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Title: The Contribution of Fission Product Decay Energy Uncertainty to Uncertainty in Calculated Reactor Decay Power

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Bernard I. Spinrad

The uncertainty in decay energy for those fission products which contribute significantly to reactor shutdown power was evaluated. The methodology used assigned significantly larger uncertainties for data which were theoretically predicted than it did for experimentally determined data. The uncertainty was modeled as an increasing function of distance from beta stability for both theoretical and experimental data.

The evaluated data were used in the ROPEY summation code to estimate the uncertainty in reactor decay heat due to the fission product decay energies. The uncertainty in reactor shutdown power after a 100-day irradiation was found to be about 8% immediately after shutdown. This uncertainty decreases to about 2% at shutdown times greater

than 100 seconds. This is in substantial agreement with results of Schmittroth and Schenter.[5] The decay energy uncertainty for short cooling times is dominated by uncertainty in the theoretically predicted data.

The Contribution of Fission Product Decay Energy Uncertainty to Uncertainty in Calculated Reactor Decay Power

by

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I. INTRODUCTION

1.1 The After-Heat Problem

Many heavy elements fission when they are bombarded with neutrons, releasing a relatively large amount of energy essentially immediately after each fission event occurs. Each fission also produces two (or sometimes three) fission fragments (or fission products) and several neutrons. The fission fragments are produced in a "spectrum" which includes over 800 nuclides, i.e., the mass and charge numbers of the fission fragments and their nuclear states can be predicted by a probability density function. Most of the fission products are radioactive with half lives ranging from milliseconds to months (seven fission products have half lives greater than one year and none of large yield have half lives greater than 100 years). It is the energy released by radioactive decay of the fission products (referred to here as "decay heat") which causes a nuclear (fission) reactor to continue to produce power after it has been shut-down. It is necessary to predict accurately the amount of decay heat produced by a particular reactor with a given power history in order to conduct safety analyses for that reactor. One method of predicting this decay heat is the "summation method" in which the power being produced by decay of each fission product at time t after shut-down is calculated, and the reactor shut-down power being produced at time t is obtained by summing over all of the fission products. The evaluated nuclear data file, ENDF/B-IV, supplies the nuclear decay data which are recommended for use in these calculations. The following paragraphs define the functions which are of interest in decay heat discussions.

If a burst of fission occurs in a reactor at time $t = 0$, then the number of atoms of each fission product can be calculated[1] as a function of time after the fission burst. Let $N_i(t)$ be the number of atoms per fission of the i^{th} fission product present at time t after the burst where $1 \leq i \leq n$, and n is the number of fission products which contribute significantly to decay. If λ_i is the decay constant (in sec^{-1}), and E_i is the average sensible energy of decay for the i^{th} fission product (in MeV per decay), then reactor decay power per fission at time t after a fission burst is given (in MeV/sec-fission) by:

$$H_0(t) = \sum_{i=1}^{n} \lambda_i N_i(t) E_i \qquad (1-1)$$

If the reactor is operated at a steady power of P fissions/second from time $t = -T$ to $t = 0$ and then shutdown, then for $t \geq 0$, reactor shut-down power in MeV/second shut-down power per fission/second operating power is approximated by:

$$H_1(t,T) \approx \int_{-T}^{0} H_0(t-t')\, dt' \qquad (1\text{-}2)$$

The H_1 function can be expressed as a sum of integrals:

$$H_1(t,T) = \sum_{i=1}^{n} \lambda_i E_i \int_{-T}^{0} N_i(t-t')\, dt' \qquad (1\text{-}3)$$

It is useful to define a third function, $H_2(t,T)$, which is the decay energy released between time $t=0$ and time t:

$$\begin{aligned} H_2(t,T) &= \int_0^t H_1(t,T)\, dt \\ &= \sum_{i=1}^{n} \lambda_i E_i \int_0^t \int_{-T}^{0} N_i(t-t')\,dt'\,dt \qquad (1\text{-}4) \end{aligned}$$

H_2 has units of MeV shutdown energy per fission/second of operating power. The H_2 function represents the amount of energy available to increase fuel temperature in a loss of coolant situation.

The functions N_i can be written in a form which can be integrated analytically so that one can define a $3 \times n$ matrix, $A(t,T)$, of functions of t and T by:

$$\begin{aligned} A_{0j}(t) &= \lambda_j N_j(t), \\ A_{1j}(t,T) &= \int_{-T}^{0} \lambda_j N_j(t-t')\, dt' \\ A_{2j}(t,T) &= \int_0^t \int_{-T}^{0} \lambda_j N_j(t-t')\, dt'\, dt \qquad (1\text{-}5) \end{aligned}$$

If A_i, $1 \leq i \leq 3$ is defined to be the i^{th} row of the matrix A, and the vector E is defined by $(E)_j = E_j$, then the H functions can be expressed as the vector dot products:

$$H_i(t,T) = \sum_{j=1}^{n} A_{ij}(t,T)E_j \text{ for } 0 \leq i \leq 2 \qquad (1\text{-}6)$$

1.2 Energy Uncertainty Propagation

The data used in summation calculations are evaluated experimental data, or data which are predicted by theoretical models. In either case, some uncertainty as to the exact value of each datum must exist. If one is not certain that the data which he uses are absolutely correct, then there must be uncertainty in any computational result which is obtained using that data. Thus there are two (fairly vague) problems associated with performing calculations which use physical data: the uncertainties in the data must be discovered, and the effect that these uncertainties have on the computational results must be determined. The usual method of handling these problems is to assume that each datum is the mean of a random variable (Appendix I) which has the datum uncertainty for its standard deviation. Once the mean, standard deviation and probability density function are assigned for each datum, then the question of uncertainty propagation through a calculation (in this case the calculation is the computation of the after-heat functions, H_0, H_1 and H_2) becomes a simple and well defined mathematical problem: the calculation becomes a function of several random variables, and any such function determines a new random variable which shall be referred to as the "derived" random variable. The result of the calculation can then be defined to be the mean of the derived random variable, and the uncertainty in the answer can be defined to be the standard deviation of the derived random variable. Since the mean of the derived random variable is usually quite well approximated by performing the calculation using the means of the data random variables (this latter quantity is sometimes referred to as the "point value")[2] the distinction between the two quantities is usually ignored. When the uncertainty problem is interpreted as above, the techniques of Appendix I can be applied. If one assumes that the random variables describing the average sensible decay energy for each nuclide are normal and independent, then the uncertainty, δH_i, for the after-heat functions is given by:

$$(\delta H_i)^2 = \sum_{j=1} [A_{ij}(t,T)]^2 (\delta E_j)^2 \qquad (1\text{-}7)$$

where δE_j is the standard deviation for the random variable E_j (this follows from equation 4 of Appendix I). If the energy uncertainties are assumed to be 100% correlated, then the after-heat uncertainty is given by:

$$\delta H_i = \sum_{j=1}^{n} A_{ij}(t,T)\,\delta E_j \qquad (1\text{-}8)$$

Usually the mean and standard deviation of the derived random variable are the only parameters considered in uncertainty analysis; however much more information is available: given any interval of real numbers, (a,b), one can determine the probability that the result of the calculation is between a and b.

In determining the probability density function for the derived random variable, it may be necessary to use probabilistic techniques (Appendix I). Thus, two problems arise in determining the uncertainty in a specific calculation:

1. determination of reasonable probability density functions for the data, and
2. calculation of an approximation to the probability density function of the derived random variable which is accurate enough to be satisfactory, without requiring an unreasonable amount of computer time.

This thesis provides a methodology which can be used to approach these two tasks, and applies the methodology to the specific problem of determining the uncertainty in the decay heat functions due to uncertainties in average sensible decay energy of the fission products. The next section reviews an earlier estimate of these uncertainties, Chapter II presents a method for estimating decay energy uncertainties for each fission product (the uncertainties obtained are tabulated in Appendix III), and Chapter III applies the techniques given in Appendix I to the uncertainties of Appendix III to give uncertainty estimates for the afterheat functions.

1.3 Other Uncertainty Analyses

Two studies, one by Schmittroth[4] and the other by Schmittroth and Schenter,[5] have produced estimates of uncertainty in summation decay energy calculations due to uncertainties in the various input parameters.

Schmittroth's study is essentially a sensitivity analysis. For example, if ε_i are the average energies of decay for the fission product and σ_i are the uncertainties in those decay energies, then the relative uncertainties, r_i, are defined by: $r_i = \sigma_i/\varepsilon_i$. In order to determine the sensitivity of the decay energy calculation to energy uncertainties, Schmittroth assumes that the relative energy uncertainties are the same for all fission products (i.e., r_i is constant with respect to i). He then calculates the relative uncertainty in decay heat due to energy uncertainties, $R_\varepsilon(t) = \sigma_\varepsilon(t)/H_0(t)$, where t is the time after reactor shutdown, H_0 is the fission burst decay heat function defined in equation (1-1), and σ_ε is the uncertainty in H_0

which is due to decay energy uncertainties. Let the subscripts, x and T, be used so that x indicates that the subscripted parameter is due to nuclides for which decay energy data are experimentally determined and T refers to those nuclides for which decay energy is predicted by theoretical models. Schmittroth assumed that uncertainties due to experimental nuclides are completely uncorrelated, and theoretical uncertainties are completely correlated. He then observed that (due to the linear nature of the summation calculation) $R_{\varepsilon x}(t)/r_{\varepsilon x}$ is constant with respect to $r_{\varepsilon x}$ and $R_{\varepsilon T}(t) = r_{\varepsilon T}$. The parameters $R_{\varepsilon}(t)/r_{\varepsilon x}$, $R_{\varepsilon}(t)/r_{\varepsilon T}$, and $R_{\varepsilon}(t)/r_{\varepsilon}$ describe the sensitivity of $H_0(t)$ to uncertainties in fission product decay energies (assuming that all relative average decay energy uncertainties are the same). Schmittroth plots these ratios for cooling times less than 10^8 seconds; for these times the ratios are 0.10 or less (e.g., a relative uncertainty in fission product decay energy of 50% would result in an uncertainty of $H_0(t)$ of 5% or less). Arbitrarily assuming $r_{\varepsilon} = 0.5$, Schmittroth calculated uncertainty in $H_0(t)$ for t less than 10^8 seconds. He concluded that the uncertainty in H_0 due to energy uncertainties is about 6% at t = 10 seconds, greater at shorter cooling times and less at longer cooling times. Uncertainty in H_0 is dominated by theoretical decay energy uncertainties at times less than 100 seconds. Theoretical energy uncertainties become unimportant at decay times greater than 10^3 or 10^4 seconds (at longer decay times more of the contributing nuclides have been measured experimentally). At longer decay times, Schmittroth calculated that yield, halh life and experimental energy uncertainties contribute about equally to a total H_0 uncertainty of about 1-2%.

The study by Schmittroth and Schenter[5] examines fission product decay energy uncertainty directly. The nuclides were divided into three classes:

1. those whose average decay energies are based on detailed photon and beta spectra,
2. those whose Q-value is known but where the split between beta, gamma, and neutrino energy must be estimated, and
3. those whose Q-value must be estimated from nuclear mass systematics.

They then analyzed the data in each class in order to obtain uncertainty estimates.

Uncertainty estimates for the data in class 1 were made by comparing the ENDF/B-IV Q-values with those published by Tobias[5] and with the Q-value obtained by adding the average neutrino energy to the average beta and gamma energies. (A procedure for calculating the latter three quantities from spectral data is given in section 2.1.)

The energy split estimate for nuclides in classes 2 and 3 was made by using the formula:

$$\overline{E}_\theta = Q[a_\theta + b_\theta A + C_\theta(N-Z) + d_\theta P] \quad (1-9)$$

where Q is the decay Q-value, θ denotes either beta or gamma, A is the mass number, Z is the charge number, N is the neutron number, P is the nuclear pairing energy, and the coefficients were determined by a least-squares fit to known data. Schmittroth and Schenter used the RMS deviations from these fits to obtain beta and gamma decay energy uncertainties due to uncertainty in the coefficients of: σ_β = 0.35 MeV, and σ_γ = 0.70 MeV. Early calculations used to obtain these values yielded values of σ_β = 0.32 MeV and σ_γ = 0.65 MeV. Schmittroth made these early results available and they have been used in Oregon State University after-heat reports(6) and in Chapter II of this thesis.

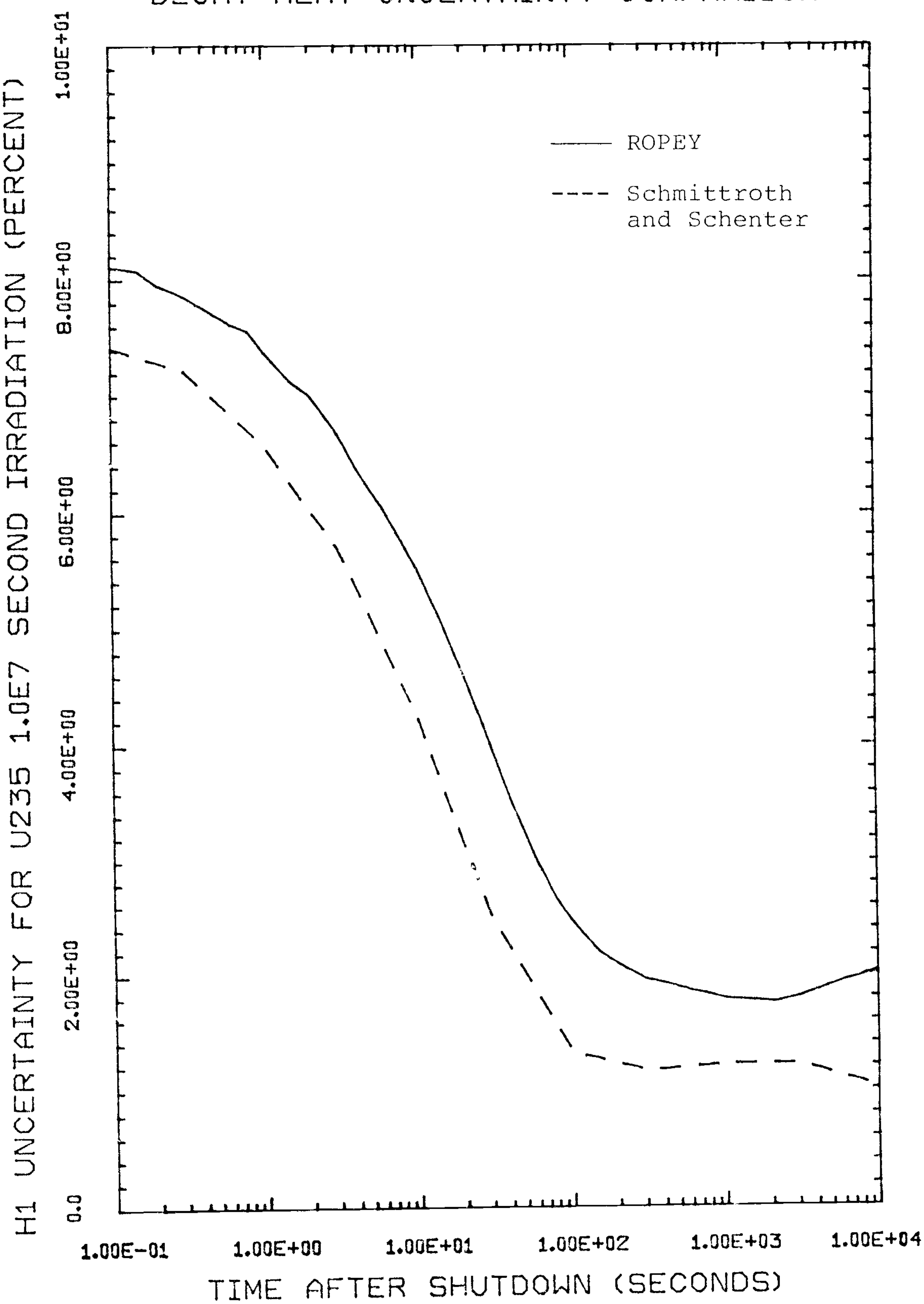
Uncertainty in Q-value must also be considered in estimating decay energy uncertainty. In order to obtain uncertainty estimates for Q-values, Schmittroth and Schenter used results from Janecke and Eynon.(5) These results indicate that the uncertainty in Q-value for a nuclide which has the most probable charge number for its mass chain should be about one MeV. Schmittroth and Schenter then reason that since a typical Q-value near the most probable charge number is about 4.3 MeV, class 3 nuclides should have a relative uncertainty of 100(1/4.3) = 23%.

They consider these uncertainties to be completely correlated.

Figure 1-1 shows relative uncertainties in the H_1 function as a function of shutdown time for a U-235 reactor after a 10^7 second irradiation as calculated by Schmittroth and Schenter. Results obtained at Oregon State University using the program, ROPEY, are shown for comparison.

Schmittroth and Schenter also investigated the contribution to the decay heat uncertainties of the yields and decay constants. Their estimate of yield uncertainty is consistant with Spinrad's.[(1)] They also conclude that, for short cooling times, decay heat uncertainty due to decay constant data is small compared to that of either energy or yield uncertainties.

FIGURE 1-1
DECAY HEAT UNCERTAINTY COMPARISON



II. ENERGY UNCERTAINTY DATA

The evaluated nuclear data file, ENDF/B-IV, gives the average sensible energy released per decay for the fission products which contribute significantly to reactor decay heat; however, this file does not list decay energy uncertainties. C. W. Reich of Aerojet Nuclear Company (now EG&G, Idaho) has supplied a source document[3] which tabulated experimentally derived nuclear data for many fission products. Using the data in the Reich file it is possible to infer decay energy uncertainties for many (but not all) of the fission products for which experimental data is avaialble. Thus, the fission products of interest can be divided into three groups:

A. Nuclides for which experimental data and evaluated uncertainties are available.

B. Nuclides for which experimental data are available but evaluated uncertainties are not available.

C. Nuclides for which decay energy data are predicted from theoretical models.

The uncertainty in each decay heat function will, therefore, have a component for each of the above groups. A further complication arises because it is possible for a theoretical model to give decay energy predictions which are biased away from the true values with a high degree of correlation. The effect of this possible bias on the decay energy functions is estimated by postulating an additional "correlated" uncertainty for each nuclide in group C, and propagating that uncertainty through the after-heat calculations along with the "uncorrelated" uncertainties. The problem, then, is to evaluate uncorrelated uncertainties for nuclides in groups B and C, and to evaluate a correlated uncertainty for nuclides in group C.

Section 2.1 shows how group A uncertainties are obtained from the Reich data, sections 2.2 and 2.3 give procedures for evaluating uncertainties for nuclides in groups B and C respectively; section 2.3 also gives a method for evaluating the correlated uncertainties. Appendix II is a copy of the Reich data with estimates of spectral uncertainties, and average decay energy uncertainties inserted.

2.1 Energy Uncertainties Due to Evaluated Experimental Data

Table II-1 illustrates the format of the Reich nuclear data file. The entries in the right hand column are identifier numbers which identify the nuclide for which data is displayed and the type of data which is given on each line. Digits 2 through 4 give the atomic number of the nuclide, digits 5 through 7 give its atomic mass number, and the last digit indicates which metastable state is being considered (0 indicates the ground state). The first digit of the identifier is a code (or "card type") which tells what

Table II-1

```
42 990    MO                                    6                                                   10420990
PREPARED FOR FILE    10/73                                    CWR                                   20420990
REFERENCES  Q- 1973 REVISION OF WAPSTRA-GOVE MASS TABLE                                             20420990
               HALF-LIFE  N.E.HOLDEN, CHART OF THE NUCLIDES (1973),                                 20420990
                          AND PRIVATE COMMUNICATION (SEPT.,1973).                                   20420990
               OTHER- M.J.MARTIN AND P.H.BLICHERT-TOFT, NUCLEAR                                     20420990
                        DATA TABLES A 8,NOS.1-2, 1 (1970)                                           20420990
     66.02          0.01           H            2            2                                      30420990
         1             0      1356.6          1.0         13.7          1.0                         40420990
         1             1      1214.           1.0         86.3          1.0                         40420990
    584.74           0.0      186.06          0.0                                                   50420990
       1.0                         7            1                                                   60420990
      215.            1.        0.11         0.01                                                   70420990
      352.            1.        0.14         0.01                                                   70420990
      436.            1.       18.6          0.6                                                    70420990
      596.            1.        0.024        0.004                                                  70420990
      685.            1.        0.054        0.006                                                  70420990
      848.            1.        1.44         0.09                                                   70420990
     1214.            1.       80.0          1.1                                                    70420990
       1.0                        11            0                                                   80420990
    40.584          0.002       1.3          0.2          3.87                                      90420990
   140.511          0.006      14.0          0.5          0.119        0.008                        90420990
   181.06           0.04        6.7          0.2          0.15                                      90420990
   366.4            0.1         1.46         0.04                                                   90420990
   411.5            0.5         0.024        0.003                                                  90420990
   528.9            0.2         0.054        0.006                                                  90420990
   620.7            0.2         0.024        0.004                                                  90420990
   739.7            0.1        13.8          0.5                                                    90420990
   778.2            0.1         4.8          0.3                                                    90420990
   823.1            0.1         0.14         0.01                                                   90420990
   961.0            0.2         0.11         0.01                                                   90420990
```

type of data is contained on the corresponding line. The meaning of the codes is given in Table II-2 which is copied from reference (3). Notice that provisions are made to list uncertainties for average beta and average gamma energies although these uncertainties are not listed. Techniques for supplying those uncertainties are given in this chapter. The uncertainties obtained are given in Appendix II.

The beta decay energy listed in the first entry of the type 7 cards is the end point energy for each of the measured beta decay modes. The intensity listed in the third entry of the type 7 cards is (when normalized by the first entry in the type 6 card) the percentage of the total decays which should decay with the corresponding and point energy. If the energies are denoted by $E_{\beta i}$ and the intensities are denoted by $I_{\beta i}$ where $1 \le i \le n$ and n is the number of type 7 cards (i.e., the number of beta decay modes measured), and if the normalization factor is denoted by F_β, then the average beta energy of decay for the nuclide under consideration, E_β, is given by (reference 3, pp. 13-14):

$$E_\beta = \frac{1}{100} F_\beta \sum_{i=1}^{n} E_{\beta i} I_{\beta i} f(E_{\beta i}), \qquad (2\text{-}1)$$

where

$$f(E_{\beta i}) = \frac{1}{4} \frac{10 + 8x + 2x^2}{10 + 5x + x^2} \quad \text{and} \quad x = E_{\beta i}/511$$

The function, f, estimates the fraction of decay energy not carried away by neutrinos (the neutrino energy does not stay

Table II-2

Card Format for Input to the Nuclear Decay-Data File

(All energy values are given in keV and all intensities are given in percent of decays.)

CARD TYPE

1 NUCLIDE IDENTIFICATION (one card)

column(s) description

1-3.........Z (Atomic Number) (Right Adjusted)
4-6.........A (Mass Number) (Right Adjusted)
7...........Isomer tag:
    Blank (or zero) indicates the ground state;
    1 indicates the first isomeric state;
    2 indicates the second isomeric state; etc.
31-40.......Number of comment cards to follow (Right Adjusted)

2 COMMENT CARDS (any number of cards)

column(s) description

1-66........These include any desired comments on the decay information. They should contain the month/year the information was prepared and the references from which it was obtained.

3 HALF-LIFE (one card)

column(s) description

1-10........Half-life
11-20.......Its uncertainty
30..........Units for half-life (one letter: S, M, H, D, Y)
40..........Number of decay modes of the parent state. [This is equal to the number of decay-mode cards (type 4).]
50..........Number of "spectra", or data lists, to follow. (E.g., 0 indicates no data lists, 2 indicates two such lists, etc.)

4 DECAY MODES (one card for each mode; any number of cards)

column(s) description

10..........Mode of decay:
    1 = β^-
    2 = β^+
    3 = Isomeric transition
    4 = alpha particle
    5 = delayed neutron
    6 = spontaneous fission
20..........Is an isomeric state in the daughter nucleus fed?
    0 = no
    1 = first isomeric state in daughter is fed
    2 = second isomeric state in daughter is fed
    etc.
21-30.......Q-value of the decay. For isomeric-transition decay, this will be the energy of the isomeric state.
31-40.......Uncertainty (in keV) in this Q-value
41-50.......Percentage branching of this decay mode
51-60.......Uncertainty in this branching

Note: If both an isomeric state and the ground state in the daughter nucleus are fed in the decay, separate cards for each should be prepared.

CARD TYPE

5 AVERAGE ENERGY (one card)

column(s) description
1-10........Average beta energy
11-20.......Its uncertainty
21-30.......Average gamma energy
31-40.......Its uncertainty
41-50.......Average alpha energy
51-60.......Its uncertainty

6 INTENSITY NORMALIZATION AND RADIATION TYPE (one type-6 card to be followed by any number of type-7 cards; any number of such groups)

column(s) description
1-10........Normalization factor (abswlute intensity / relative intensity) for the list to follow in type-7 cards
11-20.......Uncertainty in the normalization factor
21-30.......Number of transitions of this type to be listed (right adjusted)
40..........Radiation type (same numerical designation as in column 10 of card 4)

7 ENERGY AND INTENSITY INFORMATION (one per card in order of increasing energy of each individual transition of the radiation type given on card 6; any number of cards)

column(s) description
1-10........Energy of transition (gamma radiation excluded)
11-20.......Uncertainty (in keV) of the energy
21-30.......Intensity of this transition
31-40.......Uncertainty in this intensity value

8 GAMMA-RAY DATA (one type-8 card followed by any number of type-9 cards)

column(s) description
1-10........Normalization factor (absolute intensity / relative intensity) for the gamma rays listed on the type-9 cards to follow
11-20.......Uncertainty in the normalization factor
21-30.......Number of gamma rays included in the list. This is equal to the number of type-9 cards to follow. (right adjusted)
40..........0, radiation-type designation for gamma radiation

9 GAMMA-RAY ENERGY AND INTENSITY DATA (any number of cards, in order of increasing gamma-ray energy)

column(s) description
1-10........Gamma-ray energy (E_γ)
11-20.......Uncertainty in E_γ
21-30.......Gamma-ray intensity (I_γ)
31-40.......Uncertainty in I_γ
41-50.......Internal-conversion coefficient, ICC. (Generally given only for isomeric transitions or for highly converted gamma rays.)
51-60.......Uncertainty in ICC

Note: If an isomeric state in the daughter nucleus is fed, do not include in this list any transitions which result from the decay of this daughter isomer.

in the vicinity of the reactor, thus it does not contribute to sensible decay heat).

Thus, if one has uncertainties, $\delta E_{\beta i}$ and $\delta I_{\beta i}$, for all of the end point energies and intensities, and if each end point energy is assumed to be the mean of a random variable with standard deviation the listed uncertainty, then the standard deviation, σ_β, of the derived random variable (Appendix I) can be approximated by:

$$\sigma_\beta^2 \simeq \frac{1}{10{,}000} F_\beta^2 \sum_{i=1}^{n} f^2(E_{\beta i})[I_{\beta i}^2 \delta E_{\beta i}^2 + E_{\beta i}^2 \delta I_{\beta i}^2] \qquad (2\text{-}2)$$

The above approximation assumes that the function, f, is not a strongly varying function of $E_{\beta i}$. Probabilistic techniques can also be used to find σ_β (Appendix I) without making the above assumption. Appendix II includes values of σ_β obtained using both of the above methods; the agreement between the two methods is quite good.

An analogous calculation is used to find average gamma energy of decay, E_γ, and its uncertainty σ_γ. Let $E_{\gamma i}$ and $\delta E_{\gamma i}$ be the gamma decay mode energies and their uncertainties where $1 \leq i \leq m$ and m is the number of type 9 cards (i.e., m is the number of measured gamma decay modes). If F_γ is the normalization constant, IC_i are the internal conversion coefficients, and $I_{\gamma i}$ and $\delta I_{\gamma i}$ relative intensities and intensity uncertainties, then

$$E_\gamma = \frac{1}{100} F_\gamma \sum_{i=1}^{m} E_{\gamma i} I_{\gamma i} (1 + IC_i) \qquad (2\text{-}3)$$

and

$$\sigma_\gamma^2 = \frac{1}{10000} F_\gamma^2 \sum_{i=1}^{m} (1 + IC_i)^2 \, [I_{\gamma_i}^2 \delta E_{\gamma_i}^2 + E_{\gamma_i}^2 \delta I_{\gamma_i}^2] \qquad (2\text{-}4)$$

Appendix II includes the results of these calculations together with probabilistic estimates of σ_γ for the various nuclides.

2.2 Energy Uncertainties Due to Unevaluated Experimental Data

Energy and intensity uncertainties are listed for all of the spectral data for the nuclide illustrated in Table II-1. This uncertainty data is not complete for many of the nuclides listed in the Reich data file (cf. Table II-3). This section gives a method for analyzing the existing uncertainty data and using the results of the analysis to supply estimates for the missing uncertainty data. Tables II-4 through II-7 list various sortings of the uncertainty data which are used to make the estimates. Table II-8 gives the algorithm used to supply the estimates, and Table II-9 lists the decay data for the nuclide of Table II-3 with estimates for the missing uncertainties included. The uncertainties which were supplied by the methods described below are labeled with "*".

Table II-4 lists the 25 largest relative and absolute uncertainties found in spectral energy or intensity for all spectral lines listed in the Reich file. For example, the

Table II-3

```
441030    PU                                   12                                         10441030
   PREPARED FOR FILE* 9/73                                          RES (GULF)            20441030
   REFERENCE* H. PETTERSON ET AL., Z. PHYSIK 233, 260 (1970)                              20441030
   HALF-LIFE- N.E.HOLDEN,CHART OF THE NUCLIDES (1973)+                                    20441030
              AND PRIVATE COMMUNICATION(SEPT.,1973).                                      20441030
   Q VALUE IS FROM 1973 REVISION OF WAPSTRA-GOVE MASS TABLES.                             20441030
     GAMMA-RAY ENERGIES ARE WEIGHTED AVERAGE ENERGIES FROM                                20441030
     TABLE 2 OF REF.                                                                      20441030
   GAMMA-RAY INTENSITIES AND INTENSITY UNCERTAINTIES ARE TAKEN                            20441030
   FROM TABLE 1 OF REF., EXCEPT FOR 610.23-KEV GAMMA RAYS, FOR                            20441030
   THESE GAMMA RAYS, INTENSITY DATA FROM FIG. 4 WERE ALSO USED.                           20441030
   INTERNAL CONVERSION COEFFICIENTS WERE OBTAINED FROM DATA IN REF.                       20441030
   BETA-RAY DATA WERE TAKEN FROM FIG. 4 OF REF.                                           20441030
   39.6         0.2         0          1          2                                       30441030
        1           1    722.0       3.6       100.                                       40441030
    67.53         0.0    490.02       0.0                                                 50441030
      1.0                   6          1                                                  60441030
    111.                  0.4                                                             70441030
    112.                  6.2                                                             70441030
    225.                 90.                                                              70441030
    405.                  0.01                                                            70441030
    467.                  0.25                                                            70441030
    722.                  3.5                                                             70441030
   0.90                    10          0                                                  80441030
  53.274      0.010      0.384      0.020         2.18                                    90441030
 114.65       0.05       0.012      0.005         0.21                                    90441030
 241.82       0.13       0.014      0.004                                                 90441030
 294.88       0.06       0.284      0.015                                                 90441030
 357.27       0.13       0.007                                                            90441030
 443.82       0.07       0.402      0.018                                                 90441030
 497.080      0.013    100.                                                               90441030
 557.09       0.09       0.893      0.035                                                 90441030
 610.29       0.19       5.96                                                             90441030
 611.53       0.25       0.44                                                             90441030
```

Table II-4

THE 25 LARGEST RELATIVE AND ABSOLUTE UNCERTAINTIES LISTED IN THE AEROJET FILE

UNCERTAINTIES							
BETA				GAMMA			
ENERGY		INTENSITY		ENERGY		INTENSITY	
KEV	PERCENT	PERCENT	PERCENT	KEV	PERCENT	PERCENT	PERCENT
400.00	36.70	6.00	200.00	10.00	1.43	37.76	206.90
400.00	29.70	6.00	200.00	8.00	1.42	13.86	142.86
400.00	24.84	3.70	160.87	5.00	1.40	10.00	111.11
400.00	24.59	3.10	100.00	5.00	1.39	7.20	100.00
400.00	24.27	3.00	100.00	5.00	1.22	7.00	100.00
400.00	23.53	3.00	100.00	5.00	1.14	6.50	100.00
400.00	22.46	3.00	100.00	5.00	1.04	6.00	100.00
400.00	21.13	2.20	100.00	3.00	.93	6.00	100.00
400.00	20.65	2.20	100.00	3.00	.87	5.00	100.00
400.00	20.07	2.00	100.00	3.00	.86	5.00	100.00
300.00	18.87	2.00	100.00	3.00	.84	5.00	100.00
300.00	18.52	2.00	100.00	3.00	.79	5.00	100.00
300.00	18.40	2.00	80.00	3.00	.79	4.94	100.00
200.00	18.33	1.80	80.00	2.80	.78	4.39	100.00
200.00	17.54	1.60	73.41	2.10	.77	4.37	100.00
200.00	17.41	1.60	76.92	2.00	.71	4.26	100.00
200.00	16.50	1.50	66.67	2.00	.66	4.00	100.00
200.00	16.23	1.40	66.67	2.00	.66	3.60	100.00
200.00	16.06	1.30	51.52	2.00	.64	3.45	100.00
200.00	15.56	1.20	50.00	2.00	.64	3.20	100.00
200.00	14.89	1.10	50.00	2.00	.62	3.08	100.00
200.00	14.11	1.10	50.00	2.00	.61	3.05	100.00
200.00	13.57	1.10	50.00	2.00	.60	2.98	100.00
100.00	13.48	1.10	50.00	2.00	.60	2.92	100.00
100.00	13.45	.90	50.00	2.00	.60	2.88	100.00

Table II-5

THE 25 LARGEST RELATIVE AND ABSOLUTE UNCERTAINTIES WITH SPECTRAL LINE INTENSITY LESS THAN OR EQUAL TO ONE PERCENT OF TOTAL INTENSITY

UNCERTAINTIES

BETA				GAMMA			
ENERGY		INTENSITY		ENERGY		INTENSITY	
KEV	PERCENT	PERCENT	PERCENT	KEV	PERCENT	PERCENT	PERCENT
100.00	29.70	.80	200.00	10.00	1.43	1.60	206.40
100.00	24.34	.50	200.00	8.00	1.42	.68	142.86
100.00	24.53	.27	100.00	5.00	1.40	.57	111.11
100.00	24.27	.20	100.00	5.00	1.39	.50	100.00
100.00	23.53	.20	100.00	5.00	1.22	.47	100.00
100.00	20.65	.20	100.00	5.00	1.14	.47	100.00
100.00	20.07	.20	100.00	3.00	.87	.47	100.00
100.00	18.87	.20	100.00	3.00	.86	.47	100.00
100.00	18.52	.17	100.00	3.00	.84	.47	100.00
100.00	18.40	.11	80.00	3.00	.79	.45	100.00
100.00	17.54	.11	60.00	3.00	.78	.40	100.00
100.00	17.41	.10	73.41	3.00	.78	.40	100.00
100.00	16.50	.10	75.92	2.80	.73	.40	100.00
100.00	16.06	.10	66.67	2.10	.66	.40	100.00
100.00	15.56	.10	66.67	2.00	.64	.40	100.00
100.00	14.39	.10	51.52	2.00	.64	.40	100.00
100.00	13.57	.10	50.00	2.00	.62	.39	100.00
100.00	13.45	.10	50.00	2.00	.61	.38	100.00
100.00	13.45	.10	50.00	2.00	.60	.38	100.00
100.00	13.44	.10	50.00	2.00	.60	.38	100.00
100.00	13.27	.10	50.00	2.00	.58	.38	100.00
100.00	13.22	.10	50.00	2.00	.57	.38	100.00
100.00	12.61	.10	50.00	2.00	.56	.38	100.00
100.00	12.37	.10	50.00	2.00	.55	.36	100.00
100.00	12.01	.10	50.00	2.00	.53	.35	100.00

Table II-6

THE 25 LARGEST RELATIVE AND ABSOLUTE UNCERTAINTIES FOR SPECTRAL LINES WITH INTENSITY BETWEEN ONE AND TEN PERCENT OF TOTAL INTENSITY

UNCERTAINTIES

BETA				GAMMA			
ENERGY		INTENSITY		ENERGY		INTENSITY	
KEV	PERCENT	PERCENT	PERCENT	KEV	PERCENT	PERCENT	PERCENT
400.00	36.70	3.70	160.87	2.00	.93	2.38	50.00
400.00	22.46	1.60	100.00	2.00	.66	2.52	46.67
400.00	21.13	1.40	100.00	2.00	.60	2.45	45.00
400.00	18.33	1.10	46.67	1.50	.39	2.33	44.00
400.00	16.23	1.10	30.77	1.20	.36	2.25	42.00
400.00	13.02	.80	24.44	1.10	.33	2.00	38.57
400.00	11.49	.70	23.13	1.10	.33	1.92	36.36
400.00	10.98	.70	22.71	1.10	.29	1.87	32.25
200.00	10.73	.57	15.38	1.00	.28	1.80	30.00
200.00	9.52	.50	13.92	1.00	.27	1.65	29.00
200.00	9.14	.41	11.52	1.00	.26	1.63	28.75
200.00	8.99	.40	11.51	1.00	.25	1.62	27.78
100.00	8.45	.40	10.07	1.00	.22	1.60	27.78
100.00	8.03	.40	9.30	1.00	.22	1.60	27.27
100.00	7.85	.40	8.33	1.00	.22	1.60	27.27
100.00	7.63	.35	8.33	1.00	.18	1.55	25.81
100.00	7.52	.37	7.69	1.00	.17	1.51	25.71
100.00	7.51	.30	7.49	1.00	.15	1.41	25.00
100.00	7.34	.70	7.22	1.00	.15	1.37	25.00
100.00	6.37	.30	7.14	1.00	.15	1.34	24.24
100.00	6.13	.23	7.14	1.00	.15	1.34	24.19
100.00	6.08	.20	7.14	1.00	.15	1.32	24.19
100.00	5.85	.19	7.04	1.00	.14	1.32	24.12
100.00	5.66	.19	6.85	1.00	.14	1.32	23.53
100.00	5.63	.16	6.67	1.00	.14	1.30	23.08

Table II-7

THE 25 LARGEST RELATIVE AND ABSOLUTE UNCERTAINTIES FOR SPECTRAL LINES WITH RELATIVE INTENSITY GREATER THAN TEN PERCENT

UNCERTAINTIES

BETA				GAMMA			
ENERGY		INTENSITY		ENERGY		INTENSITY	
KEV	PERCENT	PERCENT	PERCENT	KEV	PERCENT	PERCENT	PERCENT
400.00	14.11	6.00	27.27	5.00	1.04	37.75	100.00
400.00	13.48	6.00	13.60	1.00	.71	18.88	66.67
300.00	13.40	3.10	11.75	1.00	.56	10.00	63.40
300.00	11.79	3.00	11.76	.80	.40	7.20	21.88
300.00	10.04	3.00	9.68	.50	.32	7.00	20.00
200.00	9.95	3.00	9.40	.50	.29	6.50	20.00
200.00	9.07	2.20	9.20	.50	.28	6.00	15.38
200.00	8.92	2.20	8.77	.50	.24	6.00	15.08
200.00	5.98	2.00	8.33	.50	.18	5.00	15.00
200.00	5.67	2.00	7.21	.50	.17	5.00	15.00
200.00	5.58	2.00	7.14	.50	.16	5.00	15.00
100.00	5.48	2.00	5.77	.50	.16	5.00	13.33
100.00	5.35	1.80	4.65	.50	.15	4.94	12.20
100.00	5.15	1.60	4.55	.40	.15	4.39	11.42
100.00	4.82	1.30	4.45	.40	.14	4.77	11.10
100.00	4.75	1.30	4.35	.40	.14	4.25	11.01
100.00	4.55	1.20	4.23	.40	.14	4.00	10.91
100.00	4.41	1.10	4.01	.40	.13	3.60	10.53
100.00	4.16	1.10	3.95	.30	.13	3.45	10.34
80.00	4.04	.90	3.61	.30	.13	3.20	10.34
80.00	3.82	.70	3.47	.30	.12	3.08	10.00
80.00	3.81	.70	3.23	.30	.12	3.05	10.00
80.00	3.62	.70	2.81	.30	.11	2.92	10.00
80.00	3.57	.60	2.44	.30	.11	2.88	9.94
80.00	3.55	.60	1.65	.30	.11	2.75	9.89

Table II-8

Maximum Uncertainties for Spectral Decay Data

Intensity	BETA Energy keV or %	BETA Intensity %(a) or %(b)	GAMMA Energy keV or %	GAMMA Intensity %(a) or %(b)
I ≥ 10%	400 or 15	6 or 30	5 or 1	10 or 70
10% ≥ I ≥ 1%	400 or 35	4 or 150	5 or 1	4 or 100
1% ≥ I	400 or 35	1 or 100	10 or 2	2 or 200

(a) of total intensity

(b) of line intensity

NOTE: The uncertainty to be supplied is either the first entry of the appropriate position or the second multiplied by the datum, whichever is smaller.

Table II-9

441030 RU			12			1 441030
PREPARED FOR FILE≠ 9/73				RES (GULF)		2 441030
REFERENCE≠ H. PETTERSON ET AL., Z. PHYSIK 233, 260 (1970)						2 441030
HALF-LIFE- N.E.HOLDEN,CHART OF THE NUCLIDES (1973)+						2 441030
AND PRIVATE COMMUNICATION(SEPT.,1973).						2 441030
Q VALUE IS FROM 1973 REVISION OF WAPSTRA-GOVE MASS TABLES.						2 441030
GAMMA-RAY ENERGIES ARE WEIGHTED AVERAGE ENERGIES FROM						2 441030
TABLE 2 OF REF.						2 441030
GAMMA-RAY INTENSITIES AND INTENSITY UNCERTAINTIES ARE TAKEN						2 441030
FROM TABLE 1 OF REF., EXCEPT FOR 610.29-KEV GAMMA RAYS, FOR						2 441030
THESE GAMMA RAYS, INTENSITY DATA FROM FIG. 4 WERE ALSO USED.						2 441030
INTERNAL CONVERSION COEFFICIENTS WERE OBTAINED FROM DATA IN REF.						2 441030
BETA-RAY DATA WERE TAKEN FROM FIG. 4 OF REF.						2 441030
39.6	0.2	0	1	2		3 441030
1	1	722.0	3.6	100.		4 441030
67.53	0.0	490.02	0.0			5 441030
1.0		6	1			6 441030
111.00	38.8500*	.4000	.8000*			7 441030
112.00	39.2000*	6.2000	4.0000*			7 441030
225.00	33.7500*	90.0000	6.0000*			7 441030
405.00	141.7500*	.0100	.0200*			7 441030
467.00	163.4500*	.2500	.5000*			7 441030
722.00	252.7000*	3.5000	4.0000*			7 441030
0.90		10	0			8 441030
53.27	.0100	.3840	.0200	2.1800		9 441030
114.65	.0500	.0120	.0050	.2100		9 441030
241.82	.1300	.0140	.0040			9 441030
294.88	.0600	.2840	.0150			9 441030
357.27	.1300	.0070	.0140*			9 441030
443.82	.0700	.4020	.0180			9 441030
497.08	.0130	100.0000	11.1111*			9 441030
557.09	.0900	.8930	.0350			9 441030
610.29	.1900	5.9600	4.4444*			9 441030
611.53	.2500	.4400	.3800*			9 441030

largest absolute beta endpoint energy uncertainty is 400 keV and the largest relative uncertainty in beta endpoint energy (i.e., $100\sigma_\beta/E_\beta$) is 36.7%. These maximum uncertainties need not correspond to the same spectral line or even the same nuclide. The largest absolute gamma intensity uncertainty is 37.76% of total intensity and the largest relative gamma intensity uncertainty (i.e., $100\sigma_\gamma/E_\gamma$) is 206.90%. Tables II-5, II-6, and II-7 are listings of the largest spectral uncertainty data found when attention is restricted to various subsets of the spectral data. Table II-5 lists the 25 largest uncertainties for spectral lines with intensity less than or equal to 1% of total intensity, Tables II-6 and II-7 list uncertainties for lines with relative intensities between 1 and 10%, and greater than or equal to 10% respectively. The expected pattern is found: the more intense spectral lines have been more accurately measured. Table II-8 summarizes this observation and gives an algorithm for estimating uncertainties for those spectral data which do not have evaluated uncertainties: for a given datum an uncertainty is assigned to be either the first entry in the appropriate position in Table II-8 or the second multiplied by the datum,whichever is smaller. Table II-9 shows the result of applying the algorithm to the Ruthenium-103 data given in the Reich file.

Once the spectral uncertainties are supplied for group B nuclides, average beta and gamma energies of decay can be calculated as they were for group A nuclides. Many of the uncertainties supplied above are quite large compared to the corresponding data; some relative uncertainties are greater than 100%. This means that it is not reasonable to model these data as normal random variables since that model gives the data a high probability of being negative. It also suggests that the derived random variable might be strongly non-normal, in which case the standard deviation as estimated by equations (2-2) and (2-4) cannot be used to infer confidence information (this topic is discussed at the end of Appendix I).

In order to resolve the above questions, data with large relative uncertainties were modeled as beta distributions as described in section 2 of Appendix I. The probabilistic technique of Appendix I was then used to determine the derived density functions for average beta and gamma decay energies. Appendix II compares standard deviations obtained using probabilistic techniques with those obtained using equations (2-2) and (2-4). Agreement between these two methods is good for group B nuclides as it was for group A nuclides. Furthermore, the derived density functions turned out to be very nearly normal. This can be explained by noticing that the spectral data with large uncertainties have small yields. This means that the non-normal spectral data contribute little to average decay energy and have correspondingly little effect on the derived density function.

2.3 Energy Uncertainties Due to Data from Theoretical Models

Most of the decay energy data used in afterheat summation calculations are predicted from theoretical models. In order to estimate the uncertainty in afterheat calculations due to uncertainty in decay energies, it is necessary to examine the possible sources of error in predicting these data. Two sources of error are considered here: a random or uncorrelated error in the decay energies predicted by the model, and a correlated error resulting from a bias in the model which systematically predicted energies too high or too low.

The decay energies listed in ENDF/B-IV were predicted by using nuclear systematics to obtain the atomic masses of the parent and daughter, and subtracting the masses to get the Q-value of the decay. This energy was then apportioned among the gamma, beta and neutrino radiation emitted from the decay according to formulae given by Schmittroth and Schenter (equation 1-9).

Several assumptions are made here in order to obtain uncertainty estimates for group C nuclides:

1. The uncertainty in Q-value, δQ, is assumed to be a function of the difference between the atomic number of the parent nuclide and the atomic

number of the first stable nuclide in the beta decay chain (Δz).

2. $\delta Q(0) = 0$ and $\delta Q(2) \simeq 1.3$ MeV [Schmittroth and Schenter,[5] and Liaw (reference 7, page 113) have independently concluded that this is a conservative assumption].

3. Correlated and uncorrelated Q-value uncertainties, δQ_c and δQ_u, apportion $\delta Q(2)$ as follows: $\delta Q_u(2) =$ 1.26 MeV and $\delta Q_c(2) =$ 0.26 MeV.

4. Uncorrelated uncertainties in average beta and gamma decay energy, δE_β and δE_γ, are at least as large as those uncertainties, 0.32 MeV and 0.65 MeV, due to the least mean squares fitting process (section 1.3, page 9 of this thesis).

5. δQ_u increases linearly with Δz.

6. The predicted masses used in estimating Q-values are consistently in error by a term which is cubic in Δz.

Assumptions 1 and 5 reflect the trend that half life gets shorter as distance from beta stability increases. It is difficult to experimentally measure nuclear parameters for nuclides with short half lives, so as Δz increases there is less experimental verification for our evaluated nuclear data.

The assignment of about one MeV uncertainty for theoretically predicted Q-value was arrived at independently by the researchers mentioned above by comparing evaluated data with predicted data (where the evaluated data is available). The value of 1.3 MeV used here is a conservative choice.

The uncertainties of assumption 3 apportion the total Q-value uncertainty between a correlated and an uncorrelated component $[(1.26)^2 + (0.26)^2 = (1.3)^2]$. The possibility of correlated Q-value uncertainty must be considered; however, the correlation cannot be too strong without showing up when predicted and observed data are compared. No such correlation has been observed. It is assumed here that a correlation would show if the correlated component were greater than 20% of the uncorrelated component.

Assumption 4 utilizes the statistical analysis that Schmittroth and Schenter have done on the evaluated beta decay data. As used here, this is a conservative assumption since it assigns finite uncertainties when $\Delta z = 0$ and linearly increases uncertainties as Δz increases.

The semi-empirical mass formula, for constant atomic mass number, is essentially a quadratic in Δz, with even-odd correction terms. The addition of a cubic term with coefficient, k, provides a mechanism for considering bias in Q-value (which increases quadratically with Δz). The coefficient, k, should be chosen large enough to accommodate any possible bias, but it cannot be so large that it would disturb the fit of the formula to known masses.

Assumption 3 imposes the appropriate limit on k. Conservation of mass and energy imposes further constraints on the size of k, but these constraints are less restrictive than assumption 3.

From assumptions 2, 3, and 5, a formula for δQ_u can be derived:

$$\delta Q_u(\Delta z) = \frac{1.26}{2}\,\Delta z = 0.63\,\Delta z$$

Next, expressions for δE_β and δE_γ as functions of Δz can be derived. Since

$$E = E_\beta + E_\gamma = Q\left(\frac{E_\beta}{Q} + \frac{E_\gamma}{Q}\right)$$

δE can be expressed in the following ways:

$$(\delta E)^2 = (\delta E_\beta)^2 + (\delta E_\gamma)^2$$

$$= (\delta Q)^2\left(\frac{E_\beta}{Q} + \frac{E_\gamma}{Q}\right)^2 + Q^2\left[\left(\delta\frac{E_\beta}{Q}\right)^2 + \left(\delta\frac{E_\gamma}{Q}\right)^2\right]$$

$$= E_\beta^2\frac{(\delta Q)^2}{Q^2}\left(1 + \frac{E_\gamma}{E_\beta}\right) + (\delta E_\beta)^2 + E_\gamma^2\frac{(\delta Q)^2}{Q^2}\left(1 + \frac{E_\beta}{E_\gamma}\right) + (\delta E_\gamma)^2$$

$$= E_\beta^2\frac{0.4\Delta z^2}{Q^2}\left(1 + \frac{E_\gamma}{E_\beta}\right) + (0.32)^2 + E_\gamma^2\frac{0.4\Delta z^2}{Q^2}\left(1 + \frac{E_\beta}{E_\gamma}\right) + (0.65)^2$$

δE_β and δE_γ are defined by:

$$(\delta E_\beta)^2 = E_\beta^2\,\frac{0.4\Delta z^2}{Q^2}\left(1 + \frac{E_\gamma}{E_\beta}\right) + (0.32)^2 \qquad (2\text{-}5)$$

and

$$(\delta E_\gamma)^2 = E_\gamma^2\,\frac{0.4\Delta z^2}{Q^2}\left(1 + \frac{E_\beta}{E_\gamma}\right) + (0.65)^2 \qquad (2\text{-}6)$$

in order to satisfy $\delta E^2 = \delta E_\beta^2 + \delta E_\gamma^2$.

From assumption 6,

$$M(\Delta z) = M_s(\Delta z) + k\Delta z^3$$

where $M(\Delta z)$ is the actual mass of the nuclide in a mass chain which is Δz charge units from beta stability, M_s is the predicted mass, and k is a constant. The Q-value can then be expressed:

$$Q(\Delta z) = M_s(\Delta z) - M_s(\Delta z - 1) + k[\Delta z^3 - (\Delta z - 1)^3]$$

and the correlated uncertainty in Q-value can be expressed as:

$$\delta Q_c(\Delta z) = k[\Delta z^3 - (\Delta z - 1)^3].$$

Since $\delta Q_c(2) = 0.26$ MeV,

$$\delta Q_c(\Delta z) = 0.375[\Delta z^3 - (\Delta z - 1)^3]. \qquad (2\text{-}7)$$

Equations 2-5, 2-6 and 2-7 were used to supply uncertainties for Appendix III when they were not available in Appendix II.

III. CONCLUSIONS AND DISCUSSION

Appendix III is a listing of the nuclides used in after-heat calculations together with energy uncertainties obtained using the techniques of Chapter II. The coefficients $A_{ij}(t,T)$ of equation 1-6 can be calculated using decay constant, yield, and branching ratios data. Appendix III data can then be used with equations 1-6, 1-7, and 1-8 to obtain the H functions as a function of irradiation time and shutdown time together with uncertainty in these functions due to decay energy uncertainties. Figures 3-1 through 3-6 display these functions and their uncertainties for a standard irradiation time of 1.28×10^8 seconds at constant power and constant flux. The effect of neutron capture during the irradiation has been neglected in these calculations. Shay[(8)] has shown that these effects can be treated with a small correction for the conditions considered here. The graphs are plotted from calculations made with 37 decay times from zero to 10^4 seconds.

Figures 3-1 through 3-3 show log-log plots of H, H_1, and H_2 respectively with total uncertainty bars. The total uncertainties have both yield and energy components; the yield components were obtained using techniques described in reference 1, and the energy components were obtained using the techniques described in this paper. Each energy component has three subcomponents; a correlated component,

FIGURE 3-1

U235 H FUNCTION WITH TOTAL UNCERTAINTY

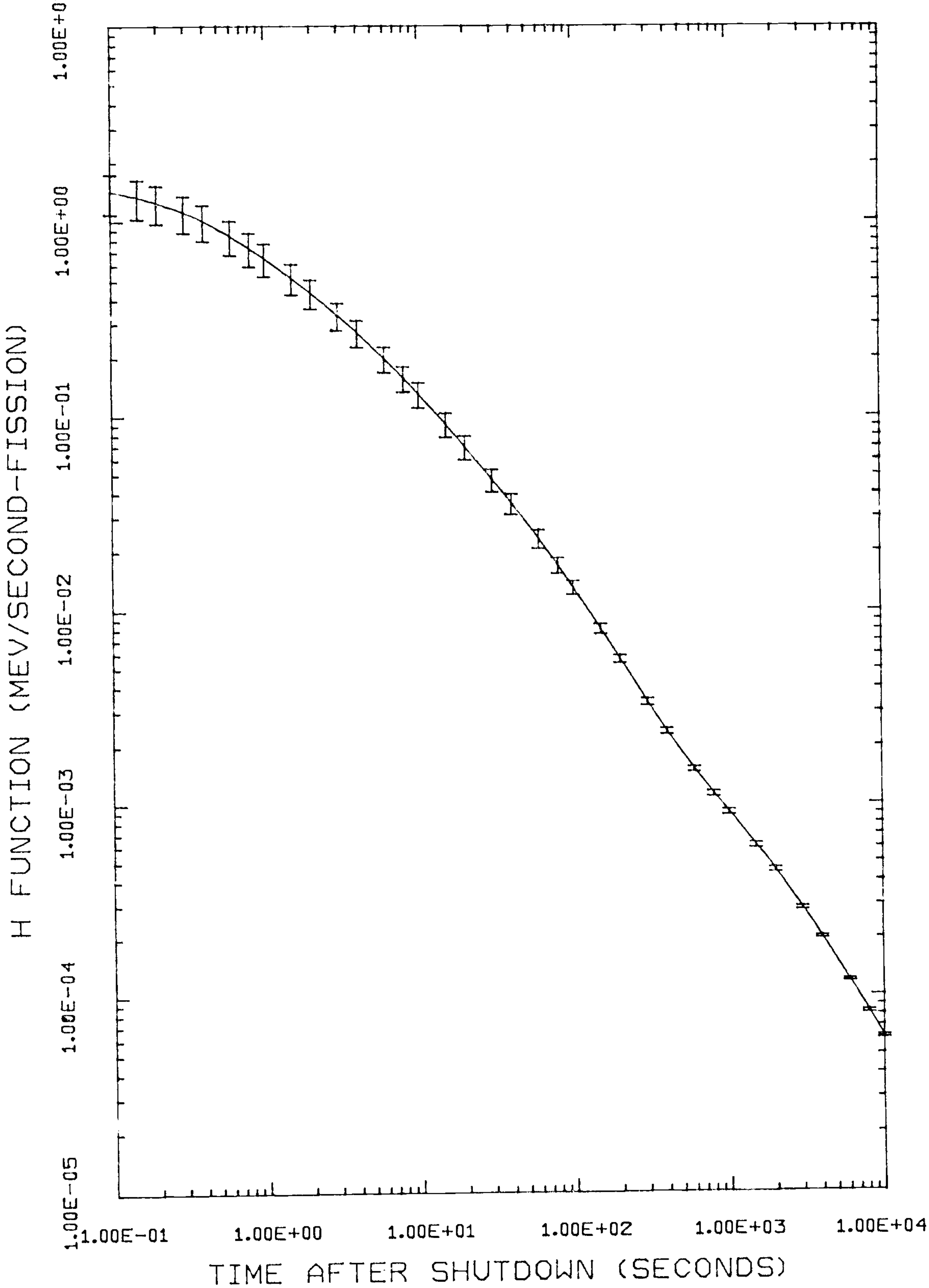


FIGURE 3-2

U235 H1 FUNCTION WITH TOTAL UNCERTAINTY

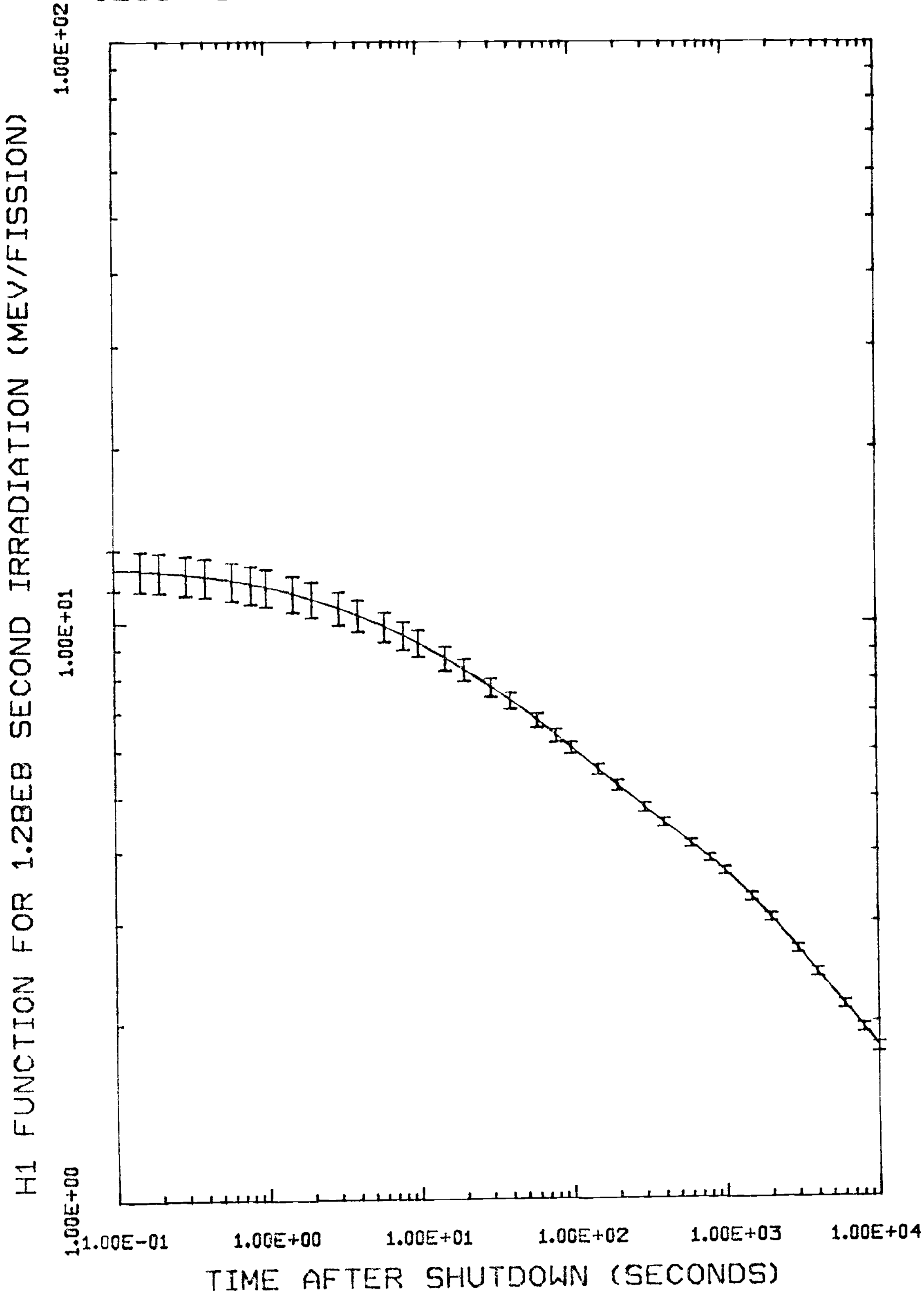
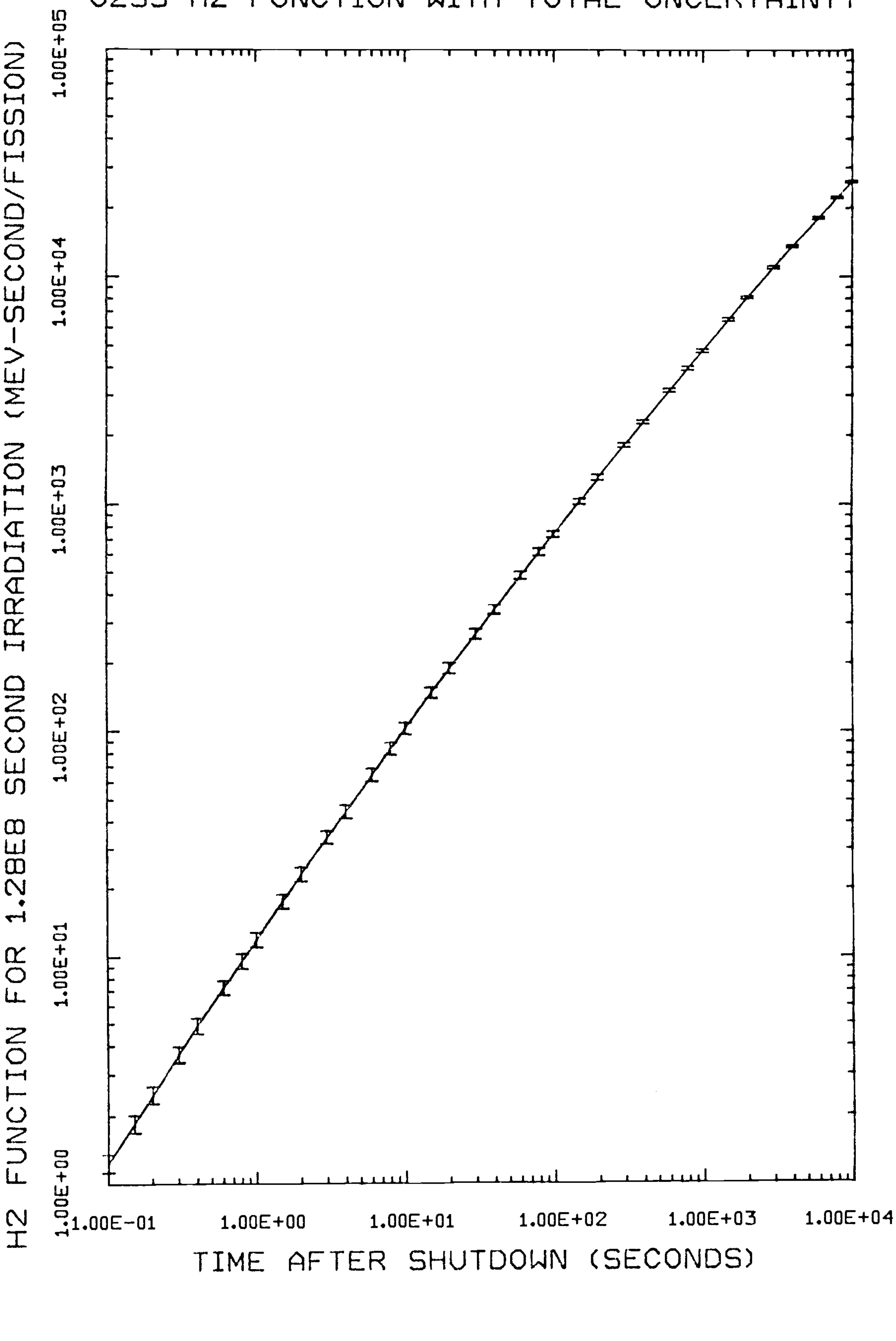


FIGURE 3-3

U235 H2 FUNCTION WITH TOTAL UNCERTAINTY



a component due to uncorrelated uncertainties in beta decay energies, and a component due to uncorrelated uncertainties in gamma decay energies. The total uncertainties are obtained by calculating the square root of the sum of the squares of the individual components.

Figure 3-4 is a semi-log plot of the H_1 function with total uncertainty bars, and Figure 3-5 is a log-log plot of the H_1 function with the uncertainty bars due to uncertainty in decay energy of the individual nuclides. Figure 3-6 compares the various energy uncertainty components.

Uncertainties are largest for short cooling times because most of the decay power immediately after shutdown comes from nuclides with short half lives. Decay data are not available for most of these nuclides since their short half lives make experimental observation difficult. Therefore, the data which contribute most to decay heat at short cooling times are predicted by nuclear chematics and have relatively large uncertainties; and these large uncertainties propagate to produce large uncertainties in the H functions.

The H_1 function predicts the amount of power which must be removed from a reactor in event of a loss of coolant accident in order to prevent any increase in fuel temperature. The H_2 function gives the amount of decay energy which has been released since the loss of coolant accident. The difference between the amount of energy removed by the

FIGURE 3-4

U235 H1 FUNCTION WITH TOTAL UNCERTAINTY

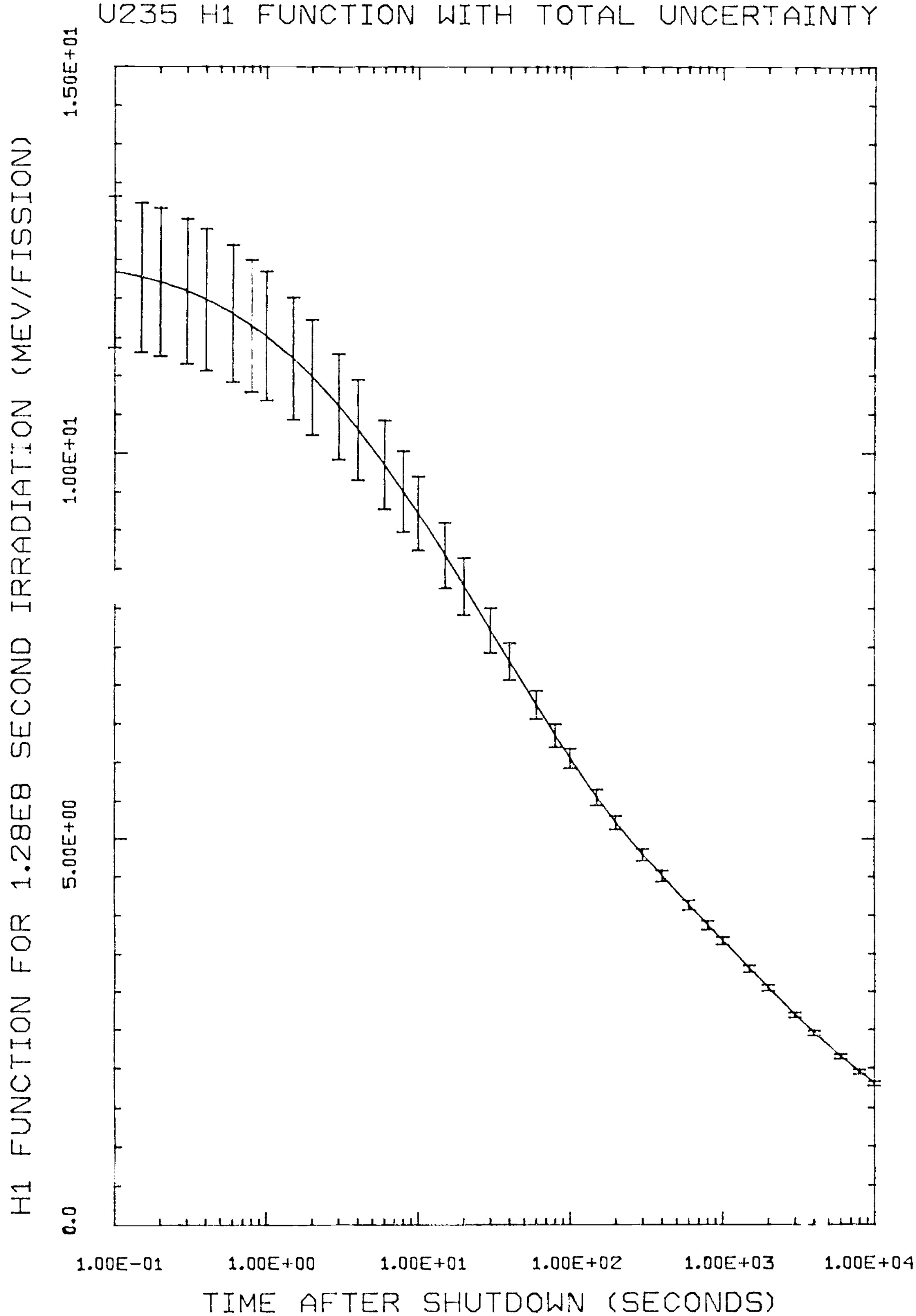


FIGURE 3-5
U235 H1 FUNCTION WITH ENERGY UNCERTAINTY

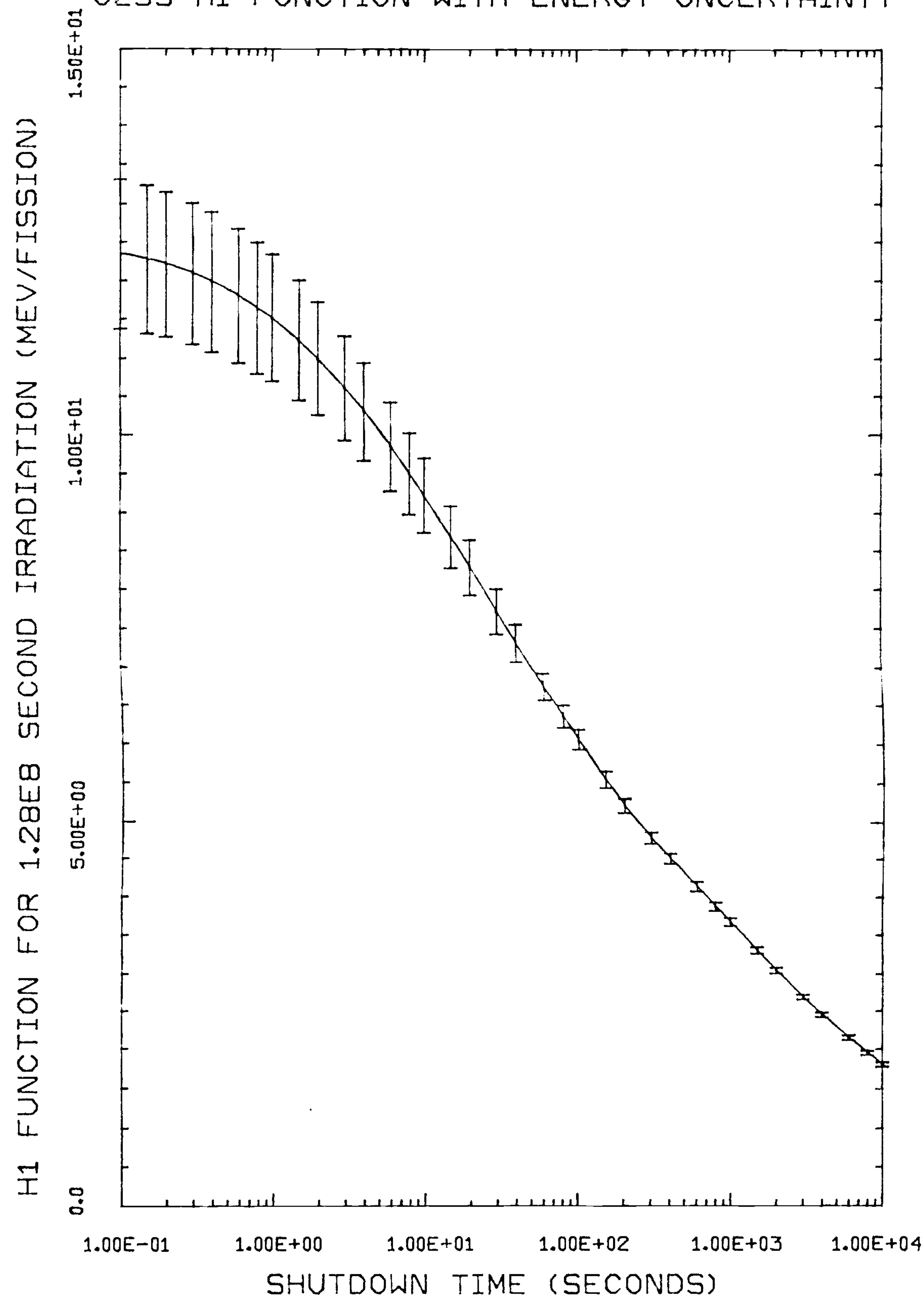
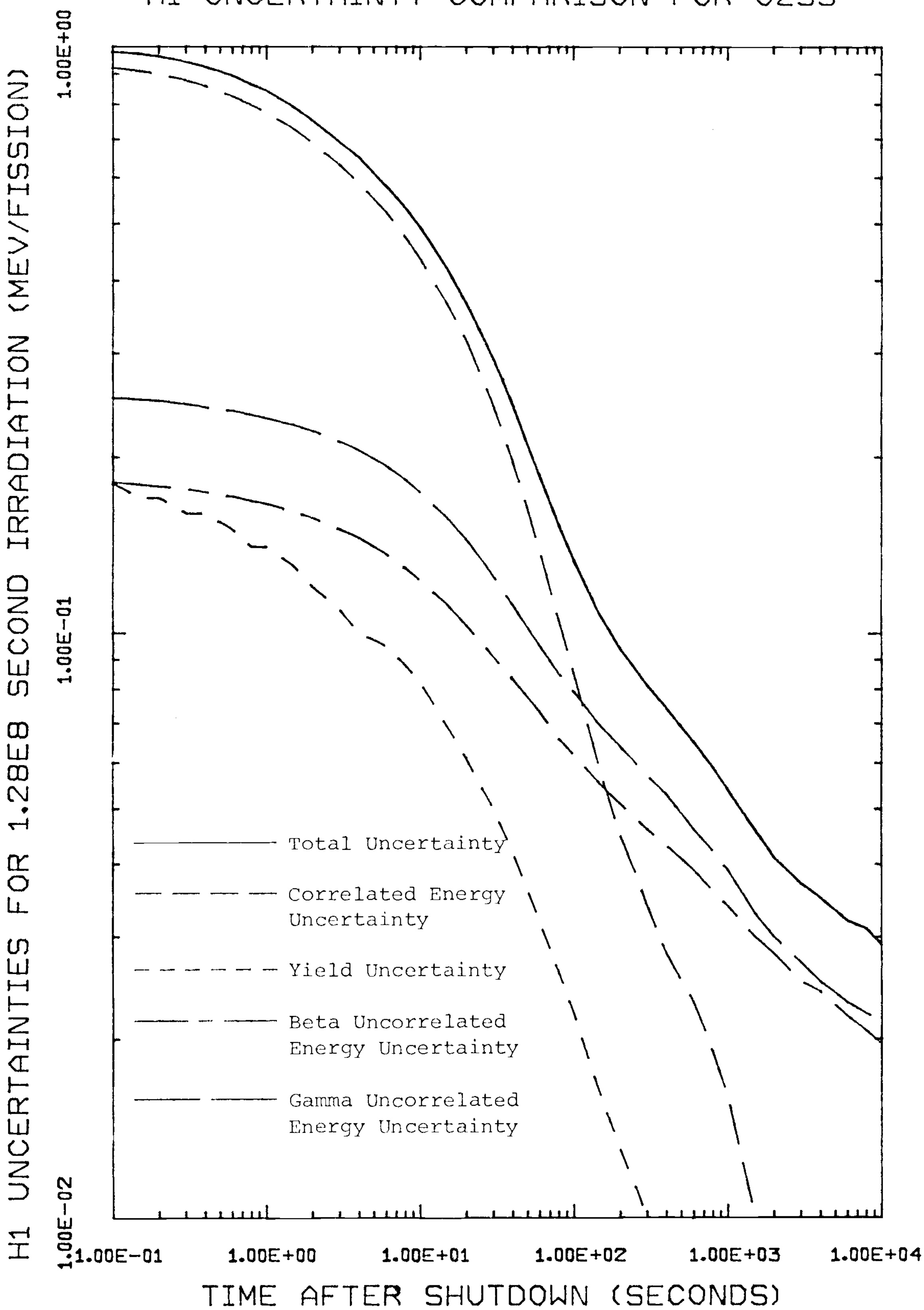


FIGURE 3-6

H1 UNCERTAINTY COMPARISON FOR U235



emergency core cooling system and the H_2 function is the energy which has produced a temperature change in the reactor fuel. The emergency core cooling systems must be designed so that fuel integrity is not damaged by this energy difference. It should be noted that the uncertainty bands for the H_2 function are much smaller than the uncertainty bands for the H_1 or H functions. This means that the amount of energy which must be removed can be calculated much more reliably than the instantaneous shutdown power.

The results presented here are intended to be used in the formulation of a new decay heat standard for the United States Regulatory Commission. The standard is used to determine adequacy of the emergency core cooling systems for commercial nuclear power plants. The emergency systems must be capable of removing the maximum amount of decay heat produced, so conservative engineering practice dictates that the emergency systems be capable of removing the maximum predicted heat plus enough extra heat that one can be confident that uncertainties in the computation will not cause reactor damage under any likely emergency condition.

The uncertainty bands given here are "one sigma" bands; i.e., the "confidence level" (Appendix I) which can be assigned to the calculation is 68%. If the emergency core cooling system is sized to remove the predicted heat plus one sigma, then one can be 84% confident that it will be adequate.

The agreement between the results presented here and those of Schmittroth and Schenter[5] is a strong indication that these uncertainty calculations are reliable. Further comparisons should be made between these results and various integral experiments which are in progress.

There are a variety of ways in which these uncertainty calculations might be refined:

1. As evaluated data become available for more nuclides the calculations can be performed with the new data set. This might change the predicted decay power, and it should decrease the uncertainties.
2. Integral experiment data might be used to infer a correlation among the nuclides for which decay data is predicted by nuclear systematics; data for these nuclides could be modified according to the correlation, changing the predicted values of reactor heat.
3. The calculations could be performed again using the latest least-squares coefficient uncertainties (cf. section 1.3 of this thesis).
4. The methods presented here do not take advantage of the fact that the sum of the beta spectral line

intensities used in equation 2-1 add up to one (this is not true for gamma spectral intensities). This latter refinement should have little effect since the component of decay heat uncertainty due experimental data is small for most decay times.

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APPENDICES

Appendix I

STATISTICAL PRELIMINARIES

Suppose that one is presented with a set of experimentally determined data, x_i, $1 \le i \le n$, together with an estimate of the uncertainty, σ_i, in each x_i. Suppose further, that an arithmetic calculation is performed using the data. The question arises: "Given that there is uncertainty in the data base, how much confidence can one have in the result of the calculation?"

The above question is usually answered in terms of random variables (defined in section 1 of this appendix); it is assumed that each time a parameter, x_i, is measured, a different answer can be obtained. If a given parameter is measured many times, then an average value, $\bar{x}_i$, and a standard deviation σ_i can be determined. The average, $\bar{x}_i$, is an estimate of the "real" value of the parameter and the standard deviation, σ_i, is a measure of how well the various experimental observations agree. If a large enough number of observations have been made, then $\bar{x}_i$ can be considered as the "best" estimate of the datum, and σ_i is a measure of the confidence that we can have in $\bar{x}_i$.

The arithmetic calculation referred to above is a continuous function of n variables, $f(x_1, x_2, \ldots x_n) = f(x)$ (where x is a real n-dimensional vector). Each time measurements are taken to determine a complete set of data, $(x_1, \ldots x_n)$, a value of f can be determined. If several such sets of measurements are taken, then several values of f are available. These values of f can be averaged to determine $\overline{f(x)}$, and a standard deviation, σ, can also be determined. The average value, $\overline{f(x)}$, is the number which we expect to be the "real" result of the calculation, and σ is an indication of how much confidence we can have in $\overline{f(x)}$. In practice, the process of evaluating data is much more complex than the process described here, but this simple approach is used as a basis for estimating uncertainty propagation. When a datum is given with an uncertainty, it is assumed that the value given for the datum is the average value of a random variable and the uncertainty is the standard deviation.

Most physical parameters which are measured experimentally are not random variables; if successive measurements disagree, it is due to imperfections in our ability to observe physical phenomena (ignoring quantum mechanical effects). Sometimes, however, it is necessary to measure parameters which are random variables. For example consider the measurement of two parameters of a radionuclide which decays by beta emission. The two parameters to be measured are Q-value and kinetic energy of the beta particle. Every time a nuclide of the type being considered decays, the Q-value is the same; disagreement among observers is used to determine "error bars" for the datum. The kinetic energy of the beta particle, however, varies widely from decay to decay. We say that the beta particles are produced in a "spectrum."

1. Random Variables

A "random variable" (x_i, p_i) is a function, $x_i : S_i \to R$, from a set, S , to the real numbers, together with a "probability density function", $p_i : R \to R^+$, from the real numbers to the non-negative real numbers. The density function, p_i, has the properties:

1. p is Lebesque integrable,
2. $\int_{-\infty}^{\infty} p_i(x)\,dx = 1$, and
3. p (x) ≥ 0 for all x.

This definition applies to the discussion above concerning experimental measurements. The set S is the set of all experimental observations of a particular phenomenon; for a particular observation, $s \in S_i$, $x_i(s)$ is the datum obtained. The integral, $\int_b^a p_i(x)\,dx$, is the probability that $x_i(s)$ is in the interval [a,b]. If a finite number of observations $(s_1, s_2, \ldots, s_m)$ are made, then p_i can be approximated by approximating its integral between any two real numbers, a and b:

$$\int_a^b p_i(x)\,dx \simeq \frac{1}{m}\, U(a,b)$$

where U(a,b) is the number of times that $x_i(s_i)$ falls in the interval [a,b].

The mean, $\overline{x_i}$, and the standard deviation, σ_i, of the random variable, (x_i,p_i) (usually denoted simply by x_i), are given by:

$$x_i = \int_{-\infty}^{\infty} xp_i(x)dx, \text{ and}$$

$$\sigma_i^2 = \int_{-\infty}^{\infty} (x-\overline{x_i})^2 p_i(x)dx$$

$$= \int_{-\infty}^{\infty} x^2 p_i(x)dx - 2\overline{x_i}\int_{-\infty}^{\infty} xp_i(x)dx + \overline{x_i}^2$$

$$= \overline{x_i^2} - \overline{x_i}^2$$

A probability density function, p_i, determines a "cumulative probability density function," P_i, by the formula:

$$P_i(x) = \int_{-\infty}^{x} p_i(x)dx$$

Cumulative density functions are monotonically increasing, i.e., if $x_1 < x_2$ then $P_i(x_1) \leq P_i(x_2)$. If a given cumulative density function is strictly increasing (i.e., if strict inequality holds above), then it has an inverse, $P_i^{-1}: I \to R$, where I is the unit interval of real numbers between zero and one.

Intuitively, $P_i(x)$ is the probability that a given observation will give a result which is less than or equal to x.

2. The Normal and Beta Distributions

In order to exhibit a particular random variable, x_i, it is necessary to provide a prescription for its probability density function, p_i. The most commonly used random variable is the "normal distribution"; its density function is given by:

$$p_i(x) = \frac{1}{\sqrt{2\pi}\ \sigma_i} \operatorname{Exp}\left(\frac{(x-\overline{x_i})^2}{2\pi\ \sigma_i^2}\right)$$

where $\overline{x_i}$ and σ_i are the mean and standard deviation as defined above.

The "beta distribution" has been used in this thesis. Its density function is given by:

$$p_i(x) = \begin{cases} x^n (M - x)^m / N & \text{if } 0 \leq x \leq M \\ 0 & \text{otherwise} \end{cases}$$

where n, m and M are positive real numbers, and N is chosen so that

$$\int_{-\infty}^{\infty} p_i(x)\,dx = 1$$

The parameters n and m are related to the mean and standard deviation of the random variable by:

$$\overline{x_i} = M \frac{n+1}{n+m+2} \quad \text{and}$$

$$\sigma_i^2 = M^2 \frac{(n+1)(m+1)}{(n+m+2)^2 (n+m+3)}$$

Beta distributions are useful because they assign zero probability to values of the random variable which fall outside the range from zero to M. It is common for physical parameters to be confined to a finite range in this manner (e.g., the beta particle from a beta decay must have a kinetic energy which is greater than zero but less than the Q-value of the decay).

3. Sampling a Distribution

If the cumulative density function, P_i, for a random variable is strictly increasing (this is the case for most density functions including those for normal and beta distributions) then it has an inverse, P_i^{-1}, (as noted above). This distribution can then be "sampled" by choosing a number, r_j, at random from those real numbers between zero and one, and then calculating $P_i^{-1}(r_j)$. If m random numbers between zero and one are chosen, then a set of numbers $P_i^{-1}(r_j)$, $1 \leq j \leq m$ is determined. For any real number, x, P(x) can be approximated by:

$$P(x) \simeq \frac{1}{m} U(x)$$

where U(x) is the number of times that $P_i^{-1}(r_j)$ falls in the interval from $-\infty$ to x.

This sampling technique provides a method of converting a "uniform" random number into one which conforms to a given probability density function. The technique can be used to model the situation described at the beginning of this appendix in which physical parameters are being measured. Selecting the random number, r_j, between zero and one corresponds to conducting an experimental measurement. The number, $P_i^{-1}(r_j)$, is modeled as the result of the experiment.

4. Propagation of Uncertainties

Suppose that n uncorrelated physical parameters, $x_1, x_2, \ldots, x_n$, are used in a calculation, $f(x_1, x_2, \ldots, x_n) = f(x)$. The information about each parameter, x_i, comes as a random variable with density function, p_i, mean, $\overline{x_i}$, and standard deviation, σ_i. The mean, $\overline{x_i}$ is modeled as the best estimate of the datum, and the standard deviation, σ_i, is modeled as a measure of the confidence in $\overline{x_i}$. Selection of n random numbers between zero and one, $r_1, r_2, \ldots, r_n$, allows one to sample each random variable. The numbers obtained by sampling, $P_1^{-1}(r_1), P_2^{-1}(r_2), \ldots, P_n^{-1}(r_n)$, can be interpreted as a set of measurements and, as such, they can be used to obtain a value of f. If the sampling process is repeated many times, then many values of f will be available and a probability density function, p(z), for the calculation (the "derived" density function) can be approximated by:

$$p(z) \simeq \frac{U(h)}{2mh}$$

where m is the number of sets of samples taken, U(h) is the number of times that f(x) fell in the interval (z-h,z+h), and h is some small positive number.

The derived density function is a complete measure of the reliability of the calculation. For example, if one wants to find an interval around $\overline{f(x)}$ such that the probability of the "real" value of f(x) being in that interval is ρ%, then one simply finds a number h such that

$$\int_{\overline{f(x)}-h}^{\overline{f(x)}+h} p(z)dz = \frac{\rho}{100}$$

The probabilistic techniques outlined above require a considerable amount of computer time, so techniques which give an indication of reliability for a calculation without sampling the density functions are very desirable. If the function, f, can be approximated by the first two Taylor terms,

$$f(x) \simeq f(\overline{x}) + \sum_{i=1}^{n} f_i(\overline{x})(x_i - \overline{x_i}),$$

$$\text{then } \overline{f(x)} \simeq f(\overline{x}) \quad \text{and } \sigma^2 \simeq \sum_{i=1}^{n} f_i(\overline{x})\sigma_i^2,$$

$$\text{where } \overline{x} = (\overline{x}_1, \overline{x}_2, \ldots \overline{x}_n)$$

$$\text{and} \quad f_i(\overline{x}) = \frac{\partial}{\partial x_i} f(\overline{x})$$

In order to show the above, notice that

$$\overline{f(x)} = \int f(x)p(x)dx$$

$$\simeq f(\overline{x})\int p(x)dx + \int \left[\sum_{i=1}^{n} f_i(\overline{x})(x_i - \overline{x_i})\right] p(x)dx$$

$$= f(\bar{x}) + \sum_{i=1}^{n} f_i(\bar{x}) \int_{-\infty}^{\infty} (x_i - \bar{x}_i) p_i(x_i) dx_i$$

$$= f(\bar{x}) \tag{3}$$

where the integral sign without limits means the integral over all of n-dimensional Euclidean space and $p(x)$ is the product of the $p_i(x_i)$.

The standard deviation can now be approximated by:

$$\sigma^2 = \int [f(x) - \overline{f(x)}]^2 p(x) dx$$
$$\approx \int [f(x) - f(\bar{x})]^2 p(x) dx$$
$$\approx \int \left[\sum_{i=1}^{n} f_i(\bar{x})(x_i - \bar{x}_i) \right]^2 p(x) dx$$
$$= \int \sum_{i=1}^{n} f_i^2(\bar{x})(x_i - \bar{x}_i)^2 p(x) dx$$
$$= \sum f_i^2(\bar{x}) \sigma_i^2 \tag{4}$$

Equations (3) and (4) both utilize the identity:

$$\int_{-\infty}^{\infty} (x_i - \bar{x}_i) p_i(x) dx = 0$$

5. Standard Deviation as a Measure of Confidence

Standard deviation has been referred to (vaguely) in this appendix as a measure of the confidence that one can have in a datum. Specifically, if x_i is a normal random variable which describes a physical datum, then the probability that the "real" datum is within one standard deviation of the mean is 0.68. That is:

$$0.68 = \int_{\overline{x}_i-\sigma_i}^{\overline{x}+\sigma_i} p_i(x)dx$$

where p_i is the density function for p_i and σ_i is the standard deviation. The probability of being within two standard deviations is 95% and the probability of being within three is 99%.

These observations relating standard deviation and confidence do not apply if the random variable in question deviates much from the normal shape. For example, consider the "uniform" distribution determined by the following probability density function:

$$p(x) = \begin{cases} 1 \text{ if } 0 \leq x \leq 1 \\ 0 \text{ otherwise} \end{cases}$$

The mean of this random variable is 0.5 and the standard deviation is given by:

$$\sigma^2 = \int_2^1 x^2dx - 0.25 = \frac{1}{12}$$

Thus the probability of being within one standard deviation of the mean is $2/\sqrt{12} \approx 0.58$, and one is certain to be within two standard deviations of the mean.

Non-normal random variables are commonly generated by normal ones; for example, if x is a normal random variable with $\overline{x} = 0$, then the derived density function fox x^2 has a maximum at zero yet it is zero for all negative values. Thus x^2 is a very "non-normal" random variable and it cannot be expected that a "one sigma" band around the mean corresponds to a 0.68 confidence level. This is also an example where the approximation:

$$\overline{f(x)} \sim f(\bar{x})$$

is very poor.

Two methods for assessing the confidence that can be placed in a given calculation have been given here:

1. calculate the derived density function, and
2. approximate the first two moments of the derived density function.

The first method works in general but it takes significant amounts of computer time. The second method can be accomplished quickly and easily, but its results are valid only when the calculation can be approximated by the first two terms of its Taylor series, and the results (when valid) can be used to assess confidence levels only when the derived density function is approximately normal.

Appendix II

ENERGY UNCERTAINTY EVALUATIONS FOR NUCLIDES LISTED IN THE REICH NUCLEAR DATA FILE

This file consists of the "5" cards of reference 3 (cf. Table II-3) together with two extra "5" cards generated as described in section 2.1 of this thesis. For each nuclide, the first "5" card is that of reference 3, the second "5" card lists energies and uncertainties calculated by equations 2-1 through 2-3, and the third "5" card lists energies and uncertainties obtained by using the probabilistic techniques of Appendix I.

The columns labeled "E BETA" and "E GAMMA" are average beta and gamma decay energies; the columns labeled "UNC BETA" and "UNC GAMMA" are "one sigma" uncertainties which are obtained from spectral uncertainty data assuming that the spectral uncertainties are completely uncorrelated. The column labeled "NUCLIDE" is an eight digit number which identifies the nuclide for which data is given. The first digit identifies the type of data presented (it is always "5" here). The next three digits give the atomic number of the nuclide, the following three digits give the atomic mass number of the nuclide, and the last digit indicates whether the data is for a metastable state or the ground state ("zero" indicates ground state and "one" indicates metastable state).

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
1882.64	0.0	251.36	0.0	5 32 790
1882.62	217.56	251.77	74.53	5 32 790
1881.54	217.52	277.02	74.97	5 32 790
2522.64	0.0	535.50	0.0	5 33 800
2522.65	276.10	535.53	117.39	5 33 800
2542.40	264.10	527.47	160.02	5 33 800
1560.43	0.0	0.0	0.0	5 33 810
1559.47	232.27	0.00	0.00	5 33 810
1556.22	221.43	0.13	0.00	5 33 810
2216.95	0.0	233.33	0.0	5 33 820
2213.93	244.48	233.33	94.57	5 33 820
2216.08	247.74	234.70	71.17	5 33 820
1319.27	0.0	2934.54	0.0	5 33 821
1319.27	215.50	2934.55	206.08	5 33 821
1322.70	214.44	2931.72	282.22	5 33 821
441.55	0.0	2594.29	0.0	5 34 830
441.84	102.26	2591.27	42.34	5 34 830
405.82	65.15	2533.07	42.72	5 34 830
1331.70	0.0	903.33	0.0	5 34 831
1331.71	114.36	903.33	58.55	5 34 831
1314.07	113.32	917.65	57.75	5 34 831
530.34	0.0	407.70	0.0	5 34 840
530.36	37.50	407.70	40.77	5 34 840
531.07	39.10	413.25	40.07	5 34 840
1258.74	0.0	1752.74	0.0	5 35 840
1258.74	159.27	1752.74	101.34	5 35 840
1264.03	156.49	1751.55	104.30	5 35 840
895.54	0.0	2758.39	0.0	5 35 841
895.54	67.41	2758.43	181.58	5 35 841
881.72	71.05	2774.34	174.15	5 35 841
934.41		54.53		5 35 850
934.41	153.48	54.63	22.46	5 35 850
958.14	153.55	54.48	27.31	5 35 850
1779.29	0.0	3317.43	0.0	5 35 860
1775.29	274.30	3317.52	143.52	5 35 860
1713.91	257.30	3514.30	140.46	5 35 860
2135.59	0.0	1726.21	0.0	5 35 870
2135.58	221.31	1726.30	723.32	5 35 870
2134.09	230.45	1713.37	321.24	5 35 870
259.59		2.25		5 36 850
229.19	.56	2.26	1.56	5 36 850
223.41	.73	3.03	0.06	5 36 850
226.07	0.0	133.72	0.0	5 36 851
226.08	3.77	133.72	4.74	5 36 851
225.67	5.33	133.33	6.07	5 36 851
1334.59	0.0	792.60	0.0	5 36 870
1334.59	45.35	792.60	22.32	5 36 870
1333.77	50.79	793.23	25.39	5 36 870
248.58	0.0	2211.32	0.0	5 36 880
249.53	63.40	2211.35	54.38	5 36 880
265.37	66.43	2212.51	53.30	5 36 880

[illegible] LIFE	UNC DATA	F GAMMA	UNC GAMMA	NUCLIDE
1241.21	0.0	2303.05	0.0	5 36 840
1241.71	213.34	2355.06	17.51	5 36 890
1355.17	149.54	2359.43	25.35	5 36 890
1187.07	0.0	1749.12	0.0	5 36 900
1187.45	120.[illegible]	1749.13	67.44	5 36 900
1215.07	117.[illegible]	1751.83	[illegible]	5 36 900
2777.80	0.0	723.75	0.0	5 36 910
2777.[illegible]	262.58	723.76	159.30	5 36 910
2673.04	266.51	731.37	161.3[illegible]	5 36 910
2403.21	0.0	751.84	0.0	5 36 920
2403.21	243.24	751.84	20.45	5 36 920
2435.72	245.20	759.61	28.35	5 36 920
2332.[illegible]	0.0	673.[illegible]	0.0	5 37 880
2332.0[illegible]	162.73	673.33	1.31	5 37 880
2309.07	157.39	653.56	0.30	5 37 880
928.84	0.0	2233.45	0.0	5 37 890
928.34	131.78	2233.33	54.30	5 37 890
947.08	126.14	2287.57	67.19	5 37 890
1658.6[illegible]		2650.40		5 37 900
1658.63	243.77	2659.42	410.3[illegible]	5 37 900
1677.34	238.29	2913.37	345.90	5 37 900
1106.[illegible]		3615.81		5 37 901
1106.77	176.74	3615.31	374.57	5 37 901
1104.21	167.56	3550.33	308.3[illegible]	5 37 901
1734.16	0.0	2737.15	0.0	5 37 910
1534.17	223.22	2733.15	460.10	5 37 910
1778.26	194.54	2835.50	391.32	5 37 910
3459.27	0.0	251.36	0.0	5 37 920
3459.27	258.21	261.56	10.52	5 37 920
3504.13	271.27	254.84	0.30	5 37 920
532.00	0.0	0.0	0.0	5 38 880
567.48	54.31	0.00	0.00	5 38 880
565.49	54.37	1.10	0.00	5 38 890
193.00	0.0	0.0	0.0	5 38 900
172.50	27.37	0.00	0.00	5 38 900
169.07	31.16	0.00	0.00	5 38 900
652.29	0.0	695.40	0.0	5 38 910
652.29	99.10	695.40	102.33	5 38 910
651.76	83.91	635.25	124.71	5 38 910
132.29	0.0	1333.84	0.0	5 38 920
132.29	41.30	1353.84	49.30	5 38 920
137.13	35.51	1340.35	45.57	5 38 920
1161.05	0.0	1335.00	0.0	5 38 930
1161.09	158.37	1735.00	195.52	5 38 930
1170.36	169.03	1513.25	127.19	5 38 930
869.64	0.0	1242.45	0.0	5 38 940
869.64	34.40	1242.40	142.30	5 38 940
870.32	35.29	1244.40	140.33	5 38 940
931.37		0.23		5 39 900
933.9[illegible]	56.01	.23	.20	5 39 900
934.43	56.15	0.00	0.00	5 39 900

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
0.85		682.46		5 39 901
.79	.24	682.47	57.17	5 39 901
0.00	0.10	682.55	54.59	5 39 901
704.00	0.0	2.66	0.0	5 39 910
793.12	97.37	2.66	1.36	5 39 910
754.37	102.41	0.07	0.01	5 39 910
0.0	0.0	555.15	0.0	5 39 911
0.00	0.00	555.15	57.77	5 39 911
0.00	0.00	552.68	56.42	5 39 911
1464.27	0.0	243.21	0.0	5 39 920
1464.24	167.39	243.21	103.46	5 39 920
1477.97	159.31	238.95	116.32	5 39 920
1134.49	0.0	33.57	0.0	5 39 930
1134.49	30.46	33.57	1.30	5 39 930
1133.80	31.32	37.16	0.10	5 39 930
1717.4		335.13		5 39 940
1727.34	195.49	335.13	138.30	5 39 940
1743.37	192.38	1003.43	111.75	5 39 940
1745.73	0.0	433.31	0.0	5 39 950
1745.73	196.37	433.32	125.58	5 39 950
1753.17	201.52	504.71	100.30	5 39 950
2157.09		335.06		5 39 970
2162.19	222.32	335.01	52.12	5 39 970
2164.55	250.84	437.50	81.41	5 39 970
0.02		2314.31		5 40 901
0.07	0.00	2314.31	239.28	5 40 901
0.00	0.00	2318.73	236.24	5 40 901
116.29	0.0	735.03	0.0	5 40 950
115.29	15.00	736.00	5.25	5 40 950
116.61	17.34	735.76	6.55	5 40 950
707.12	0.0	131.75	0.0	5 40 970
707.12	112.35	131.75	45.47	5 40 970
712.67	122.49	130.74	37.36	5 40 970
1620.93	0.0	793.70	0.0	5 40 990
1620.92	155.24	793.70	45.11	5 40 990
1617.37	181.71	791.87	44.38	5 40 990
43.56	0.0	765.84	0.0	5 41 950
43.56	7.04	765.84	76.75	5 41 950
43.37	7.39	763.91	75.56	5 41 950
0.0	0.0	235.46	0.0	5 41 951
0.00	0.00	235.46	49.56	5 41 951
0.00	0.00	151.62	87.10	5 41 951
467.34	0.0	677.03	0.0	5 41 970
467.94	75.16	677.03	67.23	5 41 970
453.79	68.72	580.04	67.57	5 41 970
0.0	0.0	742.70	0.0	5 41 971
0.00	0.00	742.70	75.35	5 41 971
0.00	0.00	743.65	74.01	5 41 971
1355.25	0.0	140.23	0.0	5 41 980
1365.29	214.47	141.23	46.51	5 41 980
1348.80	209.37	131.01	32.31	5 41 980

C BETA	UNC BETA	C GAMMA	UNC GAMM	NUCLIDE
948.11	0.0	2514.98	0.0	5 41 991
944.12	157.85	2490.79	211.98	5 41 991
947.87	137.08	2531.67	177.71	5 41 991
1572.58	0.0	193.74	0.0	5 41 990
1572.58	134.53	194.74	56.23	5 41 990
1515.09	213.16	215.41	54.87	5 41 990
453.64	0.0	1994.25	0.0	5 41 991
453.60	197.20	1994.25	231.13	5 41 991
1033.17	140.51	2330.85	212.31	5 41 991
2053.53	0.0	1323.72	0.0	5 411000
2059.59	278.74	1321.73	77.57	5 411000
2053.27	236.14	1313.00	40.56	5 411000
1350.54	0.0	723.94	0.0	5 411010
1400.55	215.73	523.93	48.40	5 411010
1338.13	231.76	527.73	40.01	5 411010
334.74	0.0	135.35	0.0	5 42 990
334.74	4.37	135.35	4.49	5 42 990
334.13	7.15	135.58	5.25	5 42 990
594.99	0.0	1335.17	0.0	5 421010
594.99	51.33	1335.20	22.20	5 421010
594.13	27.29	1334.49	23.40	5 421010
311.12	0.0	0.0	0.0	5 421020
311.17	50.26	0.00	0.00	5 421020
309.73	57.54	0.00	0.00	5 421020
0.0	0.0	142.74	0.0	5 43 991
0.00	0.00	140.61	15.72	5 43 991
0.00	0.00	141.02	15.46	5 43 991
479.95	0.0	336.25	0.0	5 431010
479.95	35.45	336.25	13.70	5 431010
480.45	34.56	335.91	14.19	5 431010
1503.87	0.0	463.90	0.0	5 431020
1503.93	183.33	463.34	92.05	5 431020
1500.04	185.57	457.63	64.52	5 431020
719.49	0.0	2546.63	0.0	5 431021
719.49	111.63	2545.64	276.25	5 431021
719.33	102.23	2545.72	226.59	5 431021
1192.96	0.0	1443.15	0.0	5 431040
1197.96	198.65	1443.14	223.32	5 431040
1225.31	169.56	1610.33	145.13	5 431040
67.57	0.0	490.02	0.0	5 441030
67.53	13.73	490.02	55.39	5 441030
64.49	11.37	431.63	53.45	5 441030
412.64	0.0	737.57	0.0	5 441050
412.64	9.45	737.63	10.24	5 441050
412.21	10.35	733.07	16.27	5 441050
9.97	0.0	0.0	0.0	5 441060
9.97	1.51	0.00	0.00	5 441060
10.12	1.56	0.00	0.00	5 441060
1237.49	0.0	251.37	0.0	5 441070
1237.49	187.33	251.37	76.59	5 441070
1249.67	188.44	257.46	71.56	5 441070

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
470.06	0.0	46.20	0.0	5 441080
470.06	67.39	46.20	16.51	5 441080
458.36	61.53	30.67	14.30	5 441080
0.0	0.0	33.73	0.0	5 451031
0.00	0.00	33.73	4.00	5 451031
0.00	0.00	33.74	4.00	5 451031
1002.97	0.0	11.48	0.0	5 451040
1002.97	161.57	11.48	10.50	5 451040
1001.77	191.19	3.04	8.12	5 451040
0.58	0.0	132.2	0.0	5 451041
.58	.15	132.19	5.32	5 451041
0.00	0.00	135.20	13.40	5 451041
152.28	0.0	78.77	0.0	5 451050
152.28	23.59	78.77	2.52	5 451050
143.69	28.31	73.63	3.35	5 451050
0.0	0.0	129.70	0.0	5 451051
0.00	0.00	129.70	64.35	5 451051
0.00	0.00	35.30	47.79	5 451051
1445.66	0.0	199.44	0.0	5 451060
1445.67	175.73	199.44	68.36	5 451060
1438.84	185.23	203.23	60.20	5 451060
348.66	0.0	2645.23	0.0	5 451061
348.66	49.21	2645.24	187.52	5 451061
348.15	53.64	2675.28	179.24	5 451061
421.19	0.0	312.20	0.0	5 451070
421.19	62.40	312.25	43.11	5 451070
427.78	68.56	321.02	35.23	5 451070
1328.05	0.0	703.50	0.0	5 451080
1328.06	215.63	703.53	126.34	5 451080
1327.77	221.39	703.21	119.12	5 451080
804.06	0.0	2439.49	0.0	5 451081
804.06	136.63	2439.50	168.40	5 451081
796.63	139.40	2452.20	168.35	5 451081
1345.67	0.0	2257.63	0.0	5 451100
1345.68	192.66	2257.65	185.23	5 451100
1354.44	199.25	2274.06	154.36	5 451100
2481.22	0.0	56.07	0.0	5 451101
2481.22	241.66	56.07	37.38	5 451101
2478.34	246.46	34.95	20.10	5 451101
364.11	0.0	0.21	0.0	5 461090
364.11	58.82	.21	.06	5 461090
362.73	68.43	0.00	0.00	5 461090
0.0	0.0	183.00	0.0	5 461091
0.00	0.00	183.00	18.39	5 461091
0.00	0.00	183.47	19.36	5 461091
844.19	0.0	52.88	0.0	5 461110
844.19	57.55	52.88	3.37	5 461110
854.89	57.78	50.62	6.34	5 461110
167.11	0.0	421.39	0.0	5 461111
167.11	35.49	421.39	17.54	5 461111
176.78	29.74	419.13	14.50	5 461111

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
0.0	0.0	87.70	0.0	5 471091
0.00	0.00	87.70	6.81	5 471091
0.00	0.00	87.41	8.84	5 471091
354.76	0.0	26.37	0.0	5 471110
354.76	56.32	26.37	15.39	5 471110
342.53	71.31	26.01	10.30	5 471110
0.0	0.0	65.00	0.0	5 471111
0.00	0.00	65.00	6.53	5 471111
0.00	0.00	64.92	6.40	5 471111
1428.89	0.0	663.75	0.0	5 471120
1428.89	187.51	663.77	125.59	5 471120
1463.69	180.95	737.08	107.34	5 471120
629.46	0.0	2575.86	0.0	5 491180
629.46	87.54	2575.87	204.17	5 491180
636.42	91.30	2593.69	[illegible]	5 491180
1775.81	0.0	213.12	0.0	5 491181
[illegible]	[illegible]	213.12	124.47	5 491181
[illegible]	[illegible]	201.03	99.27	5 491181
1038.65	0.0	3059.71	0.0	5 491200
1038.65	146.76	3059.71	261.41	5 491200
[illegible]	133.18	3108.34	[illegible]	5 491200
2471.49	0.0	175.74	0.0	5 491201
2471.48	237.36	175.74	117.16	5 491201
2480.77	220.12	112.93	[illegible]	5 491201
836.15	0.0	312.27	0.0	5 501250
836.15	135.59	312.27	67.25	5 501250
815.22	168.32	293.66	48.50	5 501250
798.01	0.0	345.85	0.0	5 501251
798.01	128.86	345.85	34.06	5 501251
807.32	146.29	346.02	34.60	5 501251
674.55	0.0	1434.31	0.0	5 501270
674.55	113.37	1434.31	52.37	5 501270
696.35	125.49	1435.21	51.47	5 501270
1134.21	0.0	494.00	0.0	5 501271
1134.21	181.29	494.00	49.65	5 501271
1140.61	210.49	494.61	47.12	5 501271
217.20	0.0	596.51	0.0	5 501280
217.20	31.34	596.51	38.73	5 501280
216.45	35.09	593.03	38.10	5 501280
660.29	0.0	1322.79	0.0	5 501320
660.30	87.38	1322.79	30.03	5 501320
662.31	100.14	1321.74	31.43	5 501320
86.86	0.0	452.07	0.0	5 511250
84.56	13.77	452.07	48.67	5 511250
84.83	15.40	450.10	45.61	5 511250
318.06	0.0	644.32	0.0	5 511270
318.06	52.48	644.32	125.50	5 511270
324.17	49.65	596.13	147.87	5 511270
418.49	0.0	3095.08	0.0	5 511280
418.49	76.76	3095.09	60.23	5 511280
424.06	73.20	3098.60	61.74	5 511280

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
947.25	0.0	1986.08	0.0	5 511281
947.25	147.07	1986.08	75.56	5 511281
945.84	159.81	1982.97	74.80	5 511281
359.11	0.0	1301.04	0.0	5 511290
359.11	79.17	1301.05	182.07	5 511290
381.17	54.83	1331.42	161.83	5 511290
1260.67	0.0	2140.83	0.0	5 511300
1260.67	175.52	2140.89	161.36	5 511300
1280.63	182.09	2143.02	145.26	5 511300
1093.22	0.0	2489.45	0.0	5 511301
1093.22	148.87	2489.46	163.87	5 511301
1099.59	152.78	2502.07	147.02	5 511301
713.69		1702.51		5 511310
713.69	126.22	1702.51	229.29	5 511310
742.56	98.47	1862.99	176.57	5 511310
1722.11	0.0	2006.60	0.0	5 511320
1722.11	213.22	2006.60	191.04	5 511320
1724.78	217.20	1999.51	173.29	5 511320
1695.95	0.0	2038.60	0.0	5 511321
1695.97	195.19	2038.62	129.32	5 511321
1693.09	192.66	2034.67	127.10	5 511321
537.11	0.0	3162.50	0.0	5 511330
537.11	91.63	3162.47	335.23	5 511330
546.70	91.28	3339.65	253.87	5 511330
3951.55	0.0	0.0	0.0	5 511340
3951.55	275.92	0.00	0.00	5 511340
3942.21	276.39	0.00	0.00	5 511340
2953.76	0.0	2094.43	0.0	5 511341
2953.77	271.77	2094.43	151.15	5 511341
2949.64	275.19	2091.61	147.91	5 511341
0.0	0.0	143.75	0.0	5 521251
0.00	0.00	143.75	111.09	5 521251
0.00	0.00	124.97	54.92	5 521251
227.28	0.0	5.17	0.0	5 521270
227.28	36.64	5.17	2.30	5 521270
220.61	41.33	5.64	1.81	5 521270
533.94	0.0	72.90	0.0	5 521290
533.94	83.76	72.90	28.08	5 521290
549.79	103.59	80.53	25.56	5 521290
214.02	0.0	23.80	0.0	5 521291
214.02	49.83	23.96	15.53	5 521291
214.77	56.35	30.39	12.51	5 521291
671.72	0.0	422.80	0.0	5 521310
671.72	92.57	422.85	91.10	5 521310
664.46	105.22	449.22	78.59	5 521310
182.18	0.0	1491.12	0.0	5 521311
182.18	46.49	1491.13	162.27	5 521311
179.24	37.41	1542.99	135.14	5 521311
60.05		263.60		5 521320
60.05	3.77	263.60	12.88	5 521320
60.25	3.82	263.43	13.00	5 521320

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
819.97		833.24		5 521330
819.98	120.39	833.24	143.88	5 521330
826.62	130.68	1024.17	113.55	5 521330
552.07	0.0	1866.14	0.0	5 521331
552.07	88.38	1866.15	176.34	5 521331
552.30	92.76	1885.85	150.07	5 521331
152.09		824.97		5 521340
152.09	20.65	824.97	24.84	5 521340
151.50	23.11	824.41	24.57	5 521340
185.50	0.0	389.28	0.0	5 531310
185.50	29.27	389.28	47.84	5 531310
189.09	33.63	391.50	45.57	5 531310
524.69	0.0	2237.7	0.0	5 531320
524.68	85.10	2237.71	174.87	5 531320
524.92	87.55	2305.13	149.39	5 531320
417.19	0.0	598.90	0.0	5 531330
417.19	66.50	598.95	76.06	5 531330
426.79	73.38	607.15	59.82	5 531330
690.93	0.0	2592.60	0.0	5 531340
690.93	105.87	2592.65	211.67	5 531340
704.09	103.26	2658.29	176.04	5 531340
0.0	0.0	315.70	0.0	5 531341
0.00	0.00	315.70	27.56	5 531341
0.00	0.00	315.56	27.76	5 531341
393.65	0.0	1456.00	0.0	5 531350
393.65	66.97	1456.04	236.03	5 531350
400.35	66.88	1510.03	217.28	5 531350
1811.03	0.0	2213.49	0.0	5 531360
1811.03	227.13	2213.49	290.50	5 531360
1822.91	224.41	2202.55	258.18	5 531360
1939.01	0.0	1925.44	0.0	5 531361
1939.01	220.06	1925.44	139.12	5 531361
1945.69	210.21	1929.45	138.59	5 531361
0.0	0.0	167.54	0.0	5 541311
0.00	0.00	167.54	8.35	5 541311
0.00	0.00	163.00	8.23	5 541311
101.88	0.0	81.44	0.0	5 541330
101.88	.89	81.44	.38	5 541330
101.31	1.73	81.43	.55	5 541330
0.0	0.0	232.69	0.0	5 541331
0.00	0.00	232.69	6.78	5 541331
0.00	0.00	232.85	6.31	5 541331
309.89	0.0	261.43	0.0	5 541350
309.89	3.10	261.43	1.59	5 541350
310.59	3.56	259.55	.41	5 541350
0.0	0.0	526.82	0.0	5 541351
0.00	0.00	526.82	3.24	5 541351
0.00	0.00	526.73	3.52	5 541351
1840.72	0.0	195.26	0.0	5 541370
1840.72	78.11	195.26	32.45	5 541370
1842.50	79.08	199.07	36.42	5 541370

E BETA	UNC BETA	I GAMMA	UNC GAMMA	NUCLIDE
657.70	0.0	1195.06	0.0	5 541380
657.70	96.53	1195.06	24.27	5 541380
663.96	98.10	1134.44	26.35	5 541380
1786.77	0.0	927.48	0.0	5 541390
1786.78	159.26	927.52	10.19	5 541390
1796.34	141.61	923.72	3.46	5 541390
161.50	0.0	1579.72	0.0	5 551340
161.70	26.52	1579.72	123.23	5 551340
162.34	29.74	1585.77	111.16	5 551340
0.0	0.0	137.60	0.0	5 551341
0.00	0.00	137.60	13.00	5 551341
0.00	0.00	138.21	13.04	5 551341
119.23	0.0	2157.34	0.0	5 551360
119.23	20.29	2157.35	147.39	5 551360
120.26	22.58	2171.87	143.32	5 551360
174.44	0.0	0.0	0.0	5 551370
174.44	1.39	0.00	0.00	5 551370
171.13	1.65	0.00	0.00	5 551370
1262.40	0.0	2329.12	0.0	5 551380
1262.40	149.94	2329.13	68.79	5 551380
1290.96	145.67	2325.01	70.85	5 551380
1146.90	0.0	2099.66	0.0	5 551381
1146.90	173.63	2099.66	153.34	5 551381
1152.19	194.76	2110.54	153.62	5 551381
1763.69	0.0	310.76	0.0	5 551390
1763.69	117.71	310.76	5.26	5 551390
1759.98	122.09	305.48	22.90	5 551390
1931.24	0.0	2131.03	0.0	5 551400
1931.24	271.74	2131.08	297.54	5 551400
1993.78	234.50	2413.15	163.32	5 551400
0.0	0.0	662.17	0.0	5 561371
0.00	0.00	662.18	2.34	5 561371
0.00	0.00	662.11	3.54	5 561371
897.27		52.23		5 561390
897.22	129.63	52.23	21.21	5 561390
378.35	146.16	37.06	15.36	5 561390
230.27		215.37		5 561400
230.27	28.47	216.37	6.76	5 561400
279.88	34.61	215.73	7.33	5 561400
915.52	0.0	887.30	0.0	5 561410
915.53	129.01	887.32	11.37	5 561410
955.75	113.09	885.72	13.25	5 561410
428.28	0.0	1012.63	0.0	5 561420
428.28	70.92	1012.63	37.57	5 561420
446.28	61.89	1014.39	37.44	5 561420
517.01	0.0	2204.39	0.0	5 571400
517.02	73.01	2204.41	217.36	5 571400
520.46	83.86	2223.35	159.39	5 571400
989.88	0.0	32.91	0.0	5 571410
989.89	62.57	32.91	1.47	5 571410
988.09	63.37	27.23	.00	5 571410

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
947.92	0.0	2564.67	0.0	5 571420
947.92	154.99	2564.69	69.24	5 571420
973.45	132.35	2553.26	69.47	5 571420
159.49	0.0	71.70	0.0	5 581410
159.49	21.37	71.70	14.56	5 581410
157.43	26.02	75.11	10.49	5 581410
419.13		235.33		5 581430
419.13	57.57	235.34	32.11	5 581430
418.07	65.37	234.17	37.50	5 581430
82.96		23.87		5 581440
82.96	.34	23.87	1.14	5 581440
82.91	1.76	23.73	1.32	5 581440
629.94	0.0	743.90	0.0	5 581450
629.94	96.37	743.93	92.42	5 581450
631.09	103.45	752.83	86.30	5 581450
242.69	0.0	314.30	0.0	5 581460
242.69	39.21	314.30	43.31	5 581460
244.44	45.92	313.34	40.49	5 581460
323.92	0.0	0.0	0.0	5 591430
323.92	52.33	0.00	0.00	5 591430
309.66	61.20	0.00	0.00	5 591430
1262.77		31.01		5 591440
1262.77	1.54	31.01	.30	5 591440
1275.47	4.70	33.58	.00	5 591440
0.30	0.0	59.73	0.0	5 591441
.30	.10	59.73	6.03	5 591441
0.00	0.00	55.92	9.02	5 591441
704.65	0.0	13.78	0.0	5 591450
704.65	113.26	13.78	4.35	5 591450
683.05	131.57	17.66	3.37	5 591450
927.90	0.0	1634.90	0.0	5 591460
927.90	146.96	1634.94	221.03	5 591460
935.10	145.43	1632.66	197.13	5 591460
747.99	0.0	820.09	0.0	5 591470
747.99	111.72	821.09	140.79	5 591470
746.51	120.30	819.23	120.78	5 591470
2043.53	0.0	300.00	0.0	5 591480
2043.53	217.18	300.00	30.15	5 591480
2047.79	225.35	298.36	33.11	5 591480
1157.82	0.0	251.26	0.0	5 591490
1157.82	151.66	251.27	54.53	5 591490
1123.38	175.51	255.35	56.63	5 591490
241.69	0.0	118.70	0.0	5 601470
241.69	37.49	118.70	50.77	5 601470
239.37	50.08	109.97	37.15	5 601470
474.39	0.0	336.75	0.0	5 601490
474.39	67.70	336.76	9.56	5 601490
480.16	59.14	337.11	10.38	5 601490
644.19	0.0	839.26	0.0	5 601510
644.19	96.51	839.27	105.31	5 601510
682.03	80.26	822.79	78.59	5 601510

E BETA	UNC BETA	E GAMMA	UNC GAMMA	NUCLIDE
63.00	0.0	0.10	0.0	5 611470
63.00	10.18	.10	.07	5 611470
61.70	10.51	0.00	0.00	5 611470
744.30	0.0	630.37	0.0	5 611480
744.30	107.83	630.36	179.59	5 611480
726.01	133.64	657.05	217.81	5 611480
147.38	0.0	2009.37	0.0	5 611481
147.38	24.20	2009.38	115.48	5 611481
149.21	25.28	2013.08	115.79	5 611481
376.58	0.0	14.23	0.0	5 611490
376.58	69.64	14.23	7.93	5 611490
380.67	73.25	12.26	4.28	5 611490
311.85	0.0	309.60	0.0	5 611510
311.85	49.91	309.60	61.77	5 611510
305.72	47.58	332.84	46.17	5 611510
1438.77	0.0	288.14	0.0	5 611520
1438.78	178.13	288.14	24.39	5 611520
1444.26	187.58	297.30	24.70	5 611520
419.48	0.0	1287.25	0.0	5 611521
419.48	91.60	1287.25	126.71	5 611521
428.34	77.35	1311.97	134.74	5 611521
672.63	0.0	77.43	0.0	5 611530
672.63	72.31	77.43	17.17	5 611530
676.66	69.44	82.24	21.03	5 611530
230.70	0.0	104.52	0.0	5 621530
230.70	25.02	104.52	1.98	5 621530
231.69	24.73	104.75	4.50	5 621530
430.20	0.0	1317.70	0.0	5 631560
430.20	82.57	1317.70	240.50	5 631560
432.10	90.24	1347.97	168.21	5 631560
0.05		0.0		5 751870
.05	.05	0.00	0.00	5 751870
.05	.05	0.00	0.00	5 751870

Appendix III

A TABULATION OF FISSION PRODUCT DECAY ENERGIES AND UNCERTAINTIES

This is a file of decay energies and energy uncertainties for those nuclides which might contribute significantly to reactor decay heat. The decay energies listed here were obtained from ENDF/B-IV; the uncertainties were estimated using the techniques of this thesis.

The column headed "NUCLIDE" identifies the nuclides for which data is displayed. Each nuclide identified is a six digit integer; the first three digits give the atomic mass number, the next two digits give the atomic charge number, and the last digit indicates the metastable state. The columns headed "E BETA" and "E GAMMA" give the beta and gamma energy of decay for the nuclide as obtained from ENDF/B-IV. The columns headed "UNC BETA," "UNC GAMMA" and "CORR TOTAL" give the uncorrelated and correlated energy uncertainties. The column headed "E TOTAL" lists the sum of the beta and gamma decay energies, and the column headed "UNC TOTAL" is the quadratic sum of the uncorrelated beta and gamma energy uncertainties. An asterisk following a nuclide identifier indicates that the energy data for that nuclide was obtained experimentally.

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
72270	5.73090	2.19023	2.84810	2.03465	8.57900	4.22488	1.51938
72280	2.00440	1.06200	1.20280	1.02037	3.20720	2.08237	.89780
72290	3.34220	1.22022	1.34890	.95291	4.69110	2.17313	.44933
72300	.08600	.22347	.14400	.27715	.23000	.48062	.15691
72310	.50100	.16032	2.72000	1.76800	3.22100	1.92880	.03409
72320	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
73260	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
73270	4.77590	1.93254	2.84830	2.05464	7.62420	3.39743	1.55016
73280	3.43630	1.41379	1.33860	1.38726	5.37540	2.80703	.91409
73290	2.27230	.92450	1.18620	.87450	3.45850	1.79810	.45509
73300	1.71020	.61475	.74507	.51337	2.45527	1.13312	.15968
73310	.44400	.14205	.31900	.20735	.76300	.34943	.02141
73321	0.00000	0.00000	.06700	.04355	.06700	.04355	.04300
73320	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
74260	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
74270	6.20270	2.31829	3.33460	2.33866	9.53730	4.65687	1.54030
74280	2.57300	1.18957	1.67700	1.29183	4.25000	2.48150	.92543
74290	3.81170	1.35436	1.79450	1.23463	5.60620	2.58343	.46200
74300	.75051	.35849	.43026	.33994	1.18077	.69883	.15350
74310	1.07000	.34240	3.04000	1.97600	4.11000	2.31840	.03152
74320	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
75270	5.21170	2.22949	3.35650	2.48392	8.56820	4.71341	2.34754
75280	4.05770	1.75041	2.36820	1.78280	6.41910	3.53321	1.53521
75290	2.86500	1.26217	1.64070	1.25231	4.50570	2.51448	.91223
75300	2.17440	.89923	1.10410	.82450	3.27850	1.72373	.45177
75310	1.36000	.51316	.02090	.03634	1.38090	.54950	.13046
75321	0.00000	0.00000	.13900	.09035	.13900	.09035	.04300
75320	.43000	.17760	.03590	.02334	.46590	.16004	.01646
75330	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
76270	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
76280	3.09660	1.31559	2.17560	1.58932	5.27220	2.90431	.94634

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
76290	4.33070	1.52131	2.24860	1.52194	6.52930	3.04375	.47059
76300	1.35760	.51308	.84130	.54755	2.19890	1.10063	.16934
76310	1.68000	.53760	2.81000	1.52650	4.49000	2.36410	.02911
76320	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
76330	1.13670	.76374	.35294	.22941	1.48964	.59315	.14652
76340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
77280	4.51030	2.06176	2.87940	2.21062	7.38970	4.27238	2.38198
77290	3.40330	1.59435	2.11850	1.65536	5.52180	3.24971	1.53734
77300	2.72250	1.22816	1.50470	1.17080	4.22720	2.39896	.90451
77310	1.68170	.77514	.87746	.69843	2.55876	1.47357	.44463
77321	.95000	.40087	.08390	.09489	1.03390	.49576	.12973
77320	.64800	.31859	1.16000	.82058	1.80800	1.13927	.14238
77330	.24103	.07713	.10296	.05692	.34399	.14405	.01745
77341	0.00000	0.00000	.25000	.16250	.25000	.16250	.04300
77340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
78280	3.59670	1.85011	2.70660	2.16196	6.30330	4.01207	2.37254
78290	4.84860	1.95294	2.74270	1.99347	7.59130	3.94641	1.53659
78300	1.84950	1.02650	1.24420	1.06179	3.09370	2.08833	.90971
78310	3.12880	1.15906	1.45530	1.02636	4.58410	2.18542	.45693
78320	.23800	.27521	.27700	.30009	.51500	.53530	.15579
78330	1.40000	.44800	1.03000	.66950	2.43000	1.11750	.02442
78340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
79290	3.91170	1.92336	2.62660	2.08519	6.53830	4.00855	2.33715
79300	3.27080	1.56459	1.99010	1.57004	5.26090	3.14453	1.02923
79310	2.22590	1.11182	1.27580	1.05147	3.50170	2.16329	.49740
79320*	1.89265	.21782	.25137	.07467	2.14402	.29250	0.00000
79330	.86100	.37646	.01800	.03889	.87900	.41535	.12336
79341	.00010	.00003	.09500	.06175	.09510	.06178	.04289
79340	.04200	.01344	.00010	.00007	.04210	.01351	.01170
79351	0.00000	0.00000	.21000	.13650	.21000	.13650	.04300
79350	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
80280	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
80290	5.81220	2.26700	3.72550	2.60170	9.53770	4.30870	1.57693
80300	2.35700	1.13708	1.70830	1.32591	4.06530	2.46239	.93709
80310	3.70050	1.32185	1.92230	1.31933	5.62280	2.64123	.46787

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
80320	.62705	.32126	.40163	.32935	1.02868	.65061	.15294
80330*	2.52264	.26420	.60658	.10602	3.12922	.37022	0.00000
80340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
80351	0.00000	0.00000	.03600	.05590	.03600	.05590	.30100
80350	.71829	.22985	.25290	.16439	.97119	.39424	.14003
80360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
81290	5.29840	2.24625	3.81320	2.77593	9.11160	5.02218	2.34099
81300	4.30060	1.80766	2.96580	2.15956	7.26640	3.96722	1.57967
81310	2.75930	1.23501	1.72080	1.30999	4.48010	2.54500	.82201
81320	2.05960	.86871	1.18700	.88311	3.24660	1.75182	.45694
81330*	1.66943	.22139	0.00000	0.00000	1.66943	.22139	0.00000
81341	0.00000	0.00000	.10300	.06695	.10300	.06695	.04300
81340	.50500	.19360	.00760	.00494	.51260	.19854	.01665
81350	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
81361	0.00000	0.00000	.19000	.12350	.19000	.12350	.30100
81360	0.00000	0.00000	.14000	.09100	.14000	.09100	.30100
82290	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
82300	3.78910	1.49226	2.94020	2.05902	6.72930	3.55128	.97204
82310	4.75960	1.63385	2.83070	1.89568	7.59030	3.52953	.49257
82320	1.21790	.47388	.84633	.59424	2.06423	1.06812	.16703
82331*	1.31923	.21446	2.99465	.28222	4.31388	.49668	0.00000
82330*	3.21093	.27774	.28809	.07193	3.49902	.34967	0.00000
82340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
82351	.02742	.00878	.05588	.03632	.08330	.04510	.15718
82350	.14000	.04480	2.65000	1.72250	2.79000	1.76730	.27036
82360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
83300	4.69430	2.09774	3.53140	2.62331	8.22570	4.72105	2.34839
83310	4.26090	1.80000	2.87260	2.10060	7.13350	3.90060	1.57304
83320	3.03660	1.30134	2.00420	1.46076	5.04080	2.76210	.93614
83330	1.67630	.77310	.98446	.76909	2.66076	1.54219	.45303
83341*	1.30171	.11382	.90933	.05775	2.21104	.17157	0.00000
83340*	.44186	.06615	2.55927	.04272	3.00113	.10887	0.00000
83350	.32400	.10368	.00730	.00475	.33130	.10843	.01516
83361	0.00000	0.00000	.04180	.02717	.04180	.02717	.04300
83360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
84300	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
84310	5.16590	2.03230	3.36000	2.39624	8.54590	4.42854	1.57709
84320	2.42120	1.14965	1.91350	1.45503	4.33470	2.66468	.95235
84330	3.76120	1.33937	2.10360	1.43607	5.86480	2.77514	.47339
84340*	.53084	.03919	.40770	.04886	.93854	.07325	0.00000
84351*	.88554	.07165	2.76840	.17819	3.65394	.24434	0.00000
84350*	1.25574	.15645	1.75274	.10490	3.00848	.26135	0.00000
84360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
85310	4.69130	2.09339	3.38730	2.53014	8.07860	4.62313	2.34212
85320	3.51860	1.61630	2.55050	1.92952	6.06910	3.54582	1.57492
85330	2.86840	1.25733	2.16900	1.59562	5.03740	2.85295	.95485
85341	2.14670	.89023	1.34780	.94435	3.49410	1.87478	.46677
85340	2.06000	.86804	1.29370	.95259	3.35370	1.82063	.46543
85350*	.99491	.19855	.06468	.02701	1.05959	.22556	0.00000
85361*	.22608	.00533	.18322	.00607	.40930	.01140	0.00000
85360*	.25059	.00073	.00223	.00156	.25282	.00229	0.00000
85370	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
86300	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
86310	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
86320	3.08620	1.30974	2.47130	1.78129	5.55750	3.09103	.96604
86330	4.15770	1.45423	2.64790	1.78376	6.80560	3.23793	.45512
86340	1.41960	.53006	1.01980	.70213	2.43940	1.23219	.17640
86351	3.08550	.98736	1.66610	1.08297	4.75160	2.07133	.02454
86350*	1.77520	.25330	3.31785	.14046	5.09305	.39376	0.00000
86360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
86371	0.00000	0.00000	.56000	.36400	.56000	.36400	.36100
86370	.67000	.21440	.09430	.06130	.76430	.27570	.12703
86380	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
87320	4.07490	1.74830	3.05010	2.22419	7.12500	3.97249	1.59758
87330	3.11130	1.31275	2.78570	1.98346	5.89700	3.29621	.96773
87340	2.49980	.98237	1.73850	1.22600	4.23830	2.20837	.47957
87350*	2.13559	.23045	1.72630	.30124	3.86189	.53169	0.00000
87360*	1.33450	.05075	.79260	.02599	2.12710	.07674	0.00000
87370	.09219	.02960	.04857	.03157	.14076	.06107	.01659
87381	.00011	.00013	.38688	.25147	.38699	.25150	.30080

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
87390	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
88320	3.50860	1.82434	2.99030	2.35375	6.49890	4.17809	2.42158
88330	4.80350	1.93790	3.10290	2.22878	7.90640	4.16668	1.56982
88340	2.10050	1.57770	1.62640	1.29115	3.72690	2.36885	.94032
88350	3.05720	1.13975	1.88110	1.30419	4.93830	2.44834	.47531
88360*	.24858	.03646	2.21183	.05790	2.46041	.09336	0.00000
88370*	2.08260	.15599	.67393	.00191	2.75653	.15790	0.00000
88380	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
89330	4.21630	1.98759	3.11740	2.38846	7.33370	4.37105	2.38181
89340	2.93810	1.46430	2.15710	1.71304	5.09520	3.19737	1.56824
89350	2.91500	1.24602	1.88210	1.47706	4.79710	2.72303	.94235
89360*	1.24121	.14954	2.06306	.02535	3.30427	.17489	0.00000
89370*	.92934	.12614	2.28898	.05719	3.21832	.18333	0.00000
89380*	.53200	.03437	0.00000	0.00000	.53200	.03437	0.00000
89391	0.00000	0.00000	.91000	.59150	.91000	.59150	.04700
89390	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
90330	5.36280	2.46742	3.66450	2.79667	9.02730	5.26409	3.31024
90340	2.51210	1.62806	2.07760	1.86585	4.58970	3.49391	2.36796
90350	3.35830	1.58084	2.31570	1.78676	5.67400	3.36760	1.56251
90360*	1.18703	.11799	1.74913	.06804	2.93616	.18603	0.00000
90371*	1.10630	.16356	3.61591	.30838	4.72221	.47194	0.00000
90370*	1.65863	.23509	2.66042	.34596	4.31905	.58407	0.00000
90380*	.19800	.03116	0.00000	0.00000	.19800	.03116	0.00000
90391*	.00088	.00024	.68247	.05459	.68335	.05483	0.00000
90390*	.93100	.05615	.00028	.00020	.93128	.05635	0.00000
90401*	0.00000	0.00000	2.31491	.23624	2.31491	.23624	0.00000
90400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
91340	3.71870	1.67579	2.82660	2.23020	6.54530	4.10589	2.45040
91350	3.06510	1.51109	2.32680	1.81397	5.39190	3.32506	1.59077
91360*	2.57780	.26861	.72356	.14136	3.30136	.40997	0.00000
91370*	1.33416	.18454	2.73316	.38132	4.06732	.56586	0.00000
91380*	.65229	.08391	.69540	.12471	1.34769	.20862	0.00000
91391*	0.00000	0.00000	.55515	.05848	.55515	.05848	0.00000
91390*	.50600	.10641	.00266	.00186	.50866	.10827	0.00000
91400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
92340	2.36280	1.71071	2.60680	2.15756	5.56960	3.36327	2.41532
92350	3.70440	1.65611	2.98550	2.20085	6.68990	3.35636	1.61141
92360*	2.40721	.24520	.75184	.02885	3.15505	.27435	0.00000
92370*	3.45927	.27127	.26136	.01032	3.72063	.28159	0.00000
92380*	.18229	.03561	1.33884	.04257	1.53113	.05413	0.00000
92390*	1.46424	.16931	.24821	.11432	1.71245	.30363	0.00000
92400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
93340	4.03560	1.95372	3.41880	2.58664	7.51440	4.54035	2.42854
93350	3.68720	1.65330	2.87720	2.13171	6.56440	3.78601	1.60218
93360	2.75780	1.23100	2.03960	1.51734	4.79740	2.74834	.94917
93370	2.02740	.85857	1.41460	1.03253	3.44200	1.39110	.47327
93380*	1.16105	.16903	1.39500	.12819	2.55605	.20722	0.00000
93391	0.00000	0.00000	.25000	.16250	.25000	.16250	.04300
93390*	1.18449	.03162	.08957	.00199	1.27406	.03381	0.00000
93400	.01254	.00401	.00742	.00482	.01996	.00883	.01530
93411	0.00000	0.00000	.03040	.01976	.03040	.01976	.00100
93410	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
94340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
94350	4.85440	1.94638	3.60120	2.54370	8.45560	4.49658	1.60590
94360	2.07030	1.06775	1.79800	1.49528	3.86830	2.47303	.85940
94370	3.00980	1.12298	1.98100	1.37922	4.99080	2.49320	.48028
94380*	.86964	.08529	1.24246	.14033	2.11210	.22562	0.00000
94390*	1.71740	.19238	.98613	.11175	2.70353	.30473	0.00000
94400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
94411	.00135	.00043	.04128	.02583	.04263	.02726	.02542
94410	.19100	.06112	1.56000	1.01400	1.75100	1.07512	.26450
94420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
95340	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
95350	4.08400	2.17734	3.40210	2.72098	7.49610	4.39327	3.34657
95360	3.25460	1.77457	2.63440	2.14591	5.88900	3.92003	2.36157
95370	2.55000	1.39855	1.97210	1.62575	4.52210	3.02530	1.56906
95380	1.93930	1.04432	1.36140	1.13102	3.30070	2.17534	.81957
95390*	1.74573	.20152	.48832	.10090	2.23405	.30242	0.00000
95400*	.11629	.01734	.73609	.00655	.85238	.02389	0.00000
95411*	0.00000	0.00000	.23546	.03710	.23546	.03710	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
95410*	.04356	.00739	.76584	.07556	.80940	.08345	0.00000
95420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
95440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
96350	5.29120	2.56030	4.07760	2.84400	9.36880	4.90480	1.62076
96360	2.54220	1.17351	2.31110	1.79504	4.85330	2.87357	.96057
96370	3.51100	1.26375	2.66040	1.80111	6.17140	3.06466	.49546
96380	1.35240	.51056	1.11960	.76831	2.47200	1.27831	.17423
96390	2.40830	.77056	1.46050	.94333	3.86880	1.71339	.02452
96400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
96410	.24900	.07958	2.46000	1.59900	2.70900	1.67358	.25434
96420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
97360	3.80440	1.38836	3.19130	2.46018	6.99570	4.34904	2.42332
97370	2.72690	1.42884	2.50400	1.95572	5.23090	3.38456	1.62436
97380	2.84970	1.13347	1.33780	1.41056	4.18750	2.54403	.94945
97390*	2.16210	.23054	.93500	.08181	3.09710	.31245	0.00000
97400*	.70712	.12249	.18175	.03768	.88887	.16037	0.00000
97411*	0.00000	0.00000	.74270	.07401	.74270	.07401	0.00000
97410*	.46794	.08872	.67703	.06755	1.14497	.15627	0.00000
97420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
98360	2.90840	1.69380	2.79860	2.28828	5.70700	3.98208	2.45303
98370	3.64210	1.63594	3.16310	2.31901	6.80520	3.95705	1.63130
98380	1.69010	.98631	1.49600	1.24408	3.18610	2.23039	.94951
98390	2.84490	1.07670	1.94260	1.74910	4.78750	2.42530	.48170
98400	.90200	.38636	.00100	.00361	.90300	.39557	.12273
98411*	.84812	.17703	2.51493	.17771	3.36305	.31474	0.00000
98410*	1.86528	.20937	.14023	.03231	2.00551	.24168	0.00000
98420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
99360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
99370	2.85150	1.67101	3.17050	2.53493	6.02200	4.20584	2.51729
99380	2.87000	1.46541	2.33420	1.63372	5.20420	3.29918	1.59433
99390	2.09160	1.07530	1.64650	1.30497	3.73810	2.38027	.94343
99400*	1.62052	.18171	.79370	.09498	2.41422	.27669	0.00000
99411*	.95365	.14661	1.99426	.21281	2.94791	.35942	0.00000
99410*	1.52253	.21312	.19974	.03497	1.72227	.24809	0.00000
99420*	.38474	.00718	.18606	.00625	.57080	.01343	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
99431*	0.00000	0.00000	.14274	.01544	.14274	.01544	0.00000
99430	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100360	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100370	-.73050	1.91256	3.72930	2.63670	8.45950	4.54325	1.62077
100380	2.04300	1.05912	1.92080	1.48715	3.96380	2.54627	.97325
100390	3.39790	1.23137	2.42790	1.65233	5.82580	2.88431	.46934
100400	.73690	.34715	.63230	.47391	1.36920	.82103	.16525
100411	2.11860	.67795	1.36560	.68764	3.48420	1.56559	.02465
100410*	2.05953	.23614	1.92053	.08036	3.98012	.31650	0.00000
100420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100430	1.40000	.44900	.07800	.05070	1.47800	.49370	.13772
100440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
101370	3.37530	2.12614	3.49930	2.80478	7.37460	4.93092	3.42654
101380	3.25770	1.77327	2.82660	2.26927	6.09450	4.04254	2.42002
101390	2.52090	1.79056	2.09180	1.70682	4.61270	3.09743	1.58857
101400	2.40000	1.15726	.35290	.40350	2.75290	1.56075	.77746
101410*	1.90055	.23136	.32999	.04801	2.23054	.27937	0.00000
101420*	.59499	.02720	1.38620	.02340	1.98119	.05050	0.00000
101430*	.47996	.03456	.33625	.01419	.81621	.04875	0.00000
101440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
102380	2.44630	1.66347	2.43340	2.10946	4.87970	3.71287	2.44555
102390	3.81530	1.68475	2.91860	2.15174	6.73390	3.83649	1.59915
102400	1.13240	.87511	1.03750	1.01790	2.16990	1.39311	.92461
102410	2.43700	.97921	1.63850	1.19396	4.17550	2.17317	.47747
102420*	.31112	.05734	0.00000	0.00000	.31112	.05734	0.00000
102431*	.71348	.10223	2.54664	.22869	3.26012	.33092	0.00000
102430*	1.50383	.18537	.46734	.08952	1.97217	.27539	0.00000
102440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
103370	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
103380	3.64770	2.07562	3.37470	2.74753	7.02240	4.82540	3.43476
103390	2.94180	1.70633	2.59750	2.15382	5.53930	3.36015	2.41649
103400	2.24880	1.33483	1.88840	1.60250	4.13720	2.93733	1.56105
103410	1.73640	.99395	1.38230	1.16443	3.11870	2.16338	.93230
103420	1.30660	.68412	.93750	.79601	2.23400	1.48013	.46346
103430	.71887	.34331	.50825	.39377	1.22712	.73708	.15846

NUCLIDE	E BETA	UNO BETA	E GAMMA	UNO GAMMA	E TOTAL	UNO TOTAL	CORR TOTAL
103440*	.06753	.01137	.43002	.05345	.55755	.06432	0.00000
103451*	0.00000	0.00000	.03973	.00400	.03973	.00400	0.00000
103450	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
104380	2.91550	1.68854	3.05610	2.45404	5.97160	4.14254	2.49239
104390	4.18350	1.77207	3.44300	2.47341	7.62650	4.24544	1.62529
104400	1.50850	.94636	1.46330	1.24730	2.97590	2.19353	.95831
104410	2.94300	1.10313	2.15250	1.49287	5.09550	2.58600	.44871
104420	.54772	.30213	.48751	.39283	1.03523	.59436	.16172
104430*	1.19296	.16956	1.44814	.22382	2.64110	.39338	0.00000
104440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
104451*	.00053	.00015	.13219	.01340	.13277	.01355	0.00000
104450*	1.00297	.19119	.01149	.01050	1.01446	.20169	0.00000
104460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
105380	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
105390	3.43460	2.03651	3.21190	2.66605	6.64650	4.70256	3.43249
105400	2.63380	1.64543	2.37670	2.04664	5.01050	3.59207	2.41100
105410	2.13680	1.31211	1.81950	1.57054	3.95630	2.48255	1.57992
105420	1.71900	.99479	1.39650	1.17563	3.11550	2.17042	.93569
105430	1.05360	.62848	.80733	.70067	1.86093	1.32915	.45529
105440*	.41264	.01885	.73768	.01627	1.23032	.02712	0.00000
105451*	0.00000	0.00000	.12970	.04779	.12970	.04779	0.00000
105450*	.15228	.02861	.07877	.00335	.23105	.03216	0.00000
105460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
106390	4.54970	2.27081	3.91060	3.01190	8.45030	5.25271	3.41957
106400	1.95140	1.51239	2.00850	1.91241	3.95990	3.42480	2.42805
106410	3.35170	1.57423	2.65290	2.00612	6.00460	3.55035	1.59916
106420	.92050	.86356	.87447	.94915	1.79497	1.76231	.81320
106430	2.23540	.92528	1.60230	1.14454	3.83770	2.06832	.47752
106440*	.00997	.00156	0.00000	0.00000	.00997	.00156	0.00000
106451*	.34865	.05364	2.64524	.17924	2.99390	.27253	0.00000
106450*	1.44567	.18523	.19944	.06020	1.64511	.24543	0.00000
106460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
107390	3.75370	2.09583	3.71260	2.95390	7.47630	5.04373	3.47694
107400	3.09160	1.73134	2.90750	2.33919	5.99910	4.07103	2.45015
107410	2.60680	1.40429	2.36150	1.87410	4.96830	3.27833	1.61702

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
107420	1.35660	1.04436	1.72620	1.36734	3.08280	2.41220	.35541
107430	1.53540	.73557	1.26560	.96112	2.80100	1.59653	.47756
107440*	1.23748	.18834	.25137	.07156	1.48885	.20050	0.00000
107450*	.42119	.06856	.31225	.03523	.73344	.10378	0.00000
107461	0.00000	0.00000	.21000	.13650	.21000	.13650	.04500
107460	.01030	.00330	.00010	.00007	.01040	.00337	.01107
107470	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
108400	2.33010	1.57531	2.52620	2.18722	4.85630	3.76253	2.47631
108410	3.83250	1.58564	3.18040	2.32018	7.01300	4.00532	1.62198
108420	1.33980	.91132	1.35140	1.19373	2.69120	2.10555	.95650
108430	2.52030	1.01374	2.00110	1.39275	4.52140	2.40549	.48870
108440*	.47006	.08153	.04620	.01651	.51626	.09804	0.00000
108451*	.80406	.13940	2.43950	.16835	3.24356	.30776	0.00000
108450*	1.82806	.22139	.70853	.11912	2.53659	.34051	0.00000
108460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
108471	0.00000	0.00000	.30000	.56500	.30000	.58500	.30100
108470	.50127	.16041	.28406	.18464	.78533	.34505	.14523
108480	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
109400	3.41920	2.02675	3.44150	2.81666	6.86070	4.34341	3.47777
109410	3.00910	1.71631	2.38650	2.53422	5.39560	4.04813	2.45575
109420	2.39420	1.35980	2.13750	1.78848	4.53170	3.14824	1.61309
109430	1.97920	1.04746	1.74400	1.37751	3.72320	2.42527	.95951
109440	1.23670	.67802	1.09490	.86800	2.33160	1.54602	.47336
109451	0.00000	0.00000	.25000	.65300	.25000	.65300	.30100
109450	.71285	.34155	.56227	.42959	1.27512	.77114	.16181
109461*	0.00000	0.00000	.13800	.01836	.13800	.01836	0.00000
109460*	.36411	.06842	.00021	.00006	.36432	.06849	0.00000
109471*	0.00000	0.00000	.08770	.00884	.08770	.00884	0.00000
109470	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
109480	.02465	.00739	.01599	.01039	.04064	.01828	.11155
110400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
110410	4.13770	1.75710	3.69460	2.63790	7.83230	4.39500	1.64775
110420	1.69810	.98117	1.31940	1.44787	3.01750	2.42304	.35469
110430	3.12530	1.15300	2.51260	1.71231	5.63790	2.36531	.49776
110440	.77479	.35573	.76407	.55752	1.53886	.91325	.17110

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
110451*	2.43122	.24646	.07607	.03738	2.53729	.28334	0.00000
110450*	1.34568	.19925	2.26763	.15486	3.61336	.35411	0.00000
110460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
110471	.06800	.02176	2.79000	1.81350	2.85800	1.83526	.25335
110470	1.18000	.37760	.04160	.02704	1.22160	.40464	.12962
110490	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
111410	3.36700	2.01631	3.40610	2.80000	6.77310	4.81631	3.47864
111420	2.75770	1.66268	2.72070	2.25534	5.47840	3.91302	2.45768
111430	2.35810	1.35142	2.20950	1.90009	4.56760	3.15151	1.61780
111440	1.71260	.99065	1.52980	1.26373	3.24240	2.25443	.95217
111450	1.23030	.66564	1.04400	.83949	2.27440	1.50517	.47120
111461*	.16711	.02974	.42139	.01450	.58850	.04424	0.00000
111460*	.34413	.05778	.05288	.00634	.39706	.06412	0.00000
111471*	0.00000	0.00000	.06500	.00640	.06500	.00640	0.00000
111470*	.35476	.07131	.02697	.01080	.38173	.08211	0.00000
111481	0.00000	0.00000	.39600	.25740	.39600	.25740	.04300
111490	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
112410	4.44530	2.24137	4.15930	3.18063	8.60460	5.42200	3.46805
112420	2.04200	1.52108	2.29200	2.08259	4.33400	3.60367	2.47615
112430	3.50350	1.60533	3.04630	2.25137	6.54980	3.85670	1.62866
112440	1.07790	.86058	1.12800	1.09000	2.20590	1.95058	.94577
112450	2.30030	.92736	1.77300	1.25468	4.07330	2.18254	.48505
112460	.07900	.20071	.07635	.20139	.15514	.40210	.13271
112470*	1.42839	.18095	.66377	.10734	2.09266	.28329	0.00000
112480	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
113420	3.15580	1.73775	3.25620	2.55798	6.41200	4.29573	2.49438
113430	2.72480	1.42434	2.70220	2.08399	5.42700	3.50333	1.64602
113440	2.05810	1.06149	1.98600	1.52812	4.04410	2.58951	.97851
113450	1.58060	.74462	1.43290	1.06687	3.01350	1.81148	.48737
113460	1.06410	.43118	.32212	.64799	1.38622	1.07317	.17149
113471	.64353	.20735	.53127	.34533	1.18080	.55313	.02304
113470	.57947	.18543	.47397	.30808	1.05344	.49351	.02274
113481	.15843	.05070	.12539	.03150	.28382	.13220	.01923
113480	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
113491	0.00000	0.00000	.39300	.25545	.39300	.25545	.30100

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
113490	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
114420	2.38630	1.57810	2.81030	2.36284	5.19660	3.34034	2.52183
114430	3.90840	1.69463	3.57310	2.57061	7.48150	4.26934	1.65085
114440	1.39900	.91934	1.54670	1.31324	2.94570	2.23303	.97772
114450	2.64220	1.01832	2.21600	1.53131	4.85820	2.54963	.49707
114460	.57923	.30873	.59369	.45976	1.17292	.76861	.16721
114470	2.11300	.67616	.08700	.05655	2.20000	.73271	.01976
114480	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
114491	.01672	.00535	.19613	.12748	.21285	.13283	.24687
114490	1.00000	.72000	.33743	.25186	1.33743	.57186	.14876
114500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
115420	3.49220	2.03430	3.72550	2.99145	7.21770	5.02525	3.51411
115430	3.09160	1.72374	3.23190	2.54874	6.32350	4.27248	2.49806
115440	2.42990	1.36169	2.46000	1.95496	4.88990	3.31665	1.64418
115450	1.92750	1.03325	1.85760	1.45607	3.78510	2.48932	.97407
115460	1.32360	.63558	1.25080	.96615	2.57440	1.65133	.46414
115471	1.01530	.41812	.89261	.63050	1.90791	1.04662	.17171
115470	.95176	.40143	.83673	.59659	1.78849	.99812	.17861
115481	.46372	.14869	.38830	.25240	.85202	.40073	.02275
115480	.31721	.10151	.26562	.17265	.58283	.27416	.02123
115491	.00837	.00268	.32931	.21405	.33768	.21673	.04009
115490	.13430	.04298	.10758	.06993	.24188	.11291	.01900
115500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
116420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
116430	4.23760	1.77916	4.02480	2.84670	8.26240	4.62576	1.68729
116440	1.72370	.98256	2.00530	1.57164	3.72900	2.55360	1.00287
116450	3.04270	1.12861	2.69410	1.53150	5.73680	2.45951	.50565
116460	.75165	.34936	.81708	.59318	1.56873	.94254	.17421
116471	1.96170	.62774	1.59470	1.03656	3.55640	1.66430	.02594
116470	2.18500	.69920	.70960	.46124	2.89460	1.16044	.02240
116480	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
116492	0.00000	0.00000	.25000	.16250	.25000	.16250	.30100
116491	1.01060	.32339	.72759	.47293	1.73819	.79632	.16606
116490	.99266	.31765	.71468	.46454	1.70734	.78219	.16476
116500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
117430	3.34720	2.06339	3.67560	2.97626	7.02280	4.38025	3.53060
117440	2.84020	1.67375	2.98000	2.41342	5.82020	4.08717	2.44951
117450	2.27170	1.32939	2.31660	1.87902	4.58830	3.20841	1.64007
117460	1.63200	.98230	1.67720	1.36211	3.36920	2.34431	.97053
117471	1.34080	.68847	1.25910	.97059	2.59990	1.65906	.44426
117470	1.27850	.67450	1.20060	.93758	2.47910	1.61208	.48232
117481	.71565	.34164	.65529	.49018	1.37094	.83182	.16649
117480	.63402	.32206	.58055	.44686	1.21457	.76892	.16476
117491	.26206	.08386	.37454	.24345	.63660	.32731	.02373
117490	.40742	.13337	.35295	.22935	.76027	.36272	.02207
117501	0.00000	0.00000	.31700	.20605	.31700	.20605	.04300
117500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
118430	4.40320	2.22373	4.52350	3.41844	8.92670	5.64217	3.52519
118440	1.33520	1.50526	2.43410	2.18469	4.42930	3.63937	2.51325
118450	3.47830	1.59656	3.20970	2.35832	6.68800	3.95480	1.64664
118460	1.05040	.65135	1.20560	1.14781	2.25600	1.33976	.96202
118471	1.23570	.67816	1.22850	.95431	2.52420	1.63247	.44380
118470	2.31940	.93152	1.99330	1.39667	4.31270	2.32734	.49548
118480	.21260	.23010	.22678	.27069	.43938	.50079	.15040
118492	0.00000	0.00000	.25000	.16250	.25000	.16250	.04300
118491*	1.77582	.20639	.21812	.09927	1.99794	.30625	0.00000
118490*	.62946	.09180	2.57567	.18660	3.20533	.27340	0.00000
118500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
119440	3.07520	1.71339	3.48960	2.71613	6.56490	4.42352	2.53585
119450	2.56240	1.38534	2.75370	2.13158	5.31610	3.51632	1.55756
119460	2.10950	1.07026	2.17300	1.64436	4.28250	2.71512	.98227
119470	1.59130	.74537	1.53830	1.16675	3.13010	1.91212	.49676
119481	1.04850	.42635	1.01520	.70883	2.06370	1.13514	.17564
119480	.94005	.39732	.91018	.64469	1.85023	1.04251	.17341
119491	.73212	.23428	.69309	.45051	1.42521	.68473	.02409
119490	.69935	.22379	.65012	.42258	1.34947	.64637	.02347
119501	0.00000	0.00000	.08900	.05785	.08900	.05785	.04300
119500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
120440	2.33820	1.56148	2.98240	2.48070	5.32060	4.04218	2.95823
120450	3.63650	1.64136	3.69700	2.66097	7.33350	4.30233	1.67459

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
120460	1.33700	.90339	1.61400	1.36599	2.95100	2.26384	.94181
120470	2.77510	1.03936	2.44920	1.68011	5.17430	2.71837	.50415
120480	.44491	.27822	.50303	.41413	.94794	.59235	.16805
120491*	2.47143	.23012	.17574	.11716	2.64722	.34724	0.00000
120490*	1.03965	.15314	3.05971	.22644	4.09936	.37462	0.00000
120500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
121450	2.92840	1.68472	3.30480	2.61276	6.23320	4.23749	2.52792
121460	2.34030	1.33727	2.61910	2.06685	4.95940	3.43412	1.67220
121470	1.37900	1.01937	1.98290	1.54151	3.36190	2.56034	.98954
121480	1.39120	.69344	1.40420	1.06286	2.79540	1.75930	.49274
121491	1.09080	.43750	1.08180	.75963	2.17260	1.19513	.17715
121490	1.02000	.41362	1.01160	.70746	2.03160	1.12604	.17606
121501	.17393	.05556	.16402	.10661	.33795	.16227	.02036
121500	.10491	.03357	.09893	.06431	.20384	.09788	.01933
121510	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
122440	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
122450	3.33890	1.69033	4.07230	2.89223	7.97120	4.59256	1.69071
122460	1.66270	.96539	2.10380	1.64080	3.76650	2.60669	1.01739
122470	2.96580	1.10497	2.81130	1.97405	5.37770	3.07902	.51456
122480	.66074	.32669	.78835	.58016	1.44909	.90685	.17553
122491	2.17130	.69432	1.92840	1.25346	4.09970	1.94825	.92613
122490	2.09380	.67002	1.85950	1.20868	3.95330	1.87870	.02607
122500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
122511	0.00000	0.00000	.16200	.10530	.16200	.10530	.35170
122510	.56774	.19156	.46631	.30310	1.03405	.48473	.15892
122520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
123450	3.17160	1.72914	3.74680	2.67169	6.91840	4.60083	2.55862
123460	2.63060	1.39435	3.03940	2.32198	5.69000	3.71633	1.69503
123470	2.22520	1.09279	2.47360	1.83003	4.69880	2.92282	1.01008
123480	1.60210	.74951	1.76580	1.23073	3.36790	2.02624	.50687
123491	1.32460	.50118	1.39430	.94692	2.71890	1.44810	.18235
123490	1.25300	.48126	1.31830	.89974	2.57190	1.38102	.18131
123501	.47183	.15039	.46548	.30256	.93731	.45355	.02313
123500	.40120	.12336	.33579	.23726	.74699	.38554	.02270
123510	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CO [illegible] TOTAL
123521	0.00000	0.00000	.34750	.16985	.34750	.16985	.70100
123520	0.00000	0.00000	.02000	.01400	.02000	.01400	.70100
124450	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
124460	1.34550	1.02252	2.57240	1.91460	4.51780	2.33771	1.15647
124470	3.27470	1.19140	3.35800	2.25690	6.63270	[illegible]	.50105
124480	1.01470	.41521	1.27270	.87600	2.28740	1.93174	.15431
124490	2.25520	.70148	2.19980	1.42947	4.45500	1.15157	[illegible]
124500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
124512	0.00000	0.00000	.25000	.10250	.25000	.10250	[illegible]
124511	0.00000	0.00000	.01000	.00650	.01000	.00650	.80100
124510	.85178	.27077	.74589	.44463	1.59767	.52052	.15178
124520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
125460	2.85140	1.86117	3.51730	2.75762	6.36870	[illegible]	[illegible]
125470	2.62560	1.37765	2.85050	2.26125	5.47610	2.65410	1.48247
125480	1.88050	1.01596	2.15970	1.65510	4.03940	2.07100	[illegible]
125491	1.79640	.74178	1.76420	1.28001	3.56060	2.08215	.50743
125490	1.52990	.72435	1.74150	1.24357	3.27140	1.47152	.50649
125501*	.79801	.14629	.34546	.03460	1.14347	.15044	0.00000
125500*	.83615	.16872	.31227	.04850	1.14842	.21552	0.00000
125510*	.38606	.01540	.45287	.04561	.83893	.06101	0.00000
125521*	0.00000	0.00000	.14375	.05492	.14375	.05492	0.00000
125520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
126460	2.24270	1.85587	3.33040	2.86444	5.57710	4.10041	2.70128
126470	3.47310	1.86540	3.79370	2.79476	7.26680	4.72155	1.00475
126480	1.27420	.88850	1.58070	1.41800	2.85490	2.00554	1.00514
126490	2.53490	.80672	2.54720	1.77804	5.18210	2.75475	.51421
126500	.07900	.19634	.04980	.16760	.11940	.30400	.12141
126511	1.00760	.32111	.89523	.54597	1.89866	.36800	.32511
126510	.37800	.11450	2.67000	1.77550	3.08400	1.85007	.33556
126520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
127470	2.83140	1.55533	3.45710	2.72120	6.28850	4.37834	2.75101
127480	2.09670	1.26304	2.56190	2.05776	4.65860	3.34030	1.54020
127491	1.95730	1.03144	2.29080	1.72298	4.24810	2.76444	1.01274
127490	1.87280	1.01542	2.18310	1.67753	4.05600	2.69090	1.00047
127501*	1.13421	.21019	.49400	.04712	1.62821	.25751	0.00000

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	FRA TOTAL
127500*	.57455	.12549	1.43431	.03147	2.13[illegible]	.1759	0.00000
127510*	.31836	.04955	.54432	.14757	.8[illegible]	.18752	0.00000
127521	.00498	.00159	.03187	.05971	.03[illegible]	.06180	.07773
127520*	.22723	.04133	.00517	.00181	.2[illegible]	.04[illegible]	0.00000
127530	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
128460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
128470	3.52060	1.61779	4.25670	3.60062	7.54[illegible]	4.4[illegible]	1.7[illegible]
128480	1.55760	.94025	2.13760	1.47418	3.6452[illegible]	2.61447	1.[illegible]71
128490	2.30420	1.05736	3.36480	2.07642	5.65[illegible]	3.134[illegible]	.[illegible]7
128500*	.21720	.06539	.53651	.03810	.81371	.07814	0.00000
128511*	.34725	.15931	1.33603	.07430	2.[illegible]	.27451	0.00000
128510*	.41543	.07520	3.33604	.15174	[illegible]	.134[illegible]	0.00000
128520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
128530	.74900	.23936	.15500	.10075	.90300	.34011	.17721
128540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
129470	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
129480	2.34310	1.32559	3.08330	2.36468	5.42640	3.09357	1.71531
129490	2.36730	1.05271	2.55190	1.49187	4.91920	2.94[illegible]	1.02[illegible]2
129501	1.21640	.65499	1.47080	1.11782	2.68720	1.77241	.70572
129500	1.14520	.63957	1.38470	1.08879	2.52990	1.72836	.6[illegible]
129510*	.35911	.05483	1.30105	.15143	1.66016	.21656	0.00000
129521*	.21402	.05038	.02960	.01261	.24362	.06301	0.00000
129520*	.23334	.10659	.07290	.02556	.30[illegible]	.12[illegible]	0.00000
129530	.06240	.01987	.04000	.02600	.102[illegible]	.04587	.[illegible]77
129541	0.00000	0.00000	.23500	.15340	.23[illegible]	.15340	.30100
129540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
130460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
130470	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
130480	1.88450	1.06508	2.69400	1.94704	4.57850	3.01277	1.[illegible]1
130490	2.53060	1.07936	3.43280	2.21202	5.96340	3.39248	.[illegible]
130500	.50250	.25929	.63651	.52763	1.13901	.61657	.17035
130511*	1.09322	.15276	2.48946	.14702	3.58268	.29937	0.00000
130510*	1.25067	.18219	2.14089	.14524	3.39156	.32730	0.00000
130520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
130521	.13667	.04373	.34705	.22558	.48372	.23931	.15741

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	[illegible] TOTAL
130530	.23500	.29440	2.12000	1.37800	2.41500	1.47240	.24748
130540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
131480	3.14540	1.71805	4.25820	3.20115	7.40410	4.31120	2.46414
131490	2.34420	1.32744	3.07080	2.25560	5.41400	2.58320	1.72094
131500	1.30540	.99336	1.70690	1.43042	3.01230	2.05047	1.00041
131510*	.71368	.09347	1.70251	.17357	2.41620	.27240	0.00000
131521*	.19218	.03741	1.48113	.13514	1.67331	.17250	0.00000
131520*	.67172	.10522	.42235	.07404	1.09407	.17931	0.00000
131530*	.13553	.03555	.34928	.04567	.57470	.07433	0.00000
131541*	1.00000	0.00000	.16754	.00823	.16754	.00827	0.00000
131540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
132480	2.84120	1.61973	3.48760	3.04210	6.59951	4.04157	2.00006
132490	3.82470	1.96256	4.65060	3.07422	[illegible]	4.4564	1.70740
132500*	.66030	.10014	1.32273	.03143	1.33304	.17167	0.00000
132511*	1.63575	.19256	2.03862	.12710	3.73410	.31975	0.00000
132510*	1.70211	.21771	2.00600	.17723	3.72611	.39144	0.00000
132520*	.05035	.00632	.26860	.01360	.32365	.01532	0.00000
132530*	.52463	.08755	2.23771	.14289	2.76234	.23741	0.00000
132540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
133490	3.33730	1.75557	4.46540	3.31650	7.80270	5.06721	2.02414
133500	2.08240	1.27264	2.31490	2.21527	4.39730	3.48741	1.77220
133510*	.53711	.09128	3.16247	.20347	3.69954	.34317	0.00000
133521*	.55207	.09276	1.86615	.17007	2.41822	.24253	0.00000
133520*	.41933	.12058	.93324	.11757	1.30322	.24427	0.00000
133531	0.00000	0.00000	.25000	.05700	.25000	.05700	.01100
133530*	.41713	.07538	.59335	.05447	1.01013	.13354	0.00000
133541*	0.00000	0.00000	.23269	.00641	.23265	.00641	0.00000
133540*	.10183	.01173	.08144	.00356	.18302	.00221	0.00000
133550	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
134490	4.01150	1.70502	5.17700	3.57237	9.14800	5.27754	1.78336
134500	1.65430	.95594	2.47110	1.97573	4.13500	2.93277	1.00043
134511*	2.99777	.27519	2.09443	.14751	5.04820	.42310	0.00000
134510*	2.35135	.27674	1.00000	0.00000	2.35135	.27553	0.00000
134520*	.15203	.02511	.32497	.02467	.47700	.04778	0.00000
134531*	0.00000	0.00000	.31570	.02776	.31570	.02775	0.00000

[illegible]	I BETA	UNC BETA	I GAMMA	UNC GAMMA	I TOTAL	UNC TOTAL	CORR TOTAL
13453D*	.63333	.1072+	2.59265	.1768+	7.2335+	.27833	0.00000
13.5+1	0.00000	0.00000	2.00000	1.00000	7.00000	1.30007	.04370
13.5+0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13.571*	0.00000	0.00000	.13750	.0130+	.17760	.0133+	0.00000
13.530*	.1513.	.0237+	1.57772	.11115	1.7+162	.1+3+0	0.00000
17.000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
17350.	2.07670	1.72+33.	3.30++0	2.03623	.5+0+0	3.50+71	1.7+60
175510	2.05400	1.0+57.	2.30750	2.05606	+.3716.	4.10273	1.0+611
175520	1.62510	.7+5+7	2.17750	1.5++35	7.33240	2.2+4.5	.72771
17553.*	.33755	.0565+	.1.+560+	.01724	1.61+26+	.25+15	0.00000
17554.1*	0.00000	0.00000	.52642	.00362	.52642	.00302	0.00000
175540*	.02930	.0036P	.2+1+3	.0015+	.57130	.00527	0.00000
175551	0.00000	0.00000	1.62100	1.05365	1.62100	1.0536+	.74330
175550	.05940	.02221	.00010	.00007	.05950	.02221	.01219
175561	0.00000	0.00000	.26300	.17420	.26500	.17+27	.30110
175560	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1756+0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
175600	1.42640	1.07+40	2.97110	2.17152	+.39450	3.16012	1.77331
176510	2.54360	1.9779+	3.60770	2.+7737	6.77620	4.00++1	.67913
176520	1.1+350	.++751	1.59770	1.1.7++	2.34130	1.54321	.13542
176571*	1.41351	.01051	1.92041	.12864	2.36440	.74310	0.00000
176530*	1.41100	.22++1	2.213+4	.13413	1.32+53	.+3204	0.00000
176541	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
176+10*	.11923	.02+67	2.16705	.1+382	2.27650	.16301	0.00000
176561	0.00000	0.00000	2.0+000	1.02500	2.0+000	1.32500	.33700
176560	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
177500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
177510	2.++320	1.041+7	3.+0330	2.55357	7.3+650	3.0007+	1.74634
177520	1.74050	.97+01	2.51170	1.+9234	+.29220	2.37+30	1.04+01
177530	1.31460	.71007	2.03460	1.+5560	7.5+320	2.17+.2	.02510
17753+0*	1.3+072	.07904	.13526	.036+2	2.0359+	.11591	0.00000
177550*	.17+++	.00155	0.00000	0.00000	.174++	.00155	0.00000
177561*	0.00000	0.00000	.56213	.0035+	.56213	.0035+	0.00000
177560	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
178500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
138510	7.22080	1.51436	4.22840	3.62816	7.44920	4.56437	1.78090
138520	1.41020	.90412	2.17800	1.71814	3.59820	2.60231	1.04742
138530	2.12120	.47072	2.70110	1.36044	4.82230	2.72114	.60109
138540*	.65770	.09410	1.18506	.02675	1.85276	.12445	0.00000
138551*	1.14690	.19475	2.08966	.15362	3.24656	.24840	0.00000
138550*	1.25240	.14657	2.32913	.07095	3.59153	.21762	0.00000
138560	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
138570	0.00000	0.00000	.84000	.54600	.84000	.54600	.30100
138580	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
139510	2.65370	1.40307	3.84260	2.98790	6.49630	4.39037	2.60364
139520	2.14540	1.27655	3.10460	2.29420	5.25000	3.57075	1.74910
139530	1.76120	.47736	2.47270	1.46919	4.23390	2.14491	1.03663
139540*	1.78678	.14131	.92752	.00846	2.71430	.14987	0.00000
139550*	1.76364	.12209	.31076	.02294	2.07440	.14503	0.00000
139560*	.33722	.14516	.03223	.01596	.34951	.16112	0.00000
139570	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
140520	1.62870	1.41287	2.61280	2.37079	4.24250	3.78376	2.62181
140530	2.08730	1.27011	2.93240	2.29614	5.01970	3.56615	1.73585
140540	.88274	.20617	1.35240	1.09096	2.23314	2.09708	1.01564
140550*	1.83124	.23450	2.13178	.29754	4.06232	.53204	0.00000
140560*	.28027	.03451	.21687	.00733	.49714	.04184	0.00000
140570*	.51702	.05736	2.20411	.14939	2.72144	.20725	0.00000
140580	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
141510	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
141520	2.41380	1.79642	3.60040	3.04706	6.01420	4.84348	2.47144
141530	1.84790	1.47610	2.84570	2.44406	4.83360	3.92016	2.00418
141540	1.57140	1.17219	2.27010	1.94659	3.44150	3.12878	1.71964
141550	1.87700	.95636	1.32490	1.43654	3.20190	2.42341	1.01549
141560*	.91553	.11309	.83782	.01325	1.50347	.12634	0.00000
141570*	.93933	.05397	.03281	.00147	1.32203	.05544	0.00000
141580*	.15943	.02652	.07170	.01049	.23113	.03711	0.00000
141590	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
142520	1.74840	1.42657	2.89050	2.52877	4.63070	3.95542	2.05110
142530	2.30410	1.44157	3.33180	2.85938	5.63590	4.30091	1.71704
142540	1.08730	.64259	1.76540	1.50381	2.85270	2.14579	1.03742

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
142550	2.04430	.85171	2.54450	1.76221	4.58930	2.61392	.52757
142560*	.42828	.06130	1.01269	.03744	1.44097	.08824	0.00000
142570*	.94702	.13235	2.56469	.06997	3.51171	.20232	0.00000
142580	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
142591	0.00000	0.00000	.25000	.16250	.25000	.16250	.30130
142590	.30700	.25624	.05820	.03783	.36520	.29027	.12580
142600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
143520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
143530	2.21000	1.78369	3.31060	2.92401	5.51960	4.68470	3.67565
143540	1.73630	1.44930	2.68890	2.33774	4.49760	3.33754	2.60063
143550	1.55440	1.17446	2.16880	1.88471	3.73320	3.05917	1.71166
143560	1.08830	.84802	1.57060	1.37862	2.65890	2.22764	1.01309
143570	.83128	.57114	1.14030	.94890	1.97208	1.52004	.50260
143580*	.41913	.06537	.29584	.03760	.71497	.10297	0.00000
143590*	.32392	.06120	0.00000	0.00000	.32392	.06120	0.00000
143600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
144520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
144530	3.01350	1.91137	4.20310	3.35635	7.21660	5.26822	3.67649
144540	1.20060	1.33748	2.00390	2.10618	3.20450	3.44366	2.58908
144550	2.34970	1.72858	3.04130	2.37682	5.39100	3.66537	1.72016
144560	.64787	.76097	1.04620	1.15245	1.69407	1.91342	.99279
144570	1.51050	.71977	1.93650	1.39606	3.44700	2.11580	.62137
144580*	.08296	.00176	.02887	.00132	.11183	.00308	0.00000
144591*	.00030	.00010	.05973	.00902	.06003	.00912	0.00000
144590*	1.26277	.00470	.03101	.00080	1.29378	.00550	0.00000
144600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
145530	2.43250	1.79343	3.79490	3.18702	6.22740	4.98047	3.72030
145540	1.98570	1.47311	3.05040	2.59212	5.03610	4.06523	2.62939
145550	1.64070	1.18417	2.38110	2.00759	4.02180	3.19176	1.72302
145560	1.28660	.88269	1.92180	1.57196	3.20840	2.45465	1.03340
145570	1.05820	.61585	1.51960	1.16431	2.57780	1.78016	.51857
145580*	.62994	.10346	.74893	.08680	1.37887	.19026	0.00000
145590*	.70465	.13157	.01378	.00435	.71843	.13592	0.00000
145600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
146540	1.44920	1.37365	2.50410	2.35333	3.95330	3.72698	2.64257

NUCLIDE	I BETA	UNC BETA	I GAMMA	UNC GAMMA	I TOTAL	UNC TOTAL	CORR TOTAL
146550	2.47840	1.35180	3.32320	2.50403	5.80160	2.86557	1.75877
146560	.72447	.77289	1.21590	1.23886	1.94977	2.11268	1.01194
146570	1.76770	.78015	2.35750	1.57322	4.12520	2.48867	.78012
146580*	.24283	.04582	.31430	.04048	.55640	.09041	0.00000
146590*	.32770	.14543	1.63484	.13713	2.59244	.33284	0.00000
146600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
147540	2.18340	1.88387	3.57230	4.30835	5.71610	5.24722	4.38431
147550	1.96260	1.72286	2.84760	2.74250	4.80580	4.44584	7.58642
147560	1.44130	1.36717	2.21690	2.19284	3.65880	4.02710	0.37440
147570	1.16170	1.09516	1.72448	1.70866	2.87846	2.77454	1.84137
147580	.85132	.81276	1.27140	1.23477	2.12272	2.04157	.88946
147590*	.74788	.12030	.82000	.12273	1.56809	.24107	0.00000
147600*	.24164	.05005	.11871	.03710	.35075	.06707	0.00000
147610*	.06800	.01001	.00010	.00157	.06810	.01000	0.00000
147620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
148540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
148550	2.72370	1.84808	3.84270	2.81577	6.56647	4.31483	1.75134
148560	.95593	.81216	1.66360	1.46774	2.61953	2.27987	1.84429
148570	1.33410	.82849	2.66650	1.64502	4.00060	2.56551	.56879
148580	.36692	.25836	.61958	.30164	.98650	.76002	.17951
148590*	2.04755	.22645	.70000	.07711	2.34357	.26884	0.00000
148600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
148611*	.14788	.02726	2.00978	.11578	2.15676	.11407	0.00000
148610*	.74430	.10504	.63038	.21761	1.37468	.35147	0.00000
148620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
149550	2.29990	1.76147	3.42250	3.02756	5.72130	4.74709	2.70246
149560	1.34210	1.41341	2.65580	2.40772	4.00790	3.80110	2.60946
149570	1.73480	1.15524	2.13220	1.52765	3.86700	3.50342	1.77712
149580	.98953	.78607	1.52400	1.47834	2.51381	2.19641	1.01965
149590*	1.15782	.17551	.25127	.05663	1.40904	.23214	0.00000
149600*	.47478	.07914	.33676	.01298	.81110	.09212	0.00000
149610*	.37663	.07325	.01423	.00403	.39081	.07757	0.00000
149620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
150550	2.91840	1.45676	4.34220	3.12975	7.26110	4.55751	1.73629
150560	1.21800	.95703	2.19310	1.75580	3.41110	2.61263	1.74165

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
150570	2.14250	.17234	3.12750	2.13454	5.27010	3.30552	.34535
150580	.55133	.29706	.96795	.70422	1.51960	1.00128	.16445
150590	1.35450	.47444	1.85760	1.20744	3.21210	1.64034	.30735
150600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
150610	.73530	.23520	1.51070	.94160	2.24600	1.21570	.27007
150620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
151560	1.37310	1.44732	3.20400	2.96152	5.07710	4.41804	1.71732
151570	1.63050	1.42017	2.71950	2.43322	4.40000	3.87834	1.31173
151580	1.17790	1.09247	1.92300	1.90217	7.10790	2.40235	1.72447
151590	.32515	.81417	1.44850	1.73540	2.37600	2.19457	1.30714
151600*	.54413	.08026	.83927	.10771	1.48340	.17557	0.00000
151610*	.31135	.04754	.30360	.04617	.62140	.04373	0.00000
151620	.01950	.00674	.00040	.00028	.01990	.00620	.01138
151630	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
152560	1.46530	1.36602	2.72600	2.47008	4.18190	3.41510	2.23436
152570	2.33850	1.32110	3.68340	2.74278	6.07190	4.06345	1.74133
152580	.73372	.78329	1.44260	1.36647	2.27630	2.14720	1.05446
152590	1.62250	.74237	2.35320	1.07460	7.48560	1.40507	.57667
152600	.20305	.22611	.35920	.07041	.56225	.59692	.17172
152610	.30966	.25919	1.15060	.74789	1.96026	1.00548	.32651
152611*	.41948	.07736	1.28725	.13474	1.70673	.21210	0.00000
152612*	1.43875	.18758	.28314	.02570	1.72692	.21233	0.00000
152620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
152632	0.00000	0.00000	.03730	.06457	.03780	.06307	.30100
152631	.43363	.13476	.57916	.37645	1.01270	.51621	.17238
152670	.42547	.13616	.56327	.36475	.98774	.50090	.17202
152640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
153570	1.34610	1.46980	3.26200	2.72761	5.20810	4.19771	1.87047
153580	1.40930	1.12595	2.41030	2.07146	3.81110	3.19701	1.71911
153590	1.19850	.86067	1.34510	1.60379	3.14360	2.46155	1.34657
153600	.72143	.55745	1.23660	1.07544	2.03800	1.61239	.62131
153610*	.57253	.06344	.37743	.07103	.75011	.09047	0.00000
153620*	.23070	.02477	.10452	.00450	.37522	.02923	0.00000
153630	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
153640	0.00000	0.00000	.12000	.07400	.12000	.07400	.47100

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	[illegible] TOTAL
154570	2.52620	1.76664	4.20750	3.65620	6.33370	4.42244	1.40201
154580	1.02400	.81579	1.82620	1.62061	2.85110	2.46910	1.00750
154590	1.30740	.79789	2.46576	1.97526	4.72310	2.77350	.84748
154600	.73041	.25985	.69455	.55050	1.07396	.81040	.16410
154611	1.03370	.37075	1.52230	.94950	2.55660	1.32929	.22779
154610	.75000	.24320	1.83470	1.22564	2.54470	1.46826	.30946
154620	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
154630	.24700	.07934	1.25000	.41250	1.49700	.49104	.20032
154640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
155570	2.23360	1.74341	3.86080	3.27755	6.12040	5.02190	1.72159
155580	1.34070	1.40017	2.93050	2.57641	4.37100	3.37650	2.54044
155590	1.44720	1.17587	2.48680	2.07358	7.35400	3.21444	1.76137
155600	.73330	.30344	1.61940	1.44445	2.35370	2.25264	1.04341
155610	.74743	.04416	1.21350	1.00924	1.96075	1.65444	.01714
155620	.37185	.25936	.61187	.43582	.98372	.75000	.17907
155630	.09453	.01745	.04755	.05691	.14204	.07434	.02140
155640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
156580	1.30700	1.33664	2.52770	2.41096	3.87070	2.74454	2.64774
156590	2.11400	1.20257	3.39460	2.59726	5.50360	3.44946	1.71444
156600	.59436	.74127	1.13020	1.07112	1.72456	1.87230	1.02726
156610	1.26630	.65408	1.94910	1.42767	3.21540	2.07433	.16365
156620	.14373	.21576	.27775	.07361	.42724	.56417	.10410
156630*	.43020	.09124	1.31770	.16421	1.74790	.25345	1.00000
156640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
157580	1.30110	1.44[illegible]	4.45200	2.4017[illegible]	5.85[illegible]	4.24257	3.7101[illegible]
157590	1.74530	1.10571	3.04240	2.41141	4.79770	3.39402	1.76440
157600	1.15420	.44600	2.04720	1.62790	3.24540	2.54741	1.05740
157610	.97720	.59308	1.54870	1.25575	2.52590	1.84451	.03750
157620	.55369	.29702	.96777	.70796	1.52146	1.02140	.13416
157630	.26037	.06990	.47074	.20694	.73107	.30532	.02433
157640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
158580	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
158590	2.33520	1.31607	3.42310	2.49460	5.31830	4.21122	1.10206
158600	.95536	.74544	1.63090	1.57294	2.53626	2.23447	1.06304
158610	1.58120	.73037	2.55410	1.73810	4.14530	2.31416	.64674

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	CORR TOTAL
158620	.24147	.23247	.46520	.42890	.73667	.66132	.17643
158630	.32487	.26346	1.37500	.84825	2.12087	1.11280	.62710
158640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
159590	2.04430	1.48654	3.68330	2.97224	5.72826	4.43337	2.71427
159600	1.39740	1.11437	2.96130	2.15738	4.35870	3.24571	1.79440
159610	1.25670	.86656	2.13860	1.75286	3.39530	2.41932	1.30647
159620	.70110	.53586	1.27580	1.07763	1.97690	1.34801	.77210
159630	.57643	.36256	1.33520	.72416	1.91163	1.32447	.14916
159640	.18920	.06376	.38127	.20133	.55047	.24217	.08444
159650	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
160590	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
160600	1.11340	.32846	2.25780	1.61324	3.37120	2.64192	1.24391
160610	1.34430	.79436	3.03900	2.61783	4.38300	2.8821	.50478
160620	.58830	.70574	1.14270	.84487	1.74100	1.10121	.19134
160630	.85024	.27364	1.41330	.91865	2.26634	1.19236	.62768
160640	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
160650	.40115	.12867	.64620	.41613	1.04135	.54400	.17868
160660	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
161600	1.65620	1.39047	5.21210	2.75030	6.86830	4.14377	2.72715
161610	1.53740	1.14366	2.78410	2.24154	4.32210	3.42556	1.79212
161620	.86235	.60486	1.78320	1.54250	2.74515	2.75140	1.30493
161630	.73846	.54325	1.33740	1.09051	2.07676	1.05374	.52846
161640	.48105	.27128	.79234	.60414	1.27400	.47447	.14841
161650	.17194	.06812	.21575	.14024	.38769	.17325	.06841
161660	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
162600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
162610	2.12480	1.56637	3.64300	2.77829	5.81747	4.36147	1.41244
162620	.71234	.75636	1.46650	1.40700	2.17844	2.16434	1.30445
162630	1.24610	.64934	2.13260	1.52643	3.34470	2.17057	.54643
162640	.20259	.02456	.41039	.40564	.61297	.43030	.17754
162651	.54810	.21952	1.14600	.74490	1.67200	.36442	.32713
162650	.62395	.20135	1.05240	.64406	1.64235	.38564	.32687
162660	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
163610	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
163620	1.23750	.34372	2.37200	1.47305	3.57950	2.71330	1.00016

NUCLIDE	E BETA	UNC BETA	E GAMMA	UNC GAMMA	E TOTAL	UNC TOTAL	[illegible] TOTAL
163620	1.04650	.60267	1.96170	1.44797	[illegible]	[illegible]	[illegible]
163640	.59008	.70230	1.03650	.77808	1.56658	[illegible]	[illegible]
163650	.35839	.11450	.65983	.42950	1.01772	[illegible]	[illegible]
163660	0.00000	0.00000	0.00000	0.00000	0.00000	[illegible]	[illegible]
164610	0.00000	0.00000	0.00000	0.00000	0.00000	[illegible]	[illegible]
164620	.34081	.79415	1.94650	1.68229	2.33721	[illegible]	[illegible]
164630	1.57820	.72325	2.83150	1.96674	[illegible]	[illegible]	[illegible]
164640	.34725	.25126	.77770	.57437	1.07455	[illegible]	[illegible]
164650	.37275	.27927	1.48990	.96844	2.36261	[illegible]	[illegible]
164660	0.00000	0.00000	0.00000	0.00000	0.00000	[illegible]	[illegible]
165620	1.45810	1.11504	2.33080	2.38318	4.33670	[illegible]	[illegible]
165630	1.23680	.56400	2.43370	1.93670	3.78350	[illegible]	[illegible]
165640	.77760	.54632	1.54940	1.21866	2.32700	[illegible]	[illegible]