7911E-02, .3107E-01, .1565E+00, DATA5260
X .7539E+00, .1432E+01, .0, .0, .0, .0, DATA5270
XO, .0, /, DATA5280
DATA (XALP(K, 16, 3), K=1, 20)/, DATA5290
X 1.453E-13, 6.189E-12, 6.941E-12, 3.335E-10, 3.960E-09, 2.716E-07, DATA5300
X 1.927E-06, 4.636E-06, 7.133E-05, 5.462E-04, 1.437E-02, ., DATA5310
X 4.122E-02, 1.510E-02, .0, .0, .0, .0, DATA5320
XO, .0, /, DATA5330
DATA (XLAM(K, 16, 3), K=1, 20)/, DATA5340
X 6.892E-10, 2.079E-07, 1.675E-06, 8.784E-06, 2.069E-05, 7.051E-05, DATA5350
X 4.956E-04, 1.579E-03, 7.532E-03, 2.272E-02, 1.325E-01, 6.950E-01, DATA5360
X 1.797E+00, .0, .0, .0, .0, .0, DATA5370
XO, .0, /, DATA5380
DATA (XALP(K, 17, 3), K=1, 20)/, DATA5390
X 3.722E-14, 8.313E-13, 4.292E-10, 1.992E-08, 1.150E-06, 2.139E-05, DATA5400
X 9.618E-05, 1.830E-03, 1.120E-02, 3.234E-02, -1.431E-02, 7.555E-03, DATA5410
X -4.665E-03, -1.395E-08, -1.568E-12, 1.454E-12, .0, ., DATA5420
XO, .0, /, DATA5430
DATA (XLAM(K, 17, 3), K=1, 20)/, DATA5440
X 7.203E-10, 3.787E-07, 1.307E-05, 6.274E-05, 1.595E-03, 8.367E-03, DATA5450
X 3.223E-02, 9.089E-02, 2.464E-01, 1.048E+00, 6.151E-01, 5.771E+00, DATA5460
X 2.811E+00, 6.510E-05, 5.143E-0, 3.850E-07, .0, ., DATA5470
XO, .0, /, DATA5480
DATA (XALP(K, 18, 3), K=1, 20)/, DATA5490
X 2.02247E-15, 4.26636E-13, 8.99431E-10, 5.76412E-8, 2.47780E-6, ., DATA5500
X 5.85628E-5, 1.03751E-3, 3.19925E-3, 1.15261E-2, -6.31111E-3, ., DATA5510
X 2.85479E-3, -1.53200E-3, -9.53371E-10, 4.09241E-10, -2.67547E-13, ., DATA5520
X 5*0./, DATA5530
DATA (XLAM(K, 18, 3), K=1, 20)/, DATA5540
X 6.81882E-10, 6.30735E-7, 1.63083E-5, 1.52073E-3, 6.16627E-3, ., DATA5550
X 1.97103E-2, 7.39598E-2, 1.74214E-1, .793894, .890645, ., DATA5560
X 2.87581, 3.57001, 1.75916E-5, 3.26377E-5, 6.3666E-7, 5*0./, DATA5570
DATA (XALP(K, 19, 3), K=1, 20)/, DATA5580
XO, .0, .0, .0, .0, .0, DATA5590
XO, .0, .0, .0, .0, .0, DATA5600
XO, .0, .0, .0, .0, .0, DATA5610
XO, .0, /, DATA5620
DATA (XLAM(K, 19, 3), K=1, 20)/, DATA5630
XO, .0, .0, .0, .0, .0, DATA5640
XO, .0, .0, .0, .0, .0, DATA5650
XO, .0, .0, .0, .0, .0, DATA5660
XO, .0, /, DATA5670
C FITS FOR PU-239 GAMMAS GROUPS 1 THROUGH 19, DATA5675
DATA (XALP(K, 1, 4), K=1, 20)/, DATA5680
X .1675E-12, .5868E-12, .6533E-11, .1563E-09, .2942E-08, .1025E-07, DATA5690
X .7436E-08, .3483E-07, .9955E-06, .4669E-05, .2706E-04, .1908E-03, DATA5700
X .5654E-03, .6856E-01, -.7029E-01, .4682E-02, -.2124E-02, .0, DATA5710
XO, .0, /, DATA5720
DATA (XLAM(K, 1, 4), K=1, 20)/, DATA5730

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X .1053E-08, .7491E-08, .3193E-07, .2533E-06, .9501E-06, .2326E-05, DATA5740
X .9554E-05, .9956E-04, .3260E-03, .1420E-02, .6438E-02, .1786E-01, DATA5750
X .9085E-01, .1582E+01, .1659E+01, .4954E+01, .7501E+01, 0, DATA5760
XO, 0, /, DATA5770
DATA (XALP(K, 2, 4), K=1, 20)/, DATA5780
X .1895E-12, .7624E-12, .1603E-10, .1104E-08, .2778E-07, .5213E-07, DATA5790
X .7963E-06, .5556E-05, .1684E-04, .8240E-04, .8442E-03, .2436E-02, DATA5800
X .2005E-01, .8527E-02, .4437E-08, 0, 0, 0, DATA5810
XO, 0, /, DATA5820
DATA (XLAM(K, 2, 4), K=1, 20)/, DATA5830
X .4578E-08, .1647E-07, .2997E-07, .2627E-06, .2903E-05, .1534E-04, DATA5840
X .1357E-03, .4019E-03, .1534E-02, .7615E-02, .4544E-01, .2401E+00, DATA5850
X .1396E+01, .1596E+01, .5917E-05, 0, 0, 0, DATA5860
XO, 0, /, DATA5870
DATA (XALP(K, 3, 4), K=1, 20)/, DATA5880
X .1904E-13, .8134E-13, .7531E-13, .1019E-10, .5421E-08, .1798E-07, DATA5890
X .6339E-07, .3285E-06, .2898E-06, .2682E-04, .4978E-04, .5306E-03, DATA5900
X .1899E-01, .1015E+00, .1124E+00, .2311E-01, .1205E-01, .1644E-01, DATA5910
XO, 0, /, DATA5920
DATA (XLAM(K, 3, 4), K=1, 20)/, DATA5930
X .6098E-08, .1012E-07, .3884E-07, .1499E-06, .6605E-06, .1235E-05, DATA5940
X .4014E-05, .1366E-04, .3175E-04, .4061E-03, .8420E-03, .9422E-02, DATA5950
X .8051E-01, .7403E+01, .6864E+01, .9396E-01, .1646E+00, .2363E+01, DATA5960
XO, 0, /, DATA5970
DATA (XALP(K, 4, 4), K=1, 20)/, DATA5980
X .1580E-12, .1981E-10, .1081E-09, .7883E-08, .3127E-07, .4183E-06, DATA5990
X .1132E-05, .1938E-04, .4860E-04, .1030E-03, .5790E-03, .6223E-03, DATA6000
X .1028E-01, .3843E-01, .1548E-01, .4805E-02, .2382E-02, .5746E-08, DATA6010
XO, 0, /, DATA6020
DATA (XLAM(K, 4, 4), K=1, 20)/, DATA6030
X .4501E-08, .1410E-07, .2817E-07, .2249E-06, .8420E-06, .1010E-04, DATA6040
X .4560E-04, .2835E-03, .9431E-03, .3519E-02, .1204E-01, .2756E-01, DATA6050
X .1147E+00, .5050E+00, .5633E+00, .2563E+01, .4641E+01, .7773E-06, DATA6060
XO, 0, /, DATA6070
DATA (XALP(K, 5, 4), K=1, 20)/, DATA6080
X .2743E-10, .1232E-10, .7873E-10, .1462E-07, .3050E-06, .8594E-06, DATA6090
X .2487E-05, .2047E-04, .3840E-04, .1538E-03, .4903E-03, .2285E-02, DATA6100
X .1239E-01, .5805E-01, .1241E+00, .7718E-01, .4958E-03, .7299E-08, DATA6110
XO, 0, /, DATA6120
DATA (XLAM(K, 5, 4), K=1, 20)/, DATA6130
X .7278E-09, .1087E-07, .2966E-07, .1240E-06, .2826E-05, .1520E-04, DATA6140
X .8046E-04, .2516E-03, .9024E-03, .2905E-02, .1092E-01, .4341E-01, DATA6150
X .2716E+00, .2337E+01, .4393E+01, .5731E+01, .2642E+00, .1969E-06, DATA6160
XO, 0, /, DATA6170
DATA (XALP(K, 6, 4), K=1, 20)/, DATA6180
X .6121E-15, .3415E-11, .3061E-11, .1473E-07, .4877E-07, .4367E-06, DATA6190
X .2233E-04, .3467E-04, .1332E-03, .3924E-03, .7549E-02, .2176E-01, DATA6200
X .2077E-01, .1701E-01, .1686E-01, 0, 0, 0, DATA6210
XO, 0, /, DATA6220
DATA (XLAM(K, 6, 4), K=1, 20)/, DATA6230
X .2209E-08, .2162E-07, .1876E-06, .6308E-06, .2943E-05, .2015E-04, DATA6240
X .1506E-03, .3421E-03, .1381E-02, .6926E-02, .4757E-01, .5772E+00, DATA6250
X .3649E+01, .6936E-01, .9324E-01, 0, 0, 0, DATA6260
XO, 0, /, DATA6270
DATA (XALP(K, 7, 4), K=1, 20)/, DATA6280
X .3386E-15, .1891E-10, .1015E-11, .5966E-09, .1488E-08, .1405E-07, DATA6290
X .9464E-07, .9313E-06, .1396E-04, .7180E-04, .1907E-03, .1327E-02, DATA6300
X .4988E-02, .2417E-01, .1155E-01, .3024E-02, .6802E-04, 0, DATA6310
XO, 0, /, DATA6320
DATA (XLAM(K, 7, 4), K=1, 20)/, DATA6330
X .1872E-08, .2159E-07, .3497E-07, .5608E-06, .1414E-05, .3147E-05, DATA6340
X .1136E-04, .3355E-04, .2250E-03, .9838E-03, .4337E-02, .2133E-01, DATA6350
X .1000E+00, .5331E+00, .1364E+01, .2902E+01, .3011E-01, 0, DATA6360
XO, 0, /, DATA6370

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DATA (XALP(K, 8, 4), K=1, 20)/
X .1035E-14, .1086E-12, .3401E-12, .1555E-10, .3557E-09, .2170E-07, DATA6380
X .2566E-07, .1673E-05, .9010E-05, .4957E-04, .1260E-03, .1326E-02, DATA6390
X .2244E-02, .9506E-02, .1301E-01, .1261E-03, 0, .0, DATA6400
XO, 0, DATA6410
DATA (XLAM(K, 8, 4), K=1, 20)/
X .2421E-08, .1670E-07, .3130E-07, .1495E-06, .6177E-06, .2425E-05, DATA6420
X .5153E-05, .4161E-04, .1913E-03, .7425E-03, .2879E-02, .1422E-01, DATA6430
X .6297E-01, .2560E+00, .8232E+00, .1514E+02, 0, .0, DATA6440
XO, 0, DATA6450
DATA (XALP(K, 9, 4), K=1, 20)/
X .6011E-16, .3490E-11, .3876E-11, .6253E-06, .7373E-04, .1356E-02, DATA6460
X .1885E-02, .6279E-02, .1381E-01, .7309E-02, .2441E-02, .4071E-02, DATA6470
X .2959E-04, .1626E-03, .1617E-05, .9953E-06, .8030E-06, .2093E-06, DATA6480
X .1985E-06, 0, DATA6490
DATA (XLAM(K, 9, 4), K=1, 20)/
X .1414E-08, .2207E-07, .3063E-07, .7440E-06, .3949E-03, .1522E-01, DATA6500
X .7589E-01, .2278E+00, .7323E+00, .5955E+00, .1533E+01, .2331E+01, DATA6510
X .4123E-03, .3979E-02, .8158E-06, .8456E-06, .4587E-04, .1344E-05, DATA6520
X .1884E-05, 0, DATA6530
DATA (XALP(K, 10, 4), K=1, 20)/
X .1420E-17, .1126E-11, .2791E-12, .8436E-11, .1764E-08, .2082E-07, DATA6540
X .4911E-06, .4814E-05, .1441E-04, .5855E-04, .2359E-03, .1169E-02, DATA6550
X .1270E-01, .8152E-02, .8864E-02, .5294E-02, .2934E-02, .1143E-02, DATA6560
XO, 0, DATA6570
DATA (XLAM(K, 10, 4), K=1, 20)/
X .1549E-09, .2180E-07, .2003E-06, .7512E-06, .2556E-05, .1121E-04, DATA6580
X .2763E-04, .1758E-03, .5645E-03, .1182E-02, .7098E-02, .2469E-01, DATA6590
X .1117E+00, .1193E+00, .3794E+00, .1297E+01, .4467E+01, .3307E+01, DATA6600
XO, 0, DATA6610
DATA (XALP(K, 11, 4), K=1, 20)/
X .9696E-18, .6832E-12, .1720E-09, .3996E-08, .4361E-07, .6644E-06, DATA6620
X .7149E-05, .4754E-04, .1041E-03, .7792E-03, .1092E-02, .4851E-02, DATA6630
X .1016E-01, .4740E-02, .3880E-02, 0, .0, .0, DATA6640
XO, 0, DATA6650
DATA (XLAM(K, 11, 4), K=1, 20)/
X .9565E-10, .2180E-07, .5658E-06, .2702E-05, .1756E-04, .6416E-04, DATA6660
X .2874E-03, .1009E-02, .4623E-02, .1667E-01, .3861E-01, .1740E+00, DATA6670
X .5496E+00, .1163E+01, .2173E+01, 0, .0, .0, DATA6680
XO, 0, DATA6690
DATA (XALP(K, 12, 4), K=1, 20)/
X .9394E-11, .5163E-15, .1838E-11, .9985E-10, .5056E-11, .3573E-08, DATA6700
X .3964E-06, .9300E-05, .4799E-04, .1216E-03, .1386E-02, .5089E-02, DATA6710
X .3932E-02, .4930E-02, .6688E-02, .3144E-05, 0, .0, DATA6720
XO, 0, DATA6730
DATA (XLAM(K, 12, 4), K=1, 20)/
X .2465E-07, .3071E-07, .9914E-07, .3122E-06, .1260E-05, .2072E-05, DATA6740
X .5483E-04, .2280E-03, .8095E-03, .4200E-02, .2219E-01, .1688E+00, DATA6750
X .5132E+00, .3755E+01, .2049E+01, .1940E-03, 0, .0, DATA6760
XO, 0, DATA6770
DATA (XALP(K, 13, 4), K=1, 20)/
X .9396E-12, .2560E-15, .1045E-11, .8002E-09, .2344E-09, .1830E-08, DATA6780
X .7367E-06, .9824E-05, .3303E-04, .2582E-03, .1420E-02, .5593E-02, DATA6790
X .4160E-02, .4263E-02, .5712E-02, .4260E-05, 0, .0, DATA6800
XO, 0, DATA6810
DATA (XLAM(K, 13, 4), K=1, 20)/
X .2179E-07, .3071E-07, .3544E-06, .6192E-06, .1211E-05, .5411E-05, DATA6820
X .5950E-04, .2018E-03, .9124E-03, .7439E-02, .2534E-01, .2142E+00, DATA6830
X .6752E+00, .4459E+01, .2545E+01, .1683E-03, 0, .0, DATA6840
XO, 0, DATA6850
DATA (XALP(K, 14, 4), K=1, 20)/
X .4848E-12, .1252E-14, .3612E-15, .3374E-08, .1407E-06, .4232E-05, DATA6860
X .4572E-04, .5981E-03, .7497E-03, .4713E-02, .3493E-02, .1039E-02, DATA6870
X .6771E-03, .5645E-03, .1469E-04, .1990E-06, .2004E-06, 0, DATA6880

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XO. ,O. / DATA7020
DATA (XLAM(K,14,4),K=1,20)/ DATA7030
X .2178E-07, .2263E-07, .2264E-07, .6139E-06, .4253E-04, .1602E-03, DATA7040
X .8998E-03, .1206E-01, .4243E-01, .2018E+00, .7063E+00, .1277E+01, DATA7050
X .2275E+01, .3738E+01, .7934E-03, .1692E-05, .1705E-05, O. DATA7060
XO. ,O. / DATA7070
DATA (XALP(K,15,4),K=1,20)/ DATA7080
X .2680E-12, .4346E-14, .7312E-10, .2684E-12, .6776E-06, .1388E-05, DATA7090
X .6886E-05, .4367E-04, .1070E-01, .1098E-01, .2709E-02, .5040E-02, DATA7100
X .1087E-01, .5809E-02, .1904E-03, O. ,O. ,O. DATA7110
XO. ,O. / DATA7120
DATA (XLAM(K,15,4),K=1,20)/ DATA7130
X .2179E-07, .2553E-07, .6240E-06, .6835E-05, .1993E-04, .1158E-03, DATA7140
X .3099E-03, .1240E-02, .1038E-01, .1074E-01, .2116E-01, .1682E+00, DATA7150
X .5767E+00, .1301E+01, .1162E+02, O. ,O. ,O. DATA7160
XO. ,O. / DATA7170
DATA (XALP(K,16,4),K=1,20)/ DATA7180
X .6978E-13, .6465E-16, .3321E-10, .1827E-06, .1733E-05, .3355E-04, DATA7190
X .1392E-03, .2059E-02, .3501E-02, .1461E-01, .1852E-10, O. DATA7200
XO. ,O. ,O. ,O. ,O. ,O. DATA7210
XO. ,O. / DATA7220
DATA (XLAM(K,16,4),K=1,20)/ DATA7230
X .2179E-07, .3507E-07, .6308E-06, .9524E-04, .1474E-03, .7336E-03, DATA7240
X .3629E-02, .1808E-01, .8523E-01, .2323E+00, .3354E-05, O. DATA7250
XO. ,O. ,O. ,O. ,O. ,O. DATA7260
XO. ,O. / DATA7270
DATA (XALP(K,17,4),K=1,20)/ DATA7280
X 7.781E-19, 8.311E-09, 2.357E-08, 1.956E-07, 1.681E-06, 1.591E-04, DATA7290
X 7.875E-04, 1.763E-03, 4.693E-03, 4.702E-05, 2.463E-05, O.0 DATA7300
XO. ,O. ,O. ,O. ,O. ,O. DATA7310
XO. ,O. / DATA7320
DATA (XLAM(K,17,4),K=1,20)/ DATA7330
X 4.142E-06, 6.800E-05, 1.478E-04, 6.896E-04, 5.208E-03, 5.207E-03, DATA7340
X 2.489E-02, 1.236E-01, .2862E+00, .9943E+00, .1620E+02, O. DATA7350
XO. ,O. ,O. ,O. ,O. ,O. DATA7360
XO. ,O. / DATA7370
DATA (XALP(K,18,4),K=1,20)/ DATA7380
X 1.200E-19, 3.004E-15, 1.191E-12, 2.959E-7, 2.493E-5, 2.012E-4, DATA7390
X 9.907E-6, 1.325E-3, 1.418E-3, -1.811E-20, O.0, O.0, O. DATA7400
XO. ,O. ,O. ,O. ,O. ,O. DATA7410
XO. ,O. / DATA7420
DATA (XLAM(K,18,4),K=1,20)/ DATA7430
X 4.289E-06, 2.022E-04, 6.552E-04, 3.006E-03, 6.336E-03, 1.921E-02, DATA7440
X 3.258E-02, 1.539E-01, 9.212E-01, 5.945E-06, O.0 ,O.0 DATA7450
XO. ,O. ,O. ,O. ,O. ,O. DATA7460
XO. ,O. / DATA7470
DATA (XALP(K,19,4),K=1,20)/ DATA7480
X 1.85545E-20, 3.30519E-17, 5.72023E-16, 3.86898E-6, 1.02786E-5, DATA7490
X 1.23228E-4, -4.42133E-5, 2.57210E-5, -6.96988E-6, -2.50522E-6, DATA7500
X -7.29476E-21, 2.15247E-20, 8*0. / DATA7510
DATA (XLAM(K,19,4),K=1,20)/ DATA7520
X 4.57245E-6, 4.41793E-4, 8.97811E-4, 8.03833E-3, 1.22545E-2, DATA7530
X 1.99914E-1, 2.53015E-1, 1.11151, 2.76967, 1.33733E-2, DATA7540
X 6.83542E-6, 6.22339E-5, 8*0. / DATA7550
DATA KTRM/ DATA7560
X18, 19, 18, 19, 17, 18, 19, 18, 15, 15, 16, 16, 15, 17, 17, 15, 13, O, 15, 16, DATA7570
X18, 16, 16, 15, 17, 17, 17, 18, 18, 14, 15, 14, 14, 16, 14, 16, 12, 15, 15, 15, DATA7580
X15, 15, 15, 15, 15, 15, 14, 14, 13, 14, 13, 16, 15, O, 17, 15, 18, 18, 18, 15, DATA7590
X17, 16, 19, 18, 15, 16, 16, 17, 15, 11, 11, 10, 12/ DATA7600
END DATA7610
SUBROUTINE SETUP (X1,Y1,L1,TL,NT,XL,NX,YL,NY,ITYPE,IMK,ICON,IGRO) SETU 10
REAL X1(L1),Y1(L1) SETU 20
INTEGER TL(2), XL(2), YL(2) SETU 30
DATA XPAGE, YPAGE /6.,6./ SETU 40

```

CALL BGNPL (-1)	SETU 50
CALL NOBRDR	SETU 60
CALL PAGE (XPAGE,YPAGE)	SETU 70
XG=XPAGE-1.7	SETU 80
YG=YPAGE-1.7	SETU 90
HITE=.03*YG	SETU 100
CALL HEIGHT (HITE)	SETU 110
CALL SCMPLEX	SETU 120
CALL MX1ALF(5HSTAND,1H>)	SETU 130
CALL MX2ALF(5HL/CST,1H<)	SETU 140
CALL MX3ALF(5HINSTR,1H#)	SETU 150
XLEFT=XRIGHT=X1(1)	SETU 160
YTOP=YBOT=Y1(1)	SETU 170
DO 5 I=2,L1	SETU 180
IF(X1(I).LT.XLEFT) XLEFT=X1(I)	SETU 190
IF(X1(I).GT.XRIGHT) XRIGHT=X1(I)	SETU 200
IF(Y1(I).LT.YBOT) YBOT=Y1(I)	SETU 210
IF(Y1(I).GT.YTOP) YTOP=Y1(I)	SETU 220
5 CONTINUE	SETU 230
IF(ITYPE.LT.3) GO TO 6	SETU 240
TDP=ALOG10(XRIGHT)	SETU 250
IF(TOP.GE.O.) XRIGHT=10.**IFIX(TOP+.99)	SETU 260
IF(TOP.LT.O.) XRIGHT=10.**IFIX(TOP)	SETU 270
IF(XLEFT.NE.O.O) GO TO 6	SETU 280
XLEFT=10.**IFIX(TOP-15.)	SETU 290
6 IF(ITYPE.NE.2.AND.ITYPE.NE.4) GO TO 7	SETU 300
TDP=ALOG10(YTOP)	SETU 310
IF(TOP.GE.O.) YTOP=10.**IFIX(TOP+.99)	SETU 320
IF(TOP.LT.O.) YTOP=10.**IFIX(TOP)	SETU 330
IF(YBOT.GT.O.O) GO TO 7	SETU 340
YBOT=10.**IFIX(TOP-15.)	SETU 350
7 IF (ITYPE.NE.1) GO TO 10	SETU 360
CALL AXSPLT (YBOT,YTOP,YG,YORIG,YSTEP,YAXIS)	SETU 370
YTOP=IFIX((YTOP+YSTEP)/YSTEP)*YSTEP	SETU 380
CALL AXSPLT (XLEFT,XRIGHT,XG,XORIG,XSTEP,XAXIS)	SETU 390
C XRIGHT=IFIX((XRIGHT+XSTEP)/XSTEP)*XSTEP	SETU 400
CALL TITLE (O.O,XL,NX,YL,NY,XG,YG)	SETU 410
CALL GRAF (XORIG,XSTEP,XRIGHT,YORIG,YSTEP,YTOP)	SETU 420
GO TO 40	SETU 430
10 IF (ITYPE.NE.2) GO TO 20	SETU 440
CALL AXSPLT (XLEFT,XRIGHT,XG,XORIG,XSTEP,XAXIS)	SETU 450
XRIGHT=IFIX((XRIGHT+XSTEP)/XSTEP)*XSTEP	SETU 460
CALL ALGPLT (YBOT,YTOP,YG,YORIG,YCYCLE)	SETU 470
CALL TITLE (O.O,O.O,YL,NY,XG,YG)	SETU 480
CALL YLOG (O.,1.,YORIG,YCYCLE)	SETU 490
CALL XGRAXS (XORIG,XSTEP,XRIGHT,XG,XL,NX,O.O.)	SETU 500
GO TO 40	SETU 510
20 CALL ALGPLT (XLEFT,XRIGHT,XG,XORIG,XCYCLE)	SETU 520
IF (ITYPE.NE.3) GO TO 30	SETU 530
CALL AXSPLT (YBOT,YTOP,YG,YORIG,YSTEP,YAXIS)	SETU 540
YTOP=IFIX((YTOP+YSTEP)/YSTEP)*YSTEP	SETU 550
CALL TITLE (O.O,XL,NX,O.O,XG,YG)	SETU 560
CALL XLOG (XORIG,XCYCLE,O.,1.)	SETU 570
CALL YGRAXS (YORIG,YSTEP,YTOP,YG,YL,NY,O.O.)	SETU 580
GO TO 40	SETU 590
30 CALL ALGPLT (YBOT,YTOP,YG,YORIG,YCYCLE)	SETU 600
CALL TITLE (O.O,XL,NX,YL,NY,XG,YG)	SETU 610
CALL LOGLOG (XORIG,XCYCLE,YORIG,YCYCLE)	SETU 620
40 CALL FRAME	SETU 630
IF(IGRD.EQ.1) CALL GRID(1,1)	SETU 640
IF(IGRD.NE.2) GO TO 41	SETU 650
CALL BLNK1(.13,XG-.13,O.,YG,O)	SETU 660
CALL GRID(O,1)	SETU 670
CALL RESET(5HBLNK1)	SETU 680
CALL BLNK1(O.,XG.,13,YG-.13,O)	SETU 690
CALL GRID(1,O)	SETU 700
CALL RESET(5HBLNK1)	SETU 710
41 IF(ICON.NE.O) CALL MARKER(IMK)	SETU 720
CALL CURVE (X1,Y1,L1,ICON)	SETU 730
IF(NT.GT.O)CALL MESSAG(TL,NT,-.5,YPAGE-1.)	SETU 740
RETURN	SETU 750
END	SETU 760

SAMPLE PROBLEM INPUT

.75,1.E+14,5.E+14,7.2E+7,-12,2,0,0
1.E+6,1.E+8
1.,1.,1.,1.

SAMPLE PROBLEM OUTPUT

FISSION PRODUCT DECAY ENERGY FOR A MIXTURE OF U-235 AND PU-239

PERCENT U-235 7.5000E+01
PERCENT PU-239 2.5000E+01
THERMAL FLUX 1.0000E+14 N/CM**2-S
EPITHERMAL FLUX 5.0000E+14 N/CM**2-S
OPERATING TIME 7.2000E+07 SECONDS
COOLING TIME 1.0000E+06 SECONDS

GRP	ELO (MEV)	EH1 (MEV)	BETA DECAY ENERGY (MEV/FIS)	GAMMA DECAY ENERGY (MEV/FIS)	TOTAL DECAY ENERGY (MEV/FIS)
1	0.0	.4	5.40222E-02	1.50357E-02	6.90579E-02
2	.4	.8	5.05763E-02	1.48899E-01	1.99475E-01
3	.8	1.0	2.15015E-02	1.64012E-02	3.79027E-02
4	1.0	1.4	3.02747E-02	7.98657E-03	3.82613E-02
5	1.4	1.8	1.88445E-02	5.68778E-02	7.57223E-02
6	1.8	2.2	1.52776E-02	5.67523E-03	2.09528E-02
7	2.2	2.6	9.02947E-03	4.91520E-03	1.39447E-02
8	2.6	3.0	2.82435E-03	6.95132E-05	2.89386E-03
9	3.0	4.0	5.75426E-04	3.15467E-05	6.06973E-04
10	4.0	5.0	2.40575E-05	0.	2.40575E-05
11	5.0	6.0	2.76628E-06	0.	2.76628E-06
12	6.0	7.5	1.77129E-07	0.	1.77129E-07

TOTALS OVER GROUPS 2.02953E-01 2.55891E-01 4.58844E-01
FISSION PRODUCT DECAY ENERGY FOR A MIXTURE OF U-235 AND PU-239

PERCENT U-235 7.5000E+01
PERCENT PU-239 2.5000E+01
THERMAL FLUX 1.0000E+14 N/CM**2-S
EPITHERMAL FLUX 5.0000E+14 N/CM**2-S
OPERATING TIME 7.2000E+07 SECONDS
COOLING TIME 1.0000E+08 SECONDS

GRP	ELO (MEV)	EH1 (MEV)	BETA DECAY ENERGY (MEV/FIS)	GAMMA DECAY ENERGY (MEV/FIS)	TOTAL DECAY ENERGY (MEV/FIS)
1	0.0	.4	1.85958E-03	7.00323E-05	1.92961E-03
2	.4	.8	1.40169E-03	7.59423E-03	8.99592E-03
3	.8	1.0	6.82085E-04	2.83293E-04	9.65378E-04
4	1.0	1.4	1.72243E-03	3.16643E-04	2.03907E-03
5	1.4	1.8	1.74267E-03	1.57313E-05	1.75840E-03
6	1.8	2.2	1.23715E-03	4.07158E-05	1.27787E-03
7	2.2	2.6	7.00417E-04	1.88010E-06	7.02297E-04
8	2.6	3.0	2.70177E-04	3.66127E-07	2.70543E-04
9	3.0	4.0	8.43223E-05	9.19320E-08	8.44143E-05
10	4.0	5.0	9.05890E-06	0.	9.05890E-06
11	5.0	6.0	2.27445E-06	0.	2.27445E-06
12	6.0	7.5	1.26854E-07	0.	1.26854E-07

TOTALS OVER GROUPS 9.71198E-03 8.32299E-03 1.80350E-02

APPENDIX B

ACCURACY ESTIMATE OF ADJUSTED SPECTRAL FITS

As an aid in estimating the accuracy of the adjusted spectral fits, calculations made with the adjusted fits were separately compared to both aggregate spectral summation results calculated using the CINDER code and ENDF/B-V data and also with the experimental results. Examples of these comparisons are shown graphically in Figs. B-1 through B-5 for the aggregate gamma-ray decay energy from fission products resulting from a pulse irradiation (1×10^{-4} s) of ^{239}Pu with thermal neutrons. (Note that although in figures comparing calculated decay energies with experiment, the experimental points have been reduced to a pulse; those figures showing the deviations take into consideration the actual irradiation times used in the experiments.) The comparisons shown in these figures are for a low-energy group (0.1-0.2 MeV) in Fig. B-1, for two intermediate-energy groups (0.8-1.0 MeV and 1.4-1.6 MeV) in Figs. B-2 and B-3, respectively, and two high-energy groups (2.2-2.4 MeV and 4.0-5.0 MeV) in Figs. B-4 and B-5, respectively. As demonstrated by these figures, the adjusted fits most closely follow the experimental data in the cooling-time range of the experiments, the ENDF/B-V aggregate data for cooling times greater than the range of the experiments, and are extrapolations of the experimental data with and ENDF/B-V "shape" for very early cooling times. Note, however, as can be seen in Fig. B-4, that for high beta- and gamma-ray energies, and for long cooling times, the dispersion of the experimental data is so great that the adjusted fits have been forced to fit the ENDF/B-V aggregate data. Also, for the highest energy group (6.0-7.5 MeV), no experimental data were available and the adjusted fits are entirely ENDF/B-V.

As a first step in estimating the reliability of the adjusted fits, we divide the cooling-time range into bins having widths of one decade, except that the last bin is understood to extend to the end of the cooling-time range (1×10^9 s). Averages of deviations of points calculated using the adjusted fits from the aggregate ENDF/B-V pulse points and from the experimental points are next tabulated separately for each energy group and cooling-time decade for the aggregate betas and gammas from each fissioning nuclide (^{235}U and ^{239}Pu) as shown in Tables B-I through B-IV. Combined "accuracy" estimates are then made as follows.

- o For cooling times less than 1 s (i.e., below the experimental range), the combined estimate is taken to be one-half the average deviation for ENDF/B-V.
- o For cooling times in the range of $1 \text{ s} - 1 \times 10^4 \text{ s}$, where it is believed that the experimental data are the most accurate, the combined estimate is taken as one-fourth the absolute value of the average deviation for ENDF/B-V plus the average deviation for the experiment.
- o For cooling times above $1.0 \times 10^4 \text{ s}$, but within the range of the experiments, it is assumed that ENDF/B-V data are as valid as the experimental data so the combined estimate is the absolute value of the average deviation for ENDF/B-V plus the absolute value of the experimental deviation. Exceptions to this are the highest energy groups for which the deviations for the experimental data are essentially ignored above 1000 s. (See Fig. B-4.)
- o For cooling times above the experimental range, the combined estimate is just the absolute value of the average deviations from the ENDF/B-V data, as the adjusted fits in this time domain are just fits to the aggregate ENDF/B-V pulse data.
- o The minimum combined estimate is taken to be 5%, as this is judged to be the "accuracy" of the ENDF/B-V fits, i.e., no point calculated with the ENDF/B-V fits deviates more than 5% from an aggregate ENDF/B-V data point.
- o The multigroup energy can be rebinned into broader groups for purposes of making uncertainty estimates, as it is generally noted that the experimental gamma-ray decay energy data are lower than the aggregate summation calculations using ENDF/B-V data for low energies, are in fair agreement for intermediate energies, and are high for high energies. (The opposite is more or less the case for the betas.) Similarly, wider cooling-time bins can also be assigned.

In accordance with the above, absolute averages of the average deviations were taken over four energy and four cooling-time ranges. The results are displayed in Tables B-V through B-VIII, which also give the bounds of energy and cooling-time ranges as well as the absolute averages of the deviations.

First, note in comparing Tables B-V through B-VIII that the deviations for the gammas are generally higher than those for the betas. This is not surprising since only one experiment (the ORNL) was included in obtaining the adjusted

beta fits. The deviations in Table B-V and B-VII, therefore, are considered somewhat optimistic.

On the other hand, the large deviations seen in Tables B-VI and B-VIII for the gammas for short cooling times and high energies seem overly pessimistic when examining the numbers in Tables B-II and B-IV. Note in these latter tables that the adjusted fits are extrapolations of closely followed experimental data. As discussed in Ref. 6, we believe that the experimental data are correct for this energy-cooling time domain, and that the data in the ENDF/B-V file are deficient for those nuclides contributing to the decay energy in this domain.

Because of the foregoing, it does not seem unreasonable to make a single estimate of "one-sigma" uncertainties for the adjusted fits for both the beta- and gamma-ray decay energies resulting from the thermal pulse irradiation of both ^{235}U and ^{239}Pu . This is done by taking simple averages of the deviations in each energy and cooling-time range in Tables B-V through B-VIII. The resulting table appears in Sec. V of the main body of this report. Note that a user may be dissatisfied with the final result of this analysis and may wish to reestimate the uncertainties according to his own needs. If so, Tables B-I through B-IV are available for this task.

Comparison with ENDF/B-V aggregate data.

Comparison with experimental data.

Fig. B-1. Comparisons of adjusted fits for Group 2 (0.1-0.2 MeV)

Comparison with ENDF/B-V aggregate data.

Comparison with experimental data.

Fig. B-2. Comparisons of adjusted fits for Group 6 (0.8-1.0 MeV).

Comparison with ENDF/B-V aggregate data.

Comparison with experimental data.

Fig. B-3. Comparisons of adjusted fits for Group 9 (1.4-1.6 MeV).

Comparison with ENDF/B-V aggregate data.

Comparison with experimental data.

Fig. B-4. Comparisons of adjusted fits for Group 13 (2.1-1.4 MeV).

Comparison with ENDF/B-V aggregate data.

Comparison with experimental data.

Fig. B-5. Comparisons of adjusted fits for Group 17 (4.0-5.0 MeV).

TABLE B-I

AVERAGE PERCENT DEVIATIONS OF ADJUSTED FITS FROM ENDF/B-V AND EXPERIMENTAL DATA FOR U-235 BETAS

COOL TIME DECADE	GROUP 1 ENDF EXP		GROUP 2 ENDF EXP		GROUP 3 ENDF EXP		GROUP 4 ENDF EXP		GROUP 5 ENDF EXP		GROUP 6 ENDF EXP		GROUP 7 ENDF EXP		GROUP 8 ENDF EXP		GROUP 9 ENDF EXP	
.1E+01-.1E+00	128.9	0.0	40.5	0.0	30.1	0.0	34.3	0.0	.7	0.0	-.9	0.0	1.7	0.0	-10.6	0.0	-4.9	0.0
.1E+00-.1E+01	141.4	0.0	49.7	0.0	38.7	0.0	30.9	0.0	-.0	0.0	1.1	0.0	1.7	0.0	-6.5	0.0	2.2	0.0
.1E+01-.1E+02	178.0	-7.6	79.4	-9.9	56.5	-.2	40.5	-.3	15.1	-1.1	12.5	-.6	8.5	-2.1	-11.9	.1	3.6	-1.9
.1E+02-.1E+03	109.0	-.3	85.8	-.4	51.0	-4.4	48.2	-.6	27.8	1.0	17.4	-.9	8.9	-.9	-8.5	.5	-2.3	-.8
.1E+03-.1E+04	68.6	-1.9	51.5	3.2	28.4	-1.2	27.3	.7	15.7	.1	11.0	-.5	.9	-2.8	-.6	-.1	-4.5	.5
.1E+04-.1E+05	66.6	-1.7	24.3	-.1	9.2	-1.0	8.5	-.0	5.8	.7	2.6	.6	-5.1	-1.6	-5.1	-.1	-11.5	-1.2
.1E+05-.1E+06	18.9	0.0	8.2	0.0	2.5	0.0	1.3	0.0	.0	0.0	-1.0	0.0	-1.8	0.0	-2.8	0.0	-3.6	0.0
.1E+06-.1E+07	-1.3	0.0	-2.6	0.0	.1	0.0	-.6	0.0	-1.2	0.0	-.2	0.0	-.5	0.0	.0	0.0	.5	0.0
COOL TIME DECADE	GROUP 10 ENDF EXP		GROUP 11 ENDF EXP		GROUP 12 ENDF EXP		GROUP 13 ENDF EXP		GROUP 14 ENDF EXP		GROUP 15 ENDF EXP		GROUP 16 ENDF EXP		GROUP 17 ENDF EXP			
.1E+01-.1E+00	-.4	0.0	-2.6	0.0	-.5	0.0	-1.5	0.0	-.4	0.0	-.1	0.0	.5	0.0	-46.3	0.0		
.1E+00-.1E+01	1.5	0.0	-1.2	0.0	.8	0.0	.9	0.0	-1.0	0.0	-1.6	0.0	-1.1	0.0	-41.4	0.0		
.1E+01-.1E+02	1.2	-.1	1.0	-3.0	-.8	.5	-3.3	-1.2	-5.6	-1.6	-11.3	-.1	-18.2	2.7	-33.7	.8		
.1E+02-.1E+03	-10.5	-1.5	-13.4	.1	-18.5	-1.4	-22.5	-.6	-26.7	-.8	-30.0	-.3	-34.6	-.6	-50.1	-5.4		
.1E+03-.1E+04	-12.3	.9	-14.3	-1.7	-17.6	.3	-18.3	.4	-25.7	-.1	-26.4	.2	-35.7	.4	-50.5	-4.5		
.1E+04-.1E+05	-10.9	-.0	-11.8	-2.3	-10.1	-.7	-14.4	-1.6	-14.0	2.4	-10.8	-1.0	-16.9	-2.1	-20.3	-4.2		
.1E+05-.1E+06	-5.0	0.0	-6.7	0.0	-6.8	0.0	-9.8	0.0	-8.5	0.0	-15.1	0.0	-25.9	0.0	4.8	0.0		
.1E+06-.1E+07	-.0	0.0	-.1	0.0	-.1	0.0	.9	0.0	2.4	0.0	3.8	0.0	20.5	0.0	1.9	0.0		

TABLE B-II

AVERAGE PERCENT DEVIATIONS OF ADJUSTED FITS FROM ENDF/B-V AND EXPERIMENTAL DATA FOR U-235 GAMMAS

COOL TIME DECADE	GROUP 1 ENDF EXP		GROUP 2 ENDF EXP		GROUP 3 ENDF EXP		GROUP 4 ENDF EXP		GROUP 5 ENDF EXP		GROUP 6 ENDF EXP		GROUP 7 ENDF EXP		GROUP 8 ENDF EXP		GROUP 9 ENDF EXP	
.1E+01-.1E+00	-1.4	0.0	-39.4	0.0	-67.9	0.0	-7.6	0.0	-40.0	0.0	.7	0.0	80.6	0.0	-1.6	0.0	-.1	0.0
.1E+00-.1E+01	14.1	0.0	-35.9	0.0	-63.6	0.0	-12.2	0.0	-42.9	0.0	.1	0.0	58.7	0.0	-8.4	0.0	-3.0	0.0
.1E+01-.1E+02	31.1	-.8	-36.6	-.9	-56.8	.6	-29.1	.0	-40.9	.4	-17.9	-.9	47.3	-1.7	-7.7	3.1	2.7	-2.4
.1E+02-.1E+03	-25.2	-.3	-11.5	.0	-37.4	-.0	-9.5	-.2	-37.5	-.6	-1.1	-.1	43.4	-1.3	9.3	-.9	7.2	.0
.1E+03-.1E+04	-30.2	-.5	-4.9	2.1	-7.1	2.5	-7.5	4.1	-4.9	1.1	9.0	.7	11.9	-2.1	5.5	1.6	8.9	5.4
.1E+04-.1E+05	.1	.2	-.9	4.2	19.9	6.2	-12.2	11.3	-2.7	2.1	.7	-1.8	-13.9	6.0	4.5	-1.7	-10.7	25.6
.1E+05-.1E+06	1.4	-4.0	28.6	4.4	-6.5	-4.8	-9.9	1.5	-4.6	.2	2.0	-4.9	-13.9	-1.7	-10.7	-9.2	7.7	9.6
.1E+06-.1E+07	-6.6	0.0	8.5	0.0	-8.3	0.0	-2.6	0.0	-1.7	0.0	3.6	0.0	-4.0	0.0	-7.0	0.0	-9.8	0.0
COOL TIME DECADE	GROUP 10 ENDF EXP		GROUP 11 ENDF EXP		GROUP 12 ENDF EXP		GROUP 13 ENDF EXP		GROUP 14 ENDF EXP		GROUP 15 ENDF EXP		GROUP 16 ENDF EXP		GROUP 17 ENDF EXP		GROUP 18 ENDF EXP	
.1E+01-.1E+00	141.2	0.0	70.3	0.0	111.6	0.0	64.0	0.0	62.2	0.0	118.2	0.0	81.5	0.0	214.5	0.0	253.7	0.0
.1E+00-.1E+01	110.5	0.0	71.0	0.0	125.3	0.0	87.3	0.0	110.9	0.0	100.7	0.0	77.1	0.0	245.2	0.0	262.4	0.0
.1E+01-.1E+02	97.8	.7	75.4	.7	234.4	-1.4	215.8	-3.6	203.3	-1.6	130.8	.6	76.6	-.8	224.7	-4.2	204.9	-2.2
.1E+02-.1E+03	60.7	-.6	96.4	-1.1	157.1	-1.5	164.8	-.8	108.3	-.1	91.7	-.4	88.9	-.4	109.2	-1.7	124.6	-.9
.1E+03-.1E+04	31.0	5.8	64.9	7.4	21.3	6.5	43.4	5.4	25.7	4.5	13.6	5.9	28.4	9.8	61.8	9.1	105.7	3.5
.1E+04-.1E+05	6.3	11.0	19.7	19.5	-15.3	23.3	-20.3	27.2	-6.4	5.8	-2.7	8.8	-4.3	3.7	8.2	-24.9	9.0	-61.3
.1E+05-.1E+06	2.6	7.1	19.6	15.6	-29.3	8.8	-27.7	34.2	44.3	3.9	58.4	-34.0	10.1	0.0	-.3	0.0	-.3	0.0
.1E+06-.1E+07	7.4	0.0	24.6	0.0	-18.7	0.0	-.2	0.0	3.2	0.0	63.2	0.0	20.4	0.0	-1.0	0.0	0.0	0.0

TABLE B-III

AVERAGE PERCENT DEVIATIONS OF ADJUSTED FITS FROM ENDF/B-V AND EXPERIMENTAL DATA FOR PU-239 BETAS

COOL TIME DECADE	GROUP 1 ENDF EXP		GROUP 2 ENDF EXP		GROUP 3 ENDF EXP		GROUP 4 ENDF EXP		GROUP 5 ENDF EXP		GROUP 6 ENDF EXP		GROUP 7 ENDF EXP		GROUP 8 ENDF EXP		GROUP 9 ENDF EXP	
.1E-01-.1E+00	15.4	0.0	51.6	0.0	28.5	0.0	-1.7	0.0	.6	0.0	.7	0.0	.1	0.0	-.2	0.0	.4	0.0
.1E+00-.1E+01	31.7	0.0	58.8	0.0	32.6	0.0	9.8	0.0	4.8	0.0	1.8	0.0	1.3	0.0	-.4	0.0	2.3	0.0
.1E+01-.1E+02	108.8	-17.9	99.7	-10.8	61.8	-8.1	52.1	.8	27.1	-.8	11.7	-5.9	11.4	-2.9	-4.9	1.9	9.2	-.3
.1E+02-.1E+03	143.3	.5	134.9	8.0	90.7	5.8	70.2	-.0	41.0	1.7	23.3	1.7	14.4	1.6	-2.6	-1.0	.8	.6
.1E+03-.1E+04	115.8	-.4	80.7	1.1	55.4	1.6	37.0	-.2	25.3	3.0	10.7	.0	1.6	-.3	-5.7	-.3	-11.1	-.5
.1E+04-.1E+05	92.2	-.4	42.4	-2.1	26.2	-1.2	11.1	-.0	3.0	.5	-5.5	.3	-8.5	2.1	-11.8	2.0	-14.0	2.0
.1E+05-.1E+06	15.9	0.0	15.6	0.0	7.4	0.0	1.7	0.0	-2.1	0.0	-3.8	0.0	-5.2	0.0	-1.7	0.0	-2.3	0.0
.1E+06-.1E+07	.6	0.0	-2.7	0.0	-2.4	0.0	-.4	0.0	.2	0.0	.8	0.0	.0	0.0	.2	0.0	-.9	0.0
COOL TIME DECADE	GROUP 10 ENDF EXP		GROUP 11 ENDF EXP		GROUP 12 ENDF EXP		GROUP 13 ENDF EXP		GROUP 14 ENDF EXP		GROUP 15 ENDF EXP		GROUP 16 ENDF EXP		GROUP 17 ENDF EXP			
.1E-01-.1E+00	5.4	0.0	3.8	0.0	2.5	0.0	3.0	0.0	2.2	0.0	.5	0.0	.4	0.0	3.8	0.0		
.1E+00-.1E+01	.0	0.0	1.0	0.0	1.2	0.0	1.9	0.0	-.0	0.0	.4	0.0	-3.9	0.0	-15.1	0.0		
.1E+01-.1E+02	6.7	-.5	7.5	-.3	7.4	-.4	1.7	-2.3	-.6	-.3	-6.8	.2	-21.6	-.4	-36.5	-2.0		
.1E+02-.1E+03	-5.0	.6	-10.2	.5	-15.3	1.0	-20.1	1.4	-27.1	.4	-35.2	.1	-48.3	.7	-63.0	-.3		
.1E+03-.1E+04	-17.2	-1.1	-19.9	-.2	-23.1	-.5	-27.8	-2.6	-31.4	-.9	-36.5	-.3	-60.6	-2.2	-65.5	-7.5		
.1E+04-.1E+05	-17.9	.7	-17.3	1.1	-18.0	.8	-19.1	1.0	-21.9	.8	-19.4	-.1	-21.0	-3.5	-13.6	9.8		
.1E+05-.1E+06	-7.0	0.0	-7.2	0.0	-5.7	0.0	-8.4	0.0	-7.7	0.0	-13.4	0.0	1.0	0.0	1.1	0.0		
.1E+06-.1E+07	-.7	0.0	-1.2	0.0	3.3	0.0	1.9	0.0	5.1	0.0	-.1	0.0	2.4	0.0	-1.0	0.0		

TABLE B-IV

AVERAGE PERCENT DEVIATIONS OF ADJUSTED FITS FROM ENDF/B-V AND EXPERIMENTAL DATA FOR ²³⁹PU GAMMAS

COOL TIME DECADE	GROUP 1 ENDF EXP		GROUP 2 ENDF EXP		GROUP 3 ENDF EXP		GROUP 4 ENDF EXP		GROUP 5 ENDF EXP		GROUP 6 ENDF EXP		GROUP 7 ENDF EXP		GROUP 8 ENDF EXP		GROUP 9 ENDF EXP	
.1E+01-.1E+00	65.0	0.0	-16.8	0.0	-68.4	0.0	-11.2	0.0	-36.6	0.0	-3.6	0.0	7.5	0.0	.1	0.0	-1.7	0.0
.1E+00-.1E+01	81.0	0.0	-29.6	0.0	-65.0	0.0	-13.7	0.0	-29.1	0.0	-12.5	0.0	15.4	0.0	-1.0	0.0	9.3	0.0
.1E+01-.1E+02	48.6	-2.8	-50.8	1.9	-55.1	1.1	-26.4	-.3	-32.8	.9	-24.0	-.1	46.0	-.3	1.3	.5	27.1	-.3
.1E+02-.1E+03	-32.2	2.5	-38.1	-.6	-47.7	-2.4	-18.6	-1.6	-41.8	-.5	-10.5	.5	58.5	.3	12.8	-.1	27.5	.7
.1E+03-.1E+04	-26.7	-.4	-24.4	.6	-16.6	-.5	-14.5	-.9	-11.4	1.0	2.0	.8	22.7	.4	17.9	.4	32.5	1.4
.1E+04-.1E+05	3.0	.1	-5.0	.2	8.8	.5	-13.4	.8	-4.9	-.2	-1.2	1.0	-11.5	-.7	17.1	-.7	-4.0	.3
.1E+05-.1E+06	-12.7	0.0	21.1	-1.4	5.4	.2	-11.7	3.1	-15.3	-2.3	-2.9	-1.7	-21.9	-4.0	-19.1	-2.1	-24.0	-9.0
.1E+06-.1E+07	-.1	0.0	7.9	0.0	-1.7	0.0	-4.2	0.0	-6.9	0.0	8.3	0.0	-6.7	0.0	-12.3	0.0	-10.8	0.0
COOL TIME DECADE	GROUP 10 ENDF EXP		GROUP 11 ENDF EXP		GROUP 12 ENDF EXP		GROUP 13 ENDF EXP		GROUP 14 ENDF EXP		GROUP 15 ENDF EXP		GROUP 16 ENDF EXP		GROUP 17 ENDF EXP		GROUP 18 ENDF EXP	
.1E+01-.1E+00	72.8	0.0	2.9	0.0	119.4	0.0	35.0	0.0	191.9	0.0	82.8	0.0	27.1	0.0	39.6	0.0	261.2	0.0
.1E+00-.1E+01	78.4	0.0	17.5	0.0	163.3	0.0	82.7	0.0	239.2	0.0	107.5	0.0	31.3	0.0	66.2	0.0	234.4	0.0
.1E+01-.1E+02	94.5	-.4	85.1	-.0	349.9	-.7	273.7	.3	329.5	3.9	180.1	.0	76.7	-.8	186.5	-3.5	181.1	-4.4
.1E+02-.1E+03	76.3	.1	155.2	-.0	242.8	.1	214.4	-.1	174.1	-1.4	167.0	-.1	152.5	-.1	171.5	-.6	154.1	-2.3
.1E+03-.1E+04	47.5	.7	103.9	.1	61.3	.0	79.6	.9	57.6	-.0	30.4	1.2	73.2	.8	96.7	1.3	78.7	-23.2
.1E+04-.1E+05	4.6	-2.0	25.4	-.2	-1.1	-1.2	-12.6	-1.8	18.9	-.3	7.9	-6.7	21.4	-2.0	7.2	-20.0	4.2	-86.0
.1E+05-.1E+06	-21.0	-.7	-6.8	-.0	-40.3	-5.1	-24.5	.7	5.3	-2.7	36.5	-21.4	-34.5	0.0	1.2	0.0	-.3	0.0
.1E+06-.1E+07	-3.8	0.0	4.3	0.0	-23.9	0.0	3.4	0.0	1.0	0.0	89.3	0.0	-10.4	0.0	.8	0.0	0.0	0.0

TABLE B-V

PERCENT ESTIMATE OF ACCURACY OF ADJUSTED FITS FOR U-235 BETAS

ENERGY RANGES (MEV)	COOLING TIME RANGES (S)			
	1.0E-02-1.0E+00	1.0E+00-1.0E+04	1.0E+04-1.0E+06	1.0E+06-1.0E+09
0.0- .6	35.8	19.5	5.6	5.0
.6-1.6	5.0	5.0	5.0	5.0
1.6-3.0	5.0	5.0	5.0	5.0
3.0-7.5	7.6	8.9	12.0	5.0

TABLE B-VI

PERCENT ESTIMATE OF ACCURACY OF ADJUSTED FITS FOR U-235 GAMMAS

ENERGY RANGES (MEV)	COOLING TIME RANGES (S)			
	1.0E-02-1.0E+00	1.0E+00-1.0E+04	1.0E+04-1.0E+06	1.0E+06-1.0E+09
0.0- .6	15.1	7.1	10.9	5.0
.6-1.6	11.8	6.6	9.0	5.0
1.6-3.0	48.9	25.9	33.6	5.0
3.0-7.5	94.5	32.0	5.4	5.0

TABLE B-VII

PERCENT ESTIMATE OF ACCURACY OF ADJUSTED FITS FOR PU-239 BETAS

ENERGY RANGES (MEV)	COOLING TIME RANGES (S)			
	1.0E-02-1.0E+00	1.0E+00-1.0E+04	1.0E+04-1.0E+06	1.0E+06-1.0E+09
0.0- .6	18.2	26.7	7.4	5.0
.6-1.6	5.0	6.1	5.0	5.0
1.6-3.0	5.0	5.0	5.0	5.0
3.0-7.5	5.0	11.2	5.0	5.0

TABLE B-VIII

PERCENT ESTIMATE OF ACCURACY OF ADJUSTED FITS FOR PU-239 GAMMAS

ENERGY RANGES (MEV)	COOLING TIME RANGES (S)			
	1.0E-02-1.0E+00	1.0E+00-1.0E+04	1.0E+04-1.0E+06	1.0E+06-1.0E+09
0.0- .6	21.9	7.8	8.7	5.0
.6-1.6	5.8	5.6	14.7	5.0
1.6-3.0	49.7	30.0	24.2	5.0
3.0-7.5	55.0	37.2	7.9	5.0