**VARIATION OF Z_p IN FISSION
WITH CHANGES IN EXCITATION ENERGY
AND COMPOUND NUCLEUS**

D. R. Nethaway

February 6, 1974

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Contents

Abstract	1
Introduction	1
Fractional Chain Yield Data	3
Least-Squares Calculation	4
Results and Discussion	5
Least-Squares Results	5
Odd-Even Effect	8
Rejected Data	9
Summary	10
Appendix 1. Summary of Input Data for Least-Squares Analysis	12
Appendix 2. Calculated Fractional Chain Yields for Rejected Data	16
Appendix 3. Final Correlation of Measured and Calculated Results	18
References	22

VARIATION OF Z_p IN FISSION WITH CHANGES IN EXCITATION ENERGY AND COMPOUND NUCLEUS

Abstract

A least-squares technique has been used to correlate all of the fractional chain yield data available for neutron-induced fission. The analysis is a modification of a method first proposed by Coryell *et al.*, in which the $Z_p(A)$ function for thermal-neutron fission of ^{235}U is used as a reference, and values of ΔZ_p are calculated for other fissioning systems. In this method it is assumed that Z_p for a given fission-product mass chain depends mainly on the neutron/proton ratio in the fissioning nucleus, and that the charge dispersion curve for a given mass chain does not change from one type of fission to another.

The coefficients in the equation $\Delta Z_p = a(Z_c - 92) + b(A_c - 236) + c(E^* - 6.52)$ have been obtained from a least-squares analysis of the available independent and cumulative fractional chain yield data. It was found that separate sets of the coefficients a and b are needed for mass numbers in the two peaks of the mass-yield distribution. The value of c was found to have a strong dependence on the fission-

product mass number, which can be correlated with mass-dependent changes in prompt-neutron emission with excitation energy. The model used for calculating ΔZ_p is surprisingly successful; the calculated values of Z_p generally agree with those inferred from the measured fractional chain yields within the uncertainty associated with the reference Z_p function. The average difference is 0.08 ± 0.01 charge unit.

The measured independent yields from low-energy fission of even- Z elements exhibit an odd-even effect in which the yields of even- Z products are enhanced and the yields of odd- Z products are reduced. The magnitude of the effect is about $\pm 14\%$ from the mean, a little less than that found previously for thermal-neutron fission of ^{235}U . The results have too much scatter for a very precise determination. This effect has been explained as being due to proton pairing in both fission fragments. The odd-even fluctuation is found to be absent in 14-MeV neutron-induced fission.

Introduction

A method of estimating independent fractional chain yields for different sources of fission was first proposed by

Coryell, Kaplan, and Fink¹ in 1961. The method consisted of using the known Z_p function for thermal-neutron fission of

^{235}U as a reference and calculating the change in Z_p for changes in the compound nucleus. The term Z_p refers to the non-integral value of the atomic number Z corresponding to the peak in the isobaric-yield distribution for a given mass number. The fractional chain yields for each mass number are generally assumed to have a Gaussian distribution in Z , centered at the value of Z_p .² However, the smooth Gaussian distribution from thermal-neutron fission of ^{235}U has been found recently to be perturbed by an odd-even effect in which the independent fractional chain yields of even- Z products are enhanced relative to those for odd- Z products.³⁻⁵ The fluctuation in yield was found to be about +25% relative to the mean value.⁵ The extent to which this odd-even effect is lessened with increasing excitation energy has not been studied until now.

Starting with thermal-neutron fission of ^{235}U as a reference state, we find for a given mass chain that changes in the compound nucleus that tend to decrease the neutron/proton ratio in the fission fragments will cause an increase in the value of Z_p , and changes that increase the neutron/proton ratio will cause a decrease in the value of Z_p . Coryell et al.¹ proposed the following equation to account for these changes in Z_p :

$$\Delta Z_p = 0.5(Z_c - 92) - 0.21(A_c - 236) + 0.19(\nu_T - 2.5), \quad (1)$$

where Z_c and A_c are the charge and mass of the compound nucleus, and ν_T is the total number of prompt neutrons emitted in fission. The value of ν_T was given by

$0.12(E^* - 6.5)$, where E^* is the excitation energy of the compound nucleus. Some useful modifications to this method were later proposed by Wolfsberg.⁶

The value of $Z_p(A)$ for a particular fission system is given by

$$Z_p(A) = Z_p(A)_{\text{ref}} + \Delta Z_p. \quad (2)$$

In this report I will use the reference Z_p function for thermal-neutron fission of ^{235}U given by Wahl et al.⁴ The Z_p values of Norea⁷ can also be used conveniently.

Coryell et al.¹ arrived at the values of the three coefficients in Eq. (1) for ΔZ_p by a rather simple procedure, and without the help of very much experimental data to test their validity. The factor 0.5 arises from the equal charge displacement postulate, and implies that on the average the addition of a proton to the compound nucleus will lead to an increase of one half unit in the nuclear charge of each fragment. Similarly, the factor 0.21 is about one half of the average slope of Z_A (and Z_p) with mass number. The third coefficient 0.19 is derived from an estimate of the change in neutron emission with excitation energy.

The equation for ΔZ_p shows, for example, that increasing the atomic number, such as from uranium to plutonium, will cause an increase in the value of $Z_p(A)$. An increase in the mass number, such as from ^{235}U to ^{238}U , will decrease the value of $Z_p(A)$. And, finally, an increase in excitation energy, such as from thermal-neutron to 14-MeV neutron fission, will increase the value of $Z_p(A)$. An increase in Z_p generally means that the independent fractional chain yields of shielded fission products, such as ^{86}Rb or ^{136}Cs , will increase.

Since the original paper by Coryell et al.,¹ a large number of independent and cumulative fractional chain yields have been measured for elements from thorium to fermium, for spontaneous, thermal-neutron, fission-spectrum, and 14-MeV neutron fission. The purpose of this paper is to explore the possibility of obtaining better values for the three coefficients in the equation for ΔZ_p from an analysis of the experimental data that are available now. From this analysis we can also see how self-consistent the data set is and what the uncertainties are in the estimation of $Z_p(A)$ values. In this paper I will consider only the fractional chain yield data for spontaneous and neutron-induced fission, and not for charged-particle induced fission.

The method that has been developed consists of using a computer program to solve for the best values of the three coefficients in the equation

$$\Delta Z_p = a(Z_c - 92) + b(A_c - 236) + c(E^* - 6.52) \quad (3)$$

Fractional Chain Yield Data

The input data for the computer program consists of the measured values of the independent and cumulative fractional chain yields and the percent errors, together with information on the compound nucleus, the neutron energy, and the excitation energy. No data for thermal-neutron fission of ^{235}U were used, as the reference Z_p function⁴ which was incorporated into the program essentially contains this information. Average values

by a least-squares fitting procedure.

The last term in the equation has been changed from that in Eq. (1) for ease in computation and application. The excitation energy E^* of the compound nucleus is corrected by 6.52 MeV for the reference fission process.

A preliminary analysis of the data showed that there was a definite dependence of the rate of change of Z_p with excitation energy on the mass region of the fission products. In particular, the value of the coefficient c for the heavy-fragment data was found to be about double the value for light-fragment data. The values for a and b were also found to depend on the fission-product mass region. The difference in $\Delta Z_p \Delta E^*$ for light-fragment and heavy-fragment products has been measured before,⁸⁻¹⁰ and is presumably due to increased neutron emission from heavy-fragment products (particularly in the region of mass 132) relative to light-fragment products as the excitation energy is increased. Umezawa¹¹ and Burnett et al.¹² have also reported this difference recently.

were used in those cases where there were multiple measurements, except that independent and cumulative yields were kept separate. A total of 35 measured values were not used because they were either reported as upper limits, or were only partial yields due to isomerism. It was not possible to use such yields within the framework of this analysis.

A total of 287 fractional chain yields were used in the least-squares analyses.

Preliminary analyses showed that 28 of these were in serious disagreement with the body of data, and they were omitted from the final calculations. Generally the rejected data are of doubtful accuracy, and appear to be in error by several standard deviations. It was felt best to reject such data, but to tabulate the n separately so that they could be compared to the expected yields.

The remaining 259 valid measurements consisted of 154 independent and 105 cumulative fractional chain yields. They were split into the following groups by element: thorium, 24; uranium, 148; neptunium, 1; plutonium, 40; americium,

13; curium, 8; californium, 21; and fermium, 4. By type of fission they were split into the following groups: spontaneous fission, 19; thermal-neutron fission, 107; fission-spectrum fission, 31; and 14-MeV fission, 102. The least-squares analyses were thus based on a reasonable variety of different types of fission.

Appendix 1 lists all of the fractional chain yield data and references, together with further details on the fission type, the $Z - Z_p$ values, and the residuals from the least-squares fit, etc. Appendix 2 summarizes similar information for the rejected data not used in the analyses.

Least-Squares Calculation

The computer program for the least-squares calculation of the three coefficient in Eq. (3) begins by calculating a value of $Z - Z_p$ and its uncertainty for each measured fractional chain yield. This is done by using a Gaussian charge-dispersion curve in cumulative form² with $\sigma = 0.56$ to relate the fractional chain yield to a value of $Z - Z_p$, and hence the value of Z_p for that mass number for the particular fissioning system. The value of ΔZ_p is then obtained from Eq. (3). Throughout this report the values of ΔZ_p inferred from measured fractional chain yields are referred to as "measured" ΔZ_p values. This is done simply to differentiate them from the values "calculated" using Eq. (3).

The uncertainty in the value of ΔZ_p is definitely underestimated if it is assumed to be due only to the uncertainty in the measured fractional chain yield. The

width parameter for the Gaussian charge-dispersion curve ($\sigma = 0.56$) has an estimated uncertainty of ± 0.06 , and an unknown variation (if any) with mass number. However, in this analysis all that is assumed is that the value of σ for a given product mass number is constant for different fissioning systems, and hence the added uncertainty in ΔZ_p due to a variation in σ is smaller than it would otherwise be. There is additional uncertainty in the reference $Z_p(A)$ function that is difficult to assess accurately, although it has been estimated to be about ± 0.1 charge unit.⁴ To account for these two additional sources of error, the uncertainty in ΔZ_p due to the error in the fractional chain yield measurement was arbitrarily increased by an additional 0.06 charge unit and also by an amount equivalent to an error of ± 0.03 in the Gaussian σ . These increases were made

in quadrature. Each ΔZ_p value was weighted by the reciprocal of the variance calculated in this manner. The results of various statistical tests, to be described later, indicated that this method of assigning an error to ΔZ_p was at least reasonable.

The final step in the computer program is to do the actual least-squares calculation for the three coefficients in Eq. (3), using the weighted measured ΔZ_p values as input. The output from the program includes the values of the coefficients, their standard deviations, and the residuals for each data point. A value for the reduced chi-squared test is calculated from

$$\chi^2_{\text{red}} = \sum_{i=1}^n R_i^2 W / (n - 4),$$

where n is the number of data points (the quantity $n - 4$ represents the degrees of

freedom), R_i is the residual (measured ΔZ_p minus calculated ΔZ_p), and W_i is the weighting factor. The value of χ^2_{red} , which is a measure of the quality of fit, has an expected value of unity and a variance of $2/(n - 4)$. The program also calculates the value of R_i / U_i for each data point (labeled residual/standard deviation in the printout), where U_i is the total uncertainty in the value of $\Delta Z_p(i)$. Values of the average residual,

$$R_{\text{ave}} = \left(\sum_{i=1}^n |R_i| \right) / n,$$

and the average residual/uncertainty

$$R/U_{\text{ave}} = \left(\sum_{i=1}^n |R_i / U_i| \right) / n,$$

are calculated as additional tests of the quality of fit.

Results and Discussion

LEAST-SQUARES RESULTS

A number of least-squares calculations were made with variations in the mass range over which fractional chain yield data were input. The different calculations are summarized below so that the effect of choosing different data groupings will be more evident.

The first calculation involved a least-squares fitting of all 287 fractional chain yields. The resulting values of the three coefficients for Eq. (3) and the various statistical tests are summarized in

Table 1. The second calculation was made with the 259 yields remaining after 28 were rejected. The yields used in this calculation covered the mass range 87 to 160. The results are also summarized in Table 1. In comparing the first and second calculations it was found that the value of the reduced χ^2 test was changed from 5.74 to 2.28, and the average residual (Z_p) from 0.171 to 0.120 charge units. The value of the average residual = 0.120 means that the calculated Z_p values agree with the measured values to ± 0.120 charge unit on the

Table 1. Results of the various least-squares calculations for the three coefficients in the equation $\Delta Z_p = a(Z_c - 92) + b(A_c - 236) + c(E_c - 6.52)$. The reduced chi-squared test (χ^2_{red}), average residual (R_{ave}), and average residual/uncertainty (R/U_{ave}) are defined in the text.

Calculation	Number of data points	a	b	c	χ^2_{red}	R_{ave}	R/U_{ave}
1. All data	287	0.488 ± 0.008	-0.167 ± 0.003	0.0336 ± 0.0007	5.74	0.171	1.67
2. Final data set (after rejecting 28)	259	0.514 ± 0.008	-0.177 ± 0.003	0.0289 ± 0.0007	2.28	0.120	1.17
3. Light fragment	92	0.414 ± 0.016	-0.143 ± 0.007	0.0174 ± 0.0013	0.85	0.082	0.69
Heavy fragment	163	0.547 ± 0.010	-0.188 ± 0.004	0.0343 ± 0.0009	2.15	0.109	1.15
4. Masses 82-87	18	In calculation 4, a and b were held fixed at their values from calculation 3.		0.0186 ± 0.0030	2.16	0.147	1.15
88-89	16			0.0237 ± 0.0036	0.54	0.084	0.49
90-91	21			0.0192 ± 0.0025	0.59	0.064	0.58
92	12			0.0136 ± 0.0024	0.34	0.037	0.45
93-95	13			0.0169 ± 0.0027	0.68	0.066	0.68
96-98	12			0.0153 ± 0.0035	0.44	0.055	0.46
120-132	15			0.0509 ± 0.0039	2.93	0.125	1.28
133-134	20			0.0471 ± 0.0031	2.39	0.124	1.21
135	17			0.0445 ± 0.0031	1.13	0.079	0.88
136	17			0.0416 ± 0.0021	0.47	0.053	0.54
137-138	25			0.0301 ± 0.0022	1.64	0.089	0.90
139	17			0.0329 ± 0.0023	1.17	0.068	0.77
140	17			0.0276 ± 0.0024	2.26	0.092	1.17
141-142	20			0.0253 ± 0.0020	0.80	0.068	0.76
143-160	15			0.0195 ± 0.0051	2.60	0.145	1.30

average. This calculation is appropriate for an overall inspection of the input data, and the details are included in the computer printout in Appendix 1.

As discussed earlier, it was expected that at least one of the coefficients would be significantly different if data for light and heavy fragments were treated separately. In the third set of calculations the fractional chain yield data were separated into two groups, ranging in mass number from 82 to 98 (92 measurements) and from 128 to 160 (163 measurements). Four measured yields in the valley region (masses 112-115) did not fit in with either group. It could not be ascertained whether these four belonged in the re-

jected group of data or in a separate group by themselves. The results of the third set of calculations are summarized in Table 1. Significant differences in the three coefficients are found in the results for the light and heavy fragments. The different values of dZ_p/dZ_c ($a = 0.41$ and 0.55) imply an uneven sharing of the proton between the two fragments as the charge of the compound nucleus is changed.

Another set of calculations was made to investigate the dependence of coefficient c on the mass number of the fission product. Preliminary calculations had shown that coefficients a and b had little, if any, significant dependence on mass

number, except for the differences noted between the light and heavy fragments. The value of coefficient c was determined in a series of 14 separate calculations, each covering a small mass range (six calculations for the light-fragment data and nine for the heavy-fragment data). The coefficients a and b were held fixed at the values determined previously in calculation 3: light-fragment $a = 0.414$, $b = -0.143$; heavy-fragment $a = 0.547$, $b = -0.188$. This was necessary because of the small number of data points in each mass subdivision. The resulting

values of c are shown in Fig. 1, and the results summarized in Table 1.

There is perhaps a small dependence of c on the mass number for products in the light-fragment region, but there is a dramatic dependence in the heavy-fragment region. This variation in dZ_p/dE^* is due to mass-dependent changes in prompt-neutron emission as the excitation energy is increased. It is rather similar, for example, to the variation in dv/dE found by Burnett *et al.* (Ref. 12, Fig. 10) for proton-induced fission of ^{233}U at different energies. This variation

Fig. 1. Variation of coefficient c (dZ_p/dE^*) with mass number. The horizontal error bars outline the mass range used in each least-squares calculation. A curve has been drawn through the data points to act as a visual aid. The dashed portion of the curve is at best an educated guess.

Table 2. Recommended values of coefficient $c(ZZ_p, dE^0)$ taken from the smooth curve in Fig. 1. Values of c are given for even mass numbers; others may be obtained by interpolation. Reasonable estimates of the uncertainty in each value are also given.

Mass number	c	% error	Mass number	c	% error
82	0.0200	8	122	0.0433	14
84	0.0200	8	124	0.0464	12
86	0.0200	8	126	0.0495	10
88	0.0196	6	128	0.0505	8
90	0.0189	6	130	0.0509	6
92	0.0181	6	132	0.0500	5
94	0.0171	6	134	0.0472	5
96	0.0160	6	136	0.0416	5
98	0.0157	6	138	0.0329	5
100	0.0159	8	140	0.0276	5
102	0.0173	10	142	0.0241	5
104	0.0190	12	144	0.0217	6
106	0.0211	14	146	0.0203	8
108	0.0233	16	148	0.0195	10
110	0.0257	18	150	0.0195	12
112	0.0283	20	152	0.0195	14
114	0.0311	20	154	0.0195	16
116	0.0341	20	156	0.0195	18
118	0.0371	18	158	0.0195	20
120	0.0402	16	160	0.0195	20

is presumably due to the change from a saw-toothed prompt-neutron emission curve to a more or less linear distribution as the excitation energy is increased. Ferguson *et al.*¹³ have recently investigated the effect of the doubly magic ^{132}Sn structure on the kinetic energy of the fission fragments and the changes with excitation energy.

ODD-EVEN EFFECT

The odd-even effect mentioned in the Introduction is known to perturb the normal smooth Gaussian distribution of

independent yields for thermal-neutron fission of ^{235}U (Refs. 3-5) and, presumably, other even- Z elements. This effect shows up as a fluctuation in yield of about $\pm 25\%$ from the mean.⁵ Proton pairing in the two fission fragments leads to an enhancement in the independent yield of even- Z products at the expense of the odd- Z products.

This odd-even effect has not been included in the least-squares calculations to this point, except to the extent that it may be naturally included in the reference Z_p function. The output from the least-squares analysis was examined to

determine the extent of the odd-even effect, and to see if there are any changes with excitation energy. The independent fractional chain yield data for even-Z fissioning nuclei (all of the independent-yield data except for 14 values for neptunium and americium fission) were split into two groups, a low-energy group consisting of the spontaneous-fission, thermal-neutron, and fission-spectrum data, and a high-energy group with the 14-MeV data. These two groups were further separated into subgroups consisting of data for even-Z products and odd-Z products. The cumulative fractional chain yield data were treated separately.

The weighted average ratio of measured to calculated independent fractional chain yield and its error was then calculated for each of the data subsets. The calculated yields were based on the a and b coefficients from calculation 3 in Table 1, and the c coefficient from the line drawn in Fig. 1. The uncertainty in the calculated yield was based on the error in the calculated value of ΔZ_p from Eq. (3), an additional uncertainty of ± 0.06 in the value of σ for the charge dispersion curve, and an uncertainty of ± 0.06 charge unit in the reference $Z_p(A)$ function.

For the low-energy data the average ratio of measured to calculated independent yields is 1.16 ± 0.11 for 14 even-Z products and 0.88 ± 0.04 for 37 odd-Z products. The ratios of measured to calculated yields show a great deal of scatter about the average values, due mainly to the inaccuracy involved in estimating very low fractional chain yields. However, the results do indicate an odd-even effect of about $\pm 14\%$ in low-energy fission of even-Z nuclei. This value is

somewhat smaller than that of Amiel and Feldstein.⁵

For the high-energy data the average ratio of measured to calculated independent yields is 0.90 ± 0.03 for 52 even-Z products and 0.96 ± 0.08 for 24 odd-Z products. Although the results again scatter a lot, especially for the odd-Z products, it is evident that the odd-even effect is not present, or at least is greatly reduced, in 14-MeV neutron-induced fission.

The average ratio of measured to calculated cumulative fractional chain yields for 67 even-Z products in the low-energy group is 1.00 ± 0.01 , and for 24 odd-Z products, 0.96 ± 0.08 . The ratio for 16 even-Z products in the high-energy group is 1.01 ± 0.02 .

REJECTED DATA

The fractional chain yield data that were not used in the final least-squares calculations are summarized in Appendix 2. These data include measurements reported as upper limits or partial isomeric yields, and 28 yields which were rejected for being too far out of line. Many of the latter measurements are fairly old, and perhaps were made without many of the advantages of modern techniques, or with limited knowledge of the necessary decay schemes. However, some of the yields reported within the past few years are in complete disagreement with the systematics developed in this report; either some sources of error have been badly underestimated or else the systematics fail occasionally. The former is more likely.

Summary

A method of correlating fractional chain yield data from different types of fission that was first proposed by Coryell et al.¹ has been revised and updated. The method is based on a model in which it is assumed that the value of Z_p for a given fission-product mass chain depends mainly on the neutron/proton ratio in the fissioning nucleus (not the compound nucleus). It is further assumed that the charge-dispersion curve for a given mass chain does not change from one type of fission to another, at least for excitation energies under 30 MeV. In this paper the charge dispersion is taken to be Gaussian in shape, with $\sigma = 0.56 \pm 0.06$ for all mass chains.

The set of Z_p values for each mass number for thermal-neutron fission of ^{235}U is used as a reference function, and changes in Z_p are calculated for changes in charge, mass, and excitation energy of the compound nucleus. Changes in charge and mass directly affect the neutron/proton ratio in the fissioning nucleus, and changes in excitation energy indirectly affect the ratio by changing the prefission neutron-emission probability. The model used for calculating ΔZ_p is surprisingly good: the calculated values of Z_p generally agree with those inferred from the measured fractional chain yields within the uncertainty associated with the reference Z_p function.

The final algorithm developed for calculating values of ΔZ_p is based on the equation

$$\Delta Z_p = a(Z_c - 92) + b(A_c - 236) + c(E^* - 6.52),$$

which has an obvious relationship to the reference fission process. The final values of the coefficients obtained in the least-squares analyses are: light fragment products, $a = 0.414 \pm 0.016$ and $b = -0.143 \pm 0.007$; heavy fragment products, $a = 0.547 \pm 0.010$ and $b = -0.188 \pm 0.004$. The values for the valley region of the mass-yield curve are poorly defined because of the lack of data. Average values of $a = 0.50 \pm 0.03$ and $b = -0.165 \pm 0.02$ are recommended in this region. The value of c was found to exhibit a striking variation with mass number due to the effect of mass-dependent changes in prompt-neutron emission with changes in excitation energy. Recommended values of c were taken from the smooth curve drawn in Fig. 1 and are summarized in Table 2.

It is necessary to modify the fractional chain yields that are obtained from the calculated Z_p values to account for the odd-even effect that is observed in low-energy fission (spontaneous, thermal, and fission-spectrum) of even- Z elements. This effect is seen as an enhancement of the yields of even- Z products and a depression of odd- Z products of about $\pm 14\%$. In applying the odd-even correction it is suggested that each calculated independent fractional chain yield be adjusted up or down by the factor 1.14. This has to be done for each member of the isobaric chain containing the particular product, so that the isobaric yields can be renormalized to add up to unity. The renormalization leads to a spread in value of the effective change, but the average will still be about $\pm 14\%$.

A final comparison of measured yields, Z_p values inferred from these yields, calculated Z_p values, and fractional chain yields inferred from the calculated Z_p values is given in Appendix 3. The calculated Z_p values and fractional chain yields are based on the final set of coeffi-

cients and the odd-even correction as just described. The weighted average of the absolute values of Z_p (meas) - Z_p (calc) is 0.084 ± 0.007 . If the four yields in the mass range 112-115 are excluded, the average is 0.081 ± 0.007 .

Appendix 1

Summary of Input Data for Least-Squares Analysis

The following table contains a summary of the input data and results for the 250 fractional chain yields used in calculation 2 (see Table 1). The column headings in the computer printout are generally self-explanatory; they are: compound nucleus, excitation energy, product nucleus, measured fractional chain yield, percent error in measured yield, cumulative or independent yield, references, Z_p inferred from measured yield, $\Delta Z_p = Z_p - Z_p(\text{ref.})$, calculated ΔZ_p , residual from least-squares analysis (measured ΔZ_p minus calculated ΔZ_p), and residual/standard deviation of measurement).

Nuclide identification symbols of the form ZZAAA have been used; ZZ represents the atomic number and AAA the mass number. Thus 38090 stands for ^{90}Sr and 92235 for ^{235}U .

COMPOUND NUCLEUS	EXC. ENERGY	PRODUCT NUCLEUS	FRACTIONAL YIELD	PERCENT ERROR	CUMULATIVE OR INDEPENDENT	REFERENCES	MEASURED Z_p	ΔZ_p	CALC. ΔZ_p	RESIDUAL	RESIDUAL/SIG. DEV.
92234	6.8	35087	1.40E-C3	12.5	I	41	32.8494/-111	0.099	0.362	-0.263	-2.362
92236	21.2	35087	2.76E-C3	20.0	I	17	32.5474/-110	0.197	0.423	-0.225	-2.441
94240	6.5	35087	9.50E-C4	11.6	I	41	32.7614/-114	0.011	0.321	-0.310	-2.126
98250	6.6	35087	1.27E-C2	2.3	I	55	33.2494/-091	0.499	0.613	-0.115	-1.253
90233	19.5	37086	1.55E-C5	20.0	I	62	34.1704/-140	-0.230	-0.123	-0.107	-0.763
92236	21.3	37086	4.20E-C4	30.0	I	62	34.6304/-127	0.230	0.476	-0.246	-1.230
92239	18.0	37086	5.00E-C5	40.0	I	62	34.3214/-143	-0.079	-0.175	0.096	0.471
96244	0.	37086	6.24E-C3	21.0	I	53	35.1004/-132	0.700	0.455	0.245	2.182
96246	6.4	37086	1.40E-C4	20.0	I	33	34.4654/-110	0.065	0.287	-0.221	-1.701
98252	0.	37086	5.40E-C5	10.0	I	36	34.3324/-133	-0.068	0.069	-0.138	-1.032
90233	19.5	35087	8.20E-C1	12.0	C	70	34.5874/-235	0.167	-0.123	0.290	1.234
90233	19.2	36087	8.70E-C2	20.0	I	52	34.7424/-094	-0.078	-0.132	0.053	0.785
92234	6.8	34087	1.90E-C1	21.1	C	70	34.6924/-107	0.172	0.362	-0.190	-1.785
92234	21.2	36087	4.52E-C1	30.0	I	52	35.4814/-204	0.661	0.775	-0.118	-0.448
92236	21.0	36087	2.77E-C1	18.0	I	52	35.1844/-108	0.364	0.417	-0.053	-0.490
92239	19.2	34087	4.80E-C2	22.0	I	52	34.5274/-103	-0.293	-0.163	-0.129	-1.255
94240	6.5	34087	3.31E-C1	10.0	C	70	34.7454/-111	-0.075	0.321	-0.396	-3.571
94240	6.5	35087	8.30E-C1	8.4	C	70	34.5664/-174	0.146	0.321	-0.175	-1.005
90233	19.2	36088	3.55E-C1	15.0	I	52	35.3184/-108	0.088	-0.132	0.220	1.247
92234	6.8	35088	4.70E-C1	12.8	C	70	35.5624/-104	0.292	0.362	-0.070	-0.470
92234	21.2	36088	5.30E-C1	30.0	I	52	35.6274/-132	0.377	0.776	-0.400	-1.214
92236	21.0	36088	3.83E-C1	20.0	I	52	35.3644/-133	0.114	0.417	-0.303	-2.123
92239	19.2	36088	2.61E-C1	12.0	I	52	35.1554/-084	-0.093	-0.162	0.068	0.815
94240	6.5	35088	6.10E-C1	90.4	C	70	35.3444/-537	0.094	0.321	-0.227	-0.424
90233	19.2	36089	4.70E-C1	11.1	I	52	35.5134/-113	-0.147	-0.132	-0.016	-0.140
92234	6.8	35089	1.90E-C1	47.4	C	70	35.9924/-207	0.332	0.362	-0.030	-0.146
92234	6.8	36089	8.61E-C1	5.8	C	31	35.8924/-147	0.232	0.362	-0.129	-0.876
92234	21.2	36089	5.76E-C1	30.0	I	52	36.2674/-312	0.607	0.779	-0.172	-0.352
92236	7.5	36089	9.35E-C1	0.6	C	66	35.6524/-080	-0.008	0.029	-0.031	-0.455
92236	21.0	36089	6.28E-C1	10.0	I	52	35.5914/-228	0.331	0.417	-0.086	-0.275
92239	6.6	36089	9.96E-C1	0.5	C	66	35.0154/-219	-0.645	-0.529	-0.116	-0.530
92239	19.2	36089	4.95E-C1	14.0	I	52	35.5584/-148	-0.102	-0.163	0.061	0.415
94240	6.5	36089	8.56E-C1	0.6	C	31	35.9054/-070	0.245	0.321	-0.076	-1.084
95243	6.4	36089	8.76E-C1	1.1	C	50	35.8694/-074	0.209	0.362	-0.053	-1.251
90233	19.2	36090	6.24E-C1	11.0	I	52	35.5274/-192	-0.133	-0.132	-0.001	-0.001
92234	6.8	35090	1.00E-C1	30.0	C	70	36.2184/-122	0.158	0.362	-0.204	-1.400
92234	6.8	36090	6.65E-C1	1.8	C	31	36.2614/-064	0.201	0.362	-0.160	-0.711
92234	21.2	36090	3.73E-C1	30.0	I	52	36.6524/-201	0.592	0.779	-0.187	-0.628
92236	21.0	36090	5.70E-C1	17.0	I	52	36.2824/-254	0.222	0.417	-0.195	-0.765
92236	21.3	39090	2.23E-C4	15.0	I	C	36.5344/-124	0.474	0.426	0.048	0.208
92239	19.2	36090	5.60E-C1	12.0	I	52	35.6934/-224	-0.367	-0.163	-0.204	-0.508
94240	6.5	35090	1.02E-C1	41.4	C	70	36.2114/-156	0.151	0.321	-0.170	-1.096
94240	6.5	36090	6.40E-C1	1.6	C	31	36.2994/-063	0.239	0.321	-0.082	-1.304
95243	6.4	36090	6.80E-C1	1.5	C	50	36.2694/-063	0.209	0.302	-0.093	-1.481
90233	19.2	36091	5.40E-C1	6.4	I	52	36.3524/-109	-0.108	-0.132	0.024	0.221

COORDINATE	LOC.	PRECED	FACT	PCY	CLM	REFER	PEASLED	DELTA	CALC	RESIDUAL	RESIDUAL/
NUCLEUS	ENERGY	NUCLEUS	FIELD	ERROR	IND	RANGES	ZP	ZP	EP/LAT ZP	STNC DEV.	
92234	6.8	36051	3.36E-C1	3.0	C	31	36.746+/-0.063	0.286	0.362	-0.074	-1.158
92234	21.2	36051	1.82E-C1	30.0	I	52	37.001+/-0.137	0.561	0.779	-0.238	-1.137
92236	7.5	36051	5.26E-C1	4.8	C	26	36.472+/-0.070	0.012	0.029	-0.011	-0.244
92236	21.0	36051	3.83E-C1	70.0	I	52	36.836+/-0.145	0.176	0.417	-0.241	-1.893
92236	21.1	36051	3.61E-C1	4.2	C	31	36.701+/-0.065	0.241	0.470	-0.179	-2.132
92239	6.6	36051	8.46E-C1	1.8	C	46	35.943+/-0.076	-0.517	-0.529	0.012	C.158
92239	19.2	36091	5.56E-C1	11.0	I	52	36.330+/-0.171	-0.130	-0.163	0.034	C.192
92239	19.3	36051	6.56E-C1	2.1	C	31 32	36.284+/-0.065	-0.176	-0.160	-0.035	-C.278
96240	6.5	36051	3.16E-C1	3.2	C	31	36.778+/-0.064	0.318	0.321	-0.007	-C.292
95243	6.4	36051	3.36E-C1	3.0	C	50	36.746+/-0.063	0.286	0.302	-C.016	-C.251
90233	19.2	36052	3.57E-C1	5.9	I	52	36.675+/-0.085	-0.181	-0.132	-0.049	-C.283
92234	6.8	36052	1.27E-C1	3.9	C	31	37.135+/-0.071	0.279	0.362	-0.083	-1.166
92234	21.2	36052	6.72E-C2	35.0	I	52	37.336+/-0.128	0.476	0.755	-C.303	-2.262
92236	7.5	36052	2.16E-C1	12.0	C	66	36.952+/-0.082	0.092	0.029	0.083	C.763
92236	21.0	36052	1.66E-C1	14.0	I	52	37.032+/-0.095	0.172	0.417	-C.245	-2.594
92236	21.1	36052	1.56E-C1	5.8	C	31	37.086+/-0.071	0.206	0.420	-C.214	-3.014
92236	21.3	36052	7.46E-C2	23.0	I	8	37.135+/-0.107	0.275	0.426	-C.190	-1.462
92239	6.6	36052	5.76E-C1	6.1	C	68	36.401+/-0.078	-0.459	-0.529	0.070	C.495
92239	19.2	36052	4.15E-C1	12.0	I	52	36.582+/-0.104	-0.278	-0.163	-0.116	-1.164
92239	19.3	36052	4.86E-C1	5.0	C	31 32	36.596+/-0.068	-0.304	-C.160	-C.163	-2.106
96240	6.5	36052	1.13E-C1	4.4	C	31	37.178+/-0.072	0.318	0.371	-C.003	-C.041
95243	6.4	36052	1.36E-C1	7.7	C	50	37.131+/-0.074	0.271	0.362	-C.031	-C.422
92234	19.2	36053	1.28E-C1	14.0	I	32	37.131+/-0.083	-0.139	-0.132	-0.007	-C.084
92234	6.8	36053	2.36E-C2	4.3	C	31	37.617+/-0.086	0.347	0.382	-C.014	-C.168
92234	21.2	36053	1.36E-C2	45.0	I	52	37.732+/-0.138	0.462	0.779	-0.317	-2.295
92236	7.5	36053	6.00E-C2	33.0	C	46	37.371+/-0.123	0.101	0.079	0.032	C.285
92236	21.1	36053	4.00E-C1	4.0	C	52 31	37.486+/-0.082	0.230	0.430	-0.236	-1.556
92239	6.6	36053	2.96E-C1	6.6	C	46	36.810+/-0.074	-0.460	-0.529	0.065	C.272
92239	19.2	36053	1.71E-C1	15.0	I	52	37.025+/-0.087	-0.245	-0.163	-0.082	-C.540
92239	19.3	36053	1.65E-C1	6.5	C	31 32	37.046+/-0.072	-0.224	-C.160	-0.064	-C.856
96240	6.5	36053	2.05E-C2	4.9	C	31	37.444+/-0.087	0.374	0.321	0.092	C.014
95243	6.4	36053	3.76E-C2	7.4	C	50	37.575+/-0.086	0.309	0.362	0.007	C.080
92239	19.2	36054	3.36E-C2	15.0	C	32	37.550+/-0.091	-0.140	-0.163	-C.021	C.251
92234	6.8	36055	3.46E-C2	18.0	I	38	38.478+/-0.093	0.399	0.362	0.037	C.400
96240	6.5	36055	2.46E-C4	25.0	C	31	38.455+/-0.127	0.375	0.321	0.054	C.427
90233	19.5	41096	9.46E-C6	30.0	C	42	38.104+/-0.145	-0.366	-0.123	-0.242	-1.172
92234	6.6	41096	1.26E-C3	15.0	I	21 2	38.800+/-0.114	0.330	0.362	-C.072	-C.275
92234	21.5	41096	4.16E-C3	12.2	I	10	39.020+/-0.104	0.550	0.788	-0.278	-2.268
92235	20.0	41096	1.50E-C3	6.5	I	10	38.643+/-0.110	0.373	0.567	-C.154	-1.765
92236	21.3	41096	7.46E-C4	6.8	I	10	38.720+/-0.115	0.250	0.426	-0.176	-1.530
92237	19.8	41096	2.76E-C4	11.1	I	10	38.962+/-0.121	0.092	0.208	-0.116	-C.553
92239	19.5	41096	2.16E-C5	10.0	I	10	38.266+/-0.137	-0.264	-0.155	-C.105	-C.795
96240	6.5	41096	7.00E-C4	13.0	I	27 2	38.711+/-0.117	0.241	0.321	-C.080	-C.085
92234	6.8	41097	1.16E-C2	36.0	I	2	39.218+/-0.121	0.348	0.362	-C.014	-C.116
96240	6.5	41097	1.56E-C2	27.0	I	2	39.285+/-0.108	0.415	0.321	0.054	C.072
92234	6.8	41098	4.00E-C2	28.0	I	19	39.521+/-0.109	0.261	0.362	-0.101	-C.430
96240	6.5	41098	3.36E-C2	30.0	I	19	39.472+/-0.112	0.212	0.321	-C.105	-C.574
92234	6.8	47112	3.00E-C4	33.0	I	47	44.578+/-0.130	-0.122	0.362	-0.064	-3.715
98250	6.6	47112	3.56E-C2	23.0	I	64	45.486+/-0.100	0.786	0.613	0.172	1.730
98252	0.	47112	9.00E-C2	44.0	I	42	45.176+/-0.135	0.476	0.065	0.406	3.013
92234	6.8	46115	6.76E-C1	3.0	C	34	46.254+/-0.069	0.594	0.362	C.232	3.274
92234	6.8	52128	3.00E-C2	17.0	I	41	50.253+/-0.135	0.591	0.362	0.231	1.708
92234	6.8	52130	1.12E-C2	6.3	I	41	50.788+/-0.112	0.590	0.362	0.037	C.325
93239	6.2	52130	9.46E-C4	33.3	I	41	50.670+/-0.129	0.280	-0.025	0.365	2.367
96240	6.5	52130	1.87E-C3	3.2	I	41	50.477+/-0.108	0.487	0.321	0.168	1.512
92234	6.8	51121	5.76E-C1	5.8	I	69	51.394+/-0.092	0.594	0.362	0.232	2.712
92234	6.8	51121	6.66E-C1	10.0	C	40	51.269+/-0.119	0.469	0.362	C.107	C.504
92234	6.8	52131	9.86E-C1	0.2	C	68	51.350+/-0.085	0.550	0.362	C.188	2.208
92234	6.8	52131	1.46E-C2	21.4	I	69	51.270+/-0.102	0.470	0.362	0.108	1.064
90233	19.5	52132	3.26E-C2	18.0	I	63	51.469+/-0.093	0.259	-0.123	0.382	4.087
92234	6.8	52132	2.56E-C2	20.0	C	54	51.598+/-0.098	0.388	0.362	0.026	0.263
92234	6.8	52132	6.00E-C2	50.0	I	40	51.631+/-0.170	0.421	0.362	0.059	C.351
92236	21.3	52132	1.60E-C1	10.0	I	16	51.550+/-0.075	0.740	0.426	0.314	4.175
96240	6.4	52132	9.46E-C1	1.1	C	48	51.629+/-0.091	0.419	0.287	0.123	1.454
98250	6.6	52132	7.66E-C1	2.6	C	48	52.104+/-0.073	0.894	0.613	0.281	3.058
100254	0.	52132	8.00E-C1	2.5	C	47	52.029+/-0.076	0.819	0.745	0.074	C.571
92234	19.5	52132	8.00E-C2	25.0	I	63	51.716+/-0.105	0.066	-C.123	0.185	1.796
92234	6.8	51123	8.00E-C2	50.0	C	69	52.287+/-0.177	0.437	0.362	0.275	1.950
92234	6.8	52123	4.26E-C1	10.0	I	69	51.591+/-0.102	0.341	0.362	-C.051	-C.115
92234	6.8	52133	1.57E-C1	11.0	I	40 39	51.542+/-0.077	0.292	0.362	-0.069	-C.001
92234	6.8	54133	1.03E-C2	8.7	I	60	52.204+/-0.094	0.554	0.362	0.152	2.044
92236	7.5	54133	9.15E-C4	6.8	I	60	51.755+/-0.113	0.105	0.029	0.076	C.072
92236	21.3	54133	2.80E-C2	30.0	I	51 66	52.431+/-0.112	0.781	0.426	0.355	3.164
92239	19.5	54133	3.00E-C3	43.0	I	51	51.561+/-0.133	0.311	-0.155	0.466	3.508
96240	6.5	52133	1.51E-C1	15.0	I	39	51.928+/-0.096	0.278	0.321	-0.043	-C.447

COMPUTE NUCLEUS	EXC. ENERGY	PRODUCT NUCLEUS	FACT C/N YIELD	PER ERROR	CLM END	REFER- ENCES	PEASLAED IDP	ELTA IF	CALL ELTA 2P	RESIDUAL	RESIDUAL SINE DEV.
94240	4.5	54133	8.73E-C3	3.4	I	40	52.1164/-0.07	0.466	0.321	0.145	-1.441
94240	4.3	54133	8.73E-C3	3.7	I	50	52.1094/-0.094	0.519	0.373	0.142	-1.745
94240	21.2	54133	1.20E-C1	20.0	I	51	52.8464/-0.06	1.196	0.742	0.450	-4.862
95243	6.4	54133	7.75E-C3	7.0	I	40	52.1454/-0.097	0.495	0.302	0.149	-1.552
90233	19.5	54134	1.52E-C1	10.0	I	43	51.4304/-0.075	-0.150	-0.173	-0.067	-0.887
92234	6.8	53134	3.50E-C1	15.0	I	4C 39	52.3094/-0.107	0.189	0.362	-0.173	-1.612
94240	6.5	53134	2.39E-C1	15.0	I	39	52.2844/-0.104	0.164	0.321	-0.157	-1.502
90246	6.4	52134	5.60E-C1	14.3	C	48	52.4154/-0.129	0.295	0.287	0.005	-0.007
98250	6.6	52134	3.90E-C1	21.0	C	48	52.8104/-0.118	0.490	0.613	0.077	-0.048
98252	0.	53134	2.80E-C1	15.0	I	42	52.1944/-0.094	0.034	0.069	-0.032	-0.100
100254	0.	52134	3.73E-C1	10.0	C	47	52.6814/-0.082	0.561	0.745	-0.127	-2.232
90233	6.0	53135	1.50E-C1	20.0	I	43	51.5254/-0.099	-0.635	-0.456	-0.175	-1.408
90233	19.5	53135	4.70E-C1	17.0	I	43	52.5134/-0.154	-0.047	-0.173	0.076	-0.475
92234	6.6	53135	8.00E-C1	4.0	I	39	52.6284/-0.165	0.268	0.362	-0.093	-0.365
92234	6.8	54135	2.20E-C1	10.0	I	46 40	53.0784/-0.076	0.518	0.362	0.152	-2.054
92236	7.9	54135	5.00E-C2	4.3	I	40	52.5854/-0.071	0.025	0.029	-0.007	-0.045
92236	21.3	54135	2.70E-C1	5.0	I	51 66	53.1724/-0.066	0.612	0.426	0.186	-2.818
92239	6.6	54135	8.90E-C2	12.0	I	40	52.1214/-0.100	-0.439	-0.529	0.090	-0.501
92239	19.5	54135	5.94E-C2	8.6	I	51 66	52.6284/-0.071	0.068	-0.155	0.223	-2.898
94240	6.5	53135	0.08E-C1	2.0	I	39	52.8374/-0.138	0.277	0.321	-0.044	-0.322
94240	6.2	54135	1.56E-C1	4.0	I	46 40	52.5464/-0.067	0.380	0.371	0.059	-0.184
94240	6.3	54135	1.91E-C1	3.8	I	40	53.0134/-0.085	0.459	0.373	0.086	-1.712
94240	21.2	54135	4.00E-C1	20.0	I	51	53.4954/-0.178	0.935	0.747	0.180	-1.054
94242	6.3	54135	3.21E-C2	4.7	I	46	52.4654/-0.082	-0.005	-0.039	-0.036	-0.602
95243	6.4	54135	1.44E-C1	3.4	I	40	52.4234/-0.067	0.363	0.302	0.061	-0.513
96246	6.4	54135	1.70E-C1	5.4	I	61	52.5734/-0.068	0.413	0.287	0.126	-1.844
98250	6.6	54135	3.60E-C1	2.3	I	61	53.3264/-0.078	0.766	0.272	0.122	-1.545
100254	0.	53135	2.10E-C1	1.4	C	67	53.1644/-0.064	0.430	0.745	-0.114	-1.787
90233	19.5	55136	2.23E-C2	6.7	I	62	52.5084/-0.107	-0.612	-0.123	0.074	-0.474
92234	6.8	55136	1.40E-C2	20.0	I	2	53.2704/-0.100	0.290	0.362	-0.072	-0.716
92234	21.5	55136	1.74E-C1	6.3	I	10	53.5824/-0.064	1.002	0.788	0.214	-3.112
92233	20.0	55136	9.50E-C2	6.3	I	10	53.7654/-0.072	0.789	0.567	0.222	-1.071
92236	6.3	55136	2.33E-C2	12.0	I	66 62	52.6154/-0.108	-0.064	0.052	-0.116	-1.074
92236	21.3	55136	4.81E-C2	3.1	I	10 66	53.7074/-0.077	0.590	0.426	0.164	-2.102
92237	19.8	55136	2.70E-C2	5.1	I	10	53.7734/-0.088	0.353	0.406	0.185	-2.097
92239	6.2	55136	3.38E-C4	10.0	I	66 62	52.4414/-0.126	-0.519	-0.529	0.010	-0.000
92239	19.5	55136	3.91E-C3	6.0	I	56	53.0114/-0.102	0.031	-0.155	0.185	-1.811
94240	6.5	55136	1.66E-C3	10.0	C	70	53.3084/-0.094	0.128	0.321	0.007	-0.777
94240	6.3	55136	2.04E-C2	10.0	I	66 62	53.3554/-0.089	0.175	0.373	0.002	-0.025
94240	21.2	55136	1.52E-C1	5.0	I	56 66	53.5304/-0.060	0.950	0.747	0.204	-3.000
96242	0.	55136	1.10E-C1	18.0	I	15	53.9174/-0.094	0.837	0.808	0.029	-0.318
96244	0.	55136	1.68E-C1	18.0	I	53	53.5134/-0.091	0.131	0.455	-0.154	-1.305
96246	6.4	55136	2.30E-C2	17.0	I	33	53.3834/-0.094	0.463	0.287	0.117	-1.238
98250	6.6	55136	6.90E-C2	17.0	I	35 55	53.6724/-0.089	0.692	0.613	0.078	-0.018
98252	0.	55136	4.80E-C2	21.0	I	36 26	53.0504/-0.108	0.070	0.069	0.000	-0.004
90233	8.0	53137	7.90E-C1	11.0	C	70	53.6804/-0.187	-0.342	-0.456	0.114	-0.610
90233	19.5	53137	5.00E-C1	18.0	C	70	53.5004/-0.128	0.110	-0.123	0.223	-1.821
90233	19.2	54237	3.27E-C2	13.0	I	52	53.2714/-0.094	-0.119	-0.192	0.012	-0.131
92234	6.8	53137	2.80E-C1	10.7	C	70	53.8264/-0.080	0.436	0.362	0.075	-0.532
92234	6.8	54137	8.90E-C1	0.6	C	31	53.7554/-0.074	0.465	0.362	0.042	-0.584
92234	21.2	54137	6.00E-C1	15.0	I	52	54.1944/-0.231	0.804	0.719	0.005	-0.100
92236	21.0	54137	6.10E-C1	1.0	I	52	53.8454/-0.229	0.455	0.417	0.039	-0.185
92239	19.2	54137	3.09E-C1	7.2	I	52	53.2404/-0.072	-0.150	-0.162	0.011	-0.186
94240	6.5	53137	4.20E-C3	5.0	C	70	53.6134/-0.067	0.222	0.321	-0.058	-1.493
94240	6.5	54137	9.17E-C1	0.5	C	31	53.7244/-0.076	0.334	0.321	0.011	-0.175
90233	19.2	54138	4.75E-C1	25.0	I	52	53.5214/-0.209	-0.269	-0.132	-0.137	-0.854
92234	6.8	52138	1.00E-C1	10.0	C	70	54.2184/-0.122	0.428	0.362	0.066	-0.100
92234	6.8	54138	8.27E-C1	1.5	C	31	53.6724/-0.072	0.182	0.362	-0.180	-2.465
92234	21.2	54138	3.74E-C1	15.0	I	52	54.6514/-0.117	0.661	0.775	0.082	-0.131
92236	21.0	54138	5.20E-C1	17.0	I	52	54.3944/-0.208	0.604	0.417	0.167	-0.653
92236	21.1	54138	3.50E-C1	2.7	C	31	54.1224/-0.073	0.332	0.420	-0.088	-1.200
92239	6.6	55138	5.90E-C2	75.0	I	59	53.1964/-0.216	-0.554	-0.529	-0.066	-0.304
92239	19.2	53138	5.00E-C1	10.0	C	30	53.4154/-0.100	-0.375	-0.163	-0.211	-2.114
92239	19.2	54138	4.66E-C1	7.1	I	52	53.5054/-0.085	-0.285	-0.163	-0.121	-1.421
92239	19.3	54138	9.40E-C1	2.1	C	31	53.6294/-0.123	-0.161	-0.160	-0.000	-0.002
92239	19.2	55138	8.30E-C2	6.0	I	30	53.7214/-0.073	-0.063	-0.163	0.100	-0.365
94240	6.5	53138	1.43E-C1	7.0	C	10	54.0914/-0.073	0.307	0.321	-0.014	-0.185
94240	6.5	54138	8.02E-C1	1.2	C	31	53.5174/-0.073	0.127	0.321	-0.164	-2.665
98250	6.6	55138	3.70E-C1	10.0	I	73	54.3434/-0.086	0.553	0.613	-0.061	-0.102
98252	0.	55138	1.10E-C1	27.0	I	42	53.8174/-0.114	0.027	0.045	-0.042	-0.372
90233	19.2	54139	5.03E-C1	13.0	I	52	54.2474/-0.224	0.057	-0.132	0.189	-0.827
92234	6.8	54139	4.76E-C1	1.7	C	31	54.5344/-0.061	0.344	0.362	-0.007	-0.007
92234	6.8	56139	8.40E-C2	6.3	I	44	54.1314/-0.075	0.541	0.362	0.175	-2.374
92234	21.2	54139	2.03E-C1	15.0	I	52	54.6564/-0.089	0.766	0.779	-0.013	-0.145
92236	7.5	54139	7.20E-C1	1.4	C	60	54.1744/-0.065	-0.016	0.029	-0.045	-0.701

COMPONENT NUCLEUS	ENC. ENERGY	PRODUCT NUCLEUS	FACIT CPM YIELD	PCP ERROR	CLM IND	REFER- ENCES	PEASLPOD 2P	DELTA 2P	CALC DELTA 2P	RESIDUAL	RESIDUAL/ SING DEV.
92236	21.1	54139	4.24E-C1	2.1	C	31	54.800+/-.061	0.416	0.420	-0.016	-0.186
92236	21.0	54139	3.82E-C1	17.0	I	52	54.802+/-.121	0.472	0.467	0.005	0.456
92239	6.6	54139	9.48E-C1	1.5	C	66	53.940+/-.062	-0.000	-0.010	-0.012	-0.186
92239	6.6	54139	6.16E-C2	21.0	I	59	53.616+/-.100	-0.054	-0.059	-0.012	-0.186
92330	19.2	54135	1.82E-C1	11.0	I	25	53.450+/-.077	-0.162	-0.162	-0.012	-0.186
92239	19.3	54135	7.44E-C1	8.0	C	31 32	54.120+/-.124	-0.004	-0.010	0.004	0.186
92239	19.2	54135	7.88E-C1	5.2	I	24	54.100+/-.066	0.010	-0.103	0.193	2.411
94740	6.8	54135	5.40E-C2	6.0	C	70	54.000+/-.211	0.210	0.121	-0.111	-0.186
94240	6.8	54135	5.48E-C2	1.5	C	31	54.435+/-.061	0.245	0.121	-0.076	-1.230
95243	6.4	54135	5.00E-C1	2.0	C	50	54.500+/-.062	0.110	0.102	0.006	0.179
90252	0.	54139	6.70E-C1	1.5	C	2	54.254+/-.063	0.064	0.064	-0.006	-0.049
90254	0.	54139	6.70E-C1	1.4	C	60	53.880+/-.108	-0.121	-0.114	-0.017	-0.186
90233	19.2	54140	5.40E-C1	13.0	I	52	54.352+/-.114	-0.230	-0.132	-0.100	-0.186
92234	6.8	54140	2.25E-C1	2.7	C	31	54.623+/-.066	0.193	0.164	-0.026	-0.186
92234	6.8	54140	2.70E-C1	15.0	I	44	55.172+/-.093	0.580	0.162	0.276	2.411
92234	6.0	57140	3.00E-C2	3.0	I	18	55.000+/-.102	0.435	0.162	0.004	0.186
92234	21.2	54140	2.70E-C2	15.0	I	52	55.258+/-.085	0.660	0.179	-0.111	-1.230
92236	7.5	54140	4.70E-C1	2.1	C	66	54.542+/-.062	-0.040	0.024	-0.077	-1.186
92236	21.1	54140	2.60E-C1	2.4	C	52 31	54.403+/-.067	0.373	0.440	-0.067	-0.186
92236	21.2	57140	7.20E-C2	7.0	I	8	55.130+/-.098	0.540	0.436	-0.114	-1.186
92239	6.6	54140	8.00E-C1	1.7	C	66	53.895+/-.078	-0.045	-0.046	-0.006	-0.186
92239	19.2	54140	5.40E-C1	1.0	I	52	54.352+/-.114	-0.230	-0.103	-0.074	-0.186
92239	19.2	54140	6.18E-C1	1.0	C	31 32	54.342+/-.063	-0.040	-0.102	-0.067	-1.186
94240	6.8	54140	3.02E-C1	2.7	C	31	54.792+/-.063	0.202	0.121	-0.116	-1.186
95243	6.4	54140	2.80E-C1	3.6	C	50	54.826+/-.065	0.236	0.102	-0.066	-1.186
90250	6.6	57140	3.50E-C2	5.0	I	58	55.488+/-.102	0.896	0.613	0.283	3.432
90252	0.	54140	4.50E-C1	2.2	C	2	54.370+/-.062	-0.020	0.064	-0.020	-1.186
90254	0.	54140	6.70E-C1	4.3	C	60	54.222+/-.068	-0.360	-0.284	-0.076	-1.186
100254	0.	56140	9.70E-C1	6.9	C	67	55.183+/-.125	0.793	0.145	0.044	0.186
90233	19.2	54141	2.50E-C1	14.0	I	52	54.850+/-.093	-0.140	-0.132	-0.008	-0.186
92234	6.0	54141	5.10E-C2	5.9	C	31	55.416+/-.080	0.426	0.362	0.064	0.186
92234	21.2	54141	2.32E-C2	21.0	I	52	55.615+/-.104	0.625	0.779	-0.154	-1.481
92236	7.5	54141	1.40E-C1	10.7	C	66	55.108+/-.070	0.015	0.029	0.014	1.481
92236	21.1	54141	5.60E-C2	5.4	C	52 31	55.300+/-.079	0.460	0.496	-0.036	-0.186
92239	6.6	54141	5.00E-C1	13.0	C	60	54.387+/-.124	-0.063	-0.074	-0.014	-0.186
92239	6.6	55141	3.20E-C1	15.0	I	59	54.255+/-.121	-0.131	-0.129	-0.002	-1.186
92239	19.2	54141	2.91E-C1	8.6	I	52	54.701+/-.075	-0.109	-0.183	-0.076	-0.186
92239	19.2	54141	2.90E-C1	6.9	C	31	54.810+/-.070	-0.180	-0.160	-0.020	-0.186
94240	6.8	54142	7.90E-C2	5.1	C	31	55.251+/-.076	0.101	0.121	-0.020	-0.186
95243	6.4	54142	8.20E-C2	2.7	C	50	55.279+/-.075	0.289	0.102	-0.017	-0.186
90252	0.	54141	1.70E-C1	2.9	C	2	55.030+/-.068	0.040	0.085	-0.040	-0.186
90254	0.	54141	3.50E-C1	5.7	C	40	54.716+/-.060	-0.274	-0.204	-0.070	-0.186
90233	19.2	54142	1.35E-C1	20.0	I	52	55.102+/-.090	-0.280	-0.132	-0.148	-1.186
92234	6.8	54142	9.80E-C3	6.6	C	31	55.807+/-.094	0.417	0.162	0.055	0.186
92236	21.0	54142	2.21E-C2	20.0	I	52	55.626+/-.098	0.236	0.417	-0.181	-1.186
92239	19.2	54142	1.65E-C1	14.0	I	52	55.235+/-.084	-0.351	-0.163	-0.188	-1.230
92239	19.2	54142	1.10E-C1	5.5	C	31	55.127+/-.073	-0.203	-0.183	-0.020	-0.186
94240	6.8	54142	1.85E-C2	4.5	C	31	55.894+/-.084	0.304	0.121	-0.181	-1.186
95243	6.4	54142	2.40E-C2	10.0	C	50	55.607+/-.080	0.217	0.102	-0.080	-0.186
92234	6.8	54142	7.20E-C4	6.3	C	21	56.284+/-.115	0.504	0.362	0.142	1.240
92239	6.6	54142	8.00E-C2	8.0	C	66	55.258+/-.077	-0.052	-0.024	0.001	0.186
94240	6.8	54142	2.60E-C3	5.8	C	31	56.065+/-.105	0.283	0.121	-0.036	-0.186
95243	6.4	54142	3.20E-C2	6.3	C	50	56.027+/-.104	0.247	0.102	-0.055	-0.186
92239	6.6	54144	2.80E-C2	14.0	C	66	55.570+/-.091	-0.010	-0.029	-0.021	-0.186
94240	6.8	54144	2.90E-C4	21.0	C	31	56.427+/-.124	0.247	0.121	-0.074	-0.186
95243	6.4	54144	1.20E-C3	6.3	C	50	56.200+/-.112	0.020	0.102	-0.082	-1.186
92239	6.6	55144	1.45E-C1	20.0	I	59	56.087+/-.099	-0.493	-0.329	-0.164	-0.186
92239	6.6	55144	3.53E-C2	21.0	I	59	56.511+/-.107	-0.469	-0.024	0.004	0.186
92234	6.8	61150	1.13E-C3	6.0	I	71	58.790+/-.111	0.090	0.362	-0.272	-2.440
94240	6.8	61150	1.70E-C3	5.0	I	71	58.860+/-.109	0.160	0.121	-0.181	-1.186
98250	6.6	61150	8.00E-C2	11.3	I	71	59.151+/-.090	0.451	0.613	-0.162	-1.186
98252	0.	61150	8.40E-C2	50.0	I	36	59.161+/-.146	0.461	0.069	-0.392	-2.682
92234	21.5	65160	4.20E-C2	21.0	I	10	63.024+/-.112	0.534	0.186	-0.348	-1.186
92236	21.3	65160	2.70E-C3	15.0	I	10	62.942+/-.108	0.472	0.426	0.046	0.426

259 DATA POINTS

AVERAGE RESIDUAL C.120

AVERAGE RESIDUAL/SIGMA 1.167

CHI SQUARE = 5.819E+02

REDUCED CHI SQUARE = 2.282E+00

Appendix 2

Calculated Fractional Chain Yields for Rejected Data

The following table contains a summary of the input data and a comparison of the measured and calculated fractional chain yields for the data not used in the final least-squares analyses. Such data consist of the 28 rejected yields and 36 yields reported as upper limits or partial yields due to isomerism. The column headings in the computer printout are: compound nucleus, excitation energy, product nuclide, cumulative or independent yield, measured fractional chain yield, calculated fractional chain yield, measured Z_p minus calculated Z_p , reference, and reason for rejection (RJ = reject, UL = upper limit, IS = partial isomeric yield).

Nuclide identification symbols of the form ZZAAA have been used; ZZ represents the atomic number and AAA the mass number. Thus 33090 stands for ^{90}Sr , and 92235 for ^{235}U .

CALCULATED FRACTIONAL CHAIN YIELDS AND RESIDUALS FOR REJECTED POINTS

COMPOUND NUCLEUS	EXCITATION ENERGY	PRODUCT NUCLEUS	CUMULATIVE OR INDEPENDENT YIELD	MEASURED FRACTIONAL CHAIN YIELD	CALCULATED FRACTIONAL CHAIN YIELD	RESIDUAL $Z_p - Z_{p, \text{CALC}}$	REFERENCE	REJECT REASON
92234	6.8	370E4	I	7.20E-05	6.21E-04	-0.320	22	RJ
94240	6.5	370E4	I	3.10E-05	4.54E-04	-0.398	22	RJ
92234	6.8	350E3	C	5.60E-01	7.56E-01	-0.304	70	RJ
94240	6.5	350E3	C	6.30E-01	2.25E-01	-0.601	70	RJ
92234	6.8	390E3	I	1.20E-02	8.56E-04	-0.485	18	RJ
90233	19.5	410E5	I	4.30E-02	1.67E-06	-1.645	57	RJ
92236	21.3	410E7	I	6.90E-02	6.29E-03	-0.569	25	RJ
90233	19.5	4711E	I	5.80E-03	5.37E-04	-0.525	57	RJ
92236	21.3	4711E	I	5.10E-02	6.76E-03	-0.469	25	RJ
90233	19.5	455.7	I	1.12E-02	9.66E-05	-0.818	63	RJ
90233	19.5	51124	I	7.20E-02	1.81E-04	-1.181	37	RJ
92239	19.5	51124	I	2.90E-02	3.55E-04	-0.935	37	RJ
90233	19.5	51126	I	5.40E-02	6.56E-03	-0.479	37	RJ
92237	19.8	51126	I	5.60E-02	3.43E-02	-0.291	10	RJ
92239	19.5	51126	I	2.80E-02	5.88E-03	-0.341	37	RJ
94240	6.5	52128	I	1.23E-04	4.05E-06	-0.446	41	RJ
90233	19.5	52130	I	5.28E-03	2.05E-04	-0.661	63	RJ
92234	6.8	52131	I	4.69E-01	2.61E-01	-0.320	69	RJ
98252	0.	51131	C	6.50E-01	9.31E-01	-0.617	49	RJ
92234	6.8	52132	I	6.28E-01	5.17E-01	-0.350	54	RJ
92236	21.3	52134	I	4.20E-01	6.03E-01	-0.390	14	RJ
94240	6.5	52137	C	1.55E-01	1.39E-02	-0.663	70	RJ
92239	19.2	54130	I	5.10E-01	6.28E-01	-0.406	29	RJ
92239	19.2	56135	I	5.60E-02	3.83E-03	-0.605	24	RJ
92239	6.6	55142	I	4.10E-01	6.06E-01	-0.418	59	RJ
92239	6.5	55142	I	4.30E-01	5.53E-01	-0.340	59	RJ
92234	6.8	61248	I	5.30E-07	3.21E-05	-0.432	65	RJ
92239	19.5	65160	I	1.29E-03	1.46E-05	-0.653	10	RJ
92234	6.8	350E0	I	1.00E-04	2.56E-05	-0.186	41	UL
94240	6.5	350E0	I	3.00E-05	1.54E-05	-0.057	41	UL
98252	0.	350E0	I	2.70E-04	1.31E-03	-0.253	36	UL
92234	6.8	390E0	I	6.00E-05	6.24E-05	-0.035	18	UL
92234	6.8	360E5	C	1.00E-04	4.18E-04	-0.212	31	UL
92234	6.8	410E5	I	3.00E-04	7.17E-05	-0.208	2	UL
94240	6.5	410E5	I	3.00E-04	5.56E-05	-0.243	2	UL

CCMF. NUCLEUS	EXC. ENERGY	PRODUCT NUCLIDE	CUM IND	FRACTIONAL MEASURED	CHAIN YIELD CALCULATED	RESIDUAL 2-ZP PEAS. - CALC.	REFERENCE	REJECT PERSON
92236	21.3	53131	I	8.00E-C2	4.35E-C2	-C.173	16	UL
90233	8.0	53133	I	5.00E-C2	9.74E-C1	-C.388	43	UL
92236	21.3	52133	I	4.00E-01	5.32E-C1	C.977	16	LL
92236	21.3	52133	I	4.00E-01	3.86E-C1	-C.023	16	UL
92239	6.6	54133	I	1.80E-C3	8.20E-C6	-C.781	60	UL
90233	8.0	53134	I	3.00E-02	6.63E-C2	C.212	43	UL
90233	19.5	54135	I	2.00E-02	5.58E-C2	C.260	43	LL
92234	6.8	52135	C	1.10E-C1	2.75E-C2	C.388	70	UL
92236	7.5	54143	C	1.60E-C2	9.59E-C3	C.102	66	UL
98234	0.	54143	C	2.00E-C2	3.31E-C2	-C.121	60	UL
92234	6.8	54144	C	3.00E-04	1.15E-C4	C.141	31	LL
98252	0.	54144	C	7.00E-03	6.05E-C4	C.436	2	LL
90233	19.5	43099	I	1.52E-03	2.74E-C8	-1.384	57	IS
92234	6.8	41099	I	2.90E-C1	1.56E-C1	-C.267	45	IS
98252	0.	41099	C	2.90E-C1	9.59E-C1	-2.067	45	IS
90233	19.5	45106	I	6.50E-C3	1.53E-C5	-C.944	57	IS
98250	6.6	46111	I	6.30E-C2	1.34E-C1	C.157	64	IS
90233	19.5	49115	I	1.33E-C2	2.48E-C7	-1.574	57	IS
92234	6.8	52131	I	2.30E-01	2.61E-C1	C.093	20	IS
92236	21.3	52131	I	3.50E-C1	4.67E-C1	C.234	16	IS
94240	6.5	52131	I	1.80E-C1	2.53E-C1	C.146	20	IS
96242	0.	52131	I	4.30E-C1	4.61E-C1	C.088	21	IS
98252	0.	52131	I	1.90E-01	6.60E-C2	-C.349	49	IS
92234	6.8	51132	I	2.71E-C1	4.04E-C1	-C.226	54	IS
90233	19.5	55134	I	5.70E-03	2.05E-C5	-C.988	57	IS
90233	19.5	55135	I	2.38E-02	3.71E-C4	-C.781	57	IS
92234	6.8	52136	C	2.70E-C1	5.53E-C1	-C.475	2	IS
94240	6.5	52136	I	3.20E-C1	5.54E-C1	-C.420	23	IS

Appendix 3

Final Correlation of Measured and Calculated Results

The following table contains a final summary of the measured fractional chain yields, Z_p values inferred from these yields, calculated Z_p values, and fractional chain yields inferred from the calculated Z_p values for the 259 measured yields. The calculated Z_p values are based on the final algorithm explained in the Summary, including the odd-even correction for low-energy fission of even-Z elements.

The assignment of errors to the "measured" Z_p values has been discussed in the section on Least-Squares Calculations. The error in the calculated Z_p values is based on a propagation of the errors in the three coefficients plus an additional 0.06 charge unit for the reference Z_p function. The error in the calculated fractional chain yields is based on the uncertainty in the calculated Z_p plus the additional error due to an uncertainty of ± 0.06 in σ for the Gaussian charge dispersion curve.

The column headings in the computer printout are: compound nucleus, excitation energy, product nuclide, references, cumulative or independent yield, measured fractional chain yield, percent error in measured yield, calculated fractional chain yield, percent error in calculated yield, measured Z_p and standard deviation, calculated Z_p and standard deviation, and measured Z_p minus calculated Z_p and standard deviation.

Nuclide identification symbols of the form ZZAAA have been used; ZZ represents the atomic number and AAA the mass number. Thus 38090 stands for ^{90}Sr and 92235 for ^{235}U .

COMP. NUCLEUS	EXC. ENERGY	PRODUCT NUCLEUS	REFERENCE	CUM. YLD.	MEASURED FRA. CHN. YLD.	PCT. ERROR	CALCULATED FRA. CHN. YLD.	PCT. ERROR	MEASURED Z_p	CALCULATED Z_p	MEAS.-CALC. Z_p
92234	6.8	35082	41	I	1.00E-03	12.5	4.15E-03	29.7	32.840 +/- .111	31.020 +/- .062	-0.192 +/- .127
92236	21.2	35082	17	I	2.78E-03	20.0	4.03E-03	88.8	32.947 +/- .110	31.043 +/- .064	-0.095 +/- .126
94240	6.5	35082	41	I	9.35E-04	11.6	3.43E-03	98.7	32.781 +/- .114	31.000 +/- .074	-0.781 +/- .135
90250	6.4	35084	25	I	1.27E-02	2.3	1.06E-02	162.9	31.265 +/- .091	31.114 +/- .150	-0.151 +/- .175
90233	19.5	37086	62	I	1.55E-05	20.0	3.15E-05	257.0	34.170 +/- .140	34.281 +/- .074	-0.090 +/- .159
92136	21.3	37086	62	I	4.20E-04	30.0	6.33E-04	142.3	34.630 +/- .127	34.655 +/- .064	-0.025 +/- .143
92239	18.8	37086	62	I	5.00E-04	40.0	2.28E-05	270.6	34.321 +/- .143	34.117 +/- .087	-0.104 +/- .150
96244	0.0	37086	53	I	6.00E-03	27.0	9.61E-04	142.5	35.100 +/- .117	34.184 +/- .105	-0.916 +/- .153
96246	6.4	37086	33	I	1.40E-04	25.0	3.50E-04	71.9	34.465 +/- .130	34.624 +/- .112	-0.159 +/- .172
98257	0.0	37086	36	I	5.40E-03	15.0	1.21E-04	235.7	34.332 +/- .133	34.666 +/- .160	-0.334 +/- .208
90233	19.5	35087	70	C	8.20E-01	12.0	4.25E-01	3.0	34.907 +/- .235	34.677 +/- .013	-0.230 +/- .247
90233	19.2	36087	52	I	8.70E-02	20.0	8.88E-02	30.9	34.342 +/- .094	34.671 +/- .013	-0.329 +/- .120
92234	6.8	36087	70	C	1.60E-01	21.1	1.60E-01	24.2	34.982 +/- .101	35.114 +/- .042	-0.132 +/- .123
92234	21.0	36087	52	I	4.52E-01	30.0	4.02E-01	9.7	35.481 +/- .264	34.566 +/- .045	-0.915 +/- .272
92236	21.0	36087	53	I	2.77E-01	18.0	2.34E-01	16.3	35.184 +/- .108	35.104 +/- .063	-0.080 +/- .125
92239	19.2	36087	52	I	4.10E-02	25.0	6.21E-02	39.0	34.527 +/- .103	34.641 +/- .066	-0.114 +/- .122
94240	6.5	36087	70	C	3.31E-01	18.0	1.77E-01	24.5	34.745 +/- .111	35.076 +/- .074	-0.331 +/- .133
94240	6.5	35087	70	C	8.30E-01	8.4	7.35E-01	6.1	34.906 +/- .174	35.076 +/- .074	-0.170 +/- .189
90233	19.2	36088	52	I	3.55E-01	15.0	2.31E-01	18.3	35.318 +/- .108	35.100 +/- .073	-0.218 +/- .130
92234	6.8	35088	70	C	4.70E-01	12.0	4.15E-01	10.5	35.562 +/- .104	35.562 +/- .062	0.000 +/- .121
92234	21.2	36088	52	I	5.30E-01	30.0	6.05E-01	8.0	35.627 +/- .132	35.825 +/- .064	-0.198 +/- .138
92236	21.0	36088	52	I	3.83E-01	20.0	4.01E-01	8.1	35.364 +/- .143	35.737 +/- .042	-0.373 +/- .156
92239	19.2	36088	52	I	2.03E-01	12.0	2.18E-01	17.9	35.155 +/- .084	35.076 +/- .045	-0.079 +/- .106
94240	6.5	35088	70	C	6.37E-01	50.4	4.41E-01	11.9	35.344 +/- .037	35.508 +/- .074	-0.164 +/- .152
90233	19.2	36089	52	I	4.70E-01	11.1	4.66E-01	9.4	35.513 +/- .113	35.505 +/- .073	-0.008 +/- .134
92234	6.8	35089	70	C	1.90E-01	47.4	1.70E-01	21.5	35.952 +/- .107	35.952 +/- .062	0.000 +/- .216
92234	6.8	36089	31	C	8.41E-01	5.0	8.02E-01	4.4	35.892 +/- .147	35.952 +/- .062	-0.059 +/- .160
92234	21.2	36089	52	I	5.70E-01	30.0	5.85E-01	8.0	36.267 +/- .148	36.125 +/- .064	-0.142 +/- .119
92236	7.5	36089	66	C	9.35E-01	0.6	9.35E-01	2.8	35.652 +/- .080	35.676 +/- .060	-0.024 +/- .100
92236	21.0	36089	52	I	6.28E-01	18.0	6.25E-01	8.1	35.591 +/- .128	35.676 +/- .062	-0.085 +/- .236
92239	6.4	36089	66	C	9.56E-01	0.5	9.56E-01	0.8	35.615 +/- .119	35.212 +/- .064	-0.403 +/- .229
92239	19.7	36089	52	I	4.50E-01	14.0	4.45E-01	8.8	35.558 +/- .148	35.479 +/- .065	-0.079 +/- .162
94240	6.5	36089	31	C	8.56E-01	0.6	8.75E-01	4.6	35.905 +/- .070	35.516 +/- .074	-0.389 +/- .101
95243	6.4	36089	50	C	8.70E-01	1.1	6.55E-01	5.2	35.869 +/- .074	35.856 +/- .061	-0.013 +/- .118
90233	19.2	36090	52	I	6.24E-01	11.0	6.21E-01	8.2	35.927 +/- .192	35.601 +/- .073	-0.326 +/- .205

- 19 -

CCPP NUCLEUS	EXC. ENERGY	PRODUCT NUCLIDE	REFER- ENCE	CUM IND	MEASURED FR CPM VEC	PLT ERRR	CALCULATED FR CPM VEC	PLT ERRR	MEASURED TO	CALCULATED TO	MEAS-CALC TO	
92234	6.8	54133	10	I	1.33E-02	8.7	4.59E-03	47.4	52.204+/-.054	52.436+/-.061	C.144+/-.112	
92236	7.9	54133	10	I	9.13E-06	6.0	1.18E-06	139.4	51.755+/-.113	51.895+/-.085	C.050+/-.128	
92236	21.3	54133	51	66	1.26E-02	10.0	2.17E-02	59.0	52.431+/-.112	52.766+/-.076	C.081+/-.142	
92338	16.5	54133	51	I	1.00E-01	9.5	7.41E-04	139.0	52.185+/-.097	51.765+/-.084	C.145+/-.155	
94240	6.9	53133	36	I	1.51E-01	19.0	1.50E-01	23.5	51.528+/-.096	51.951+/-.065	C.063+/-.116	
94240	6.5	54133	60	I	6.73E-03	3.4	3.84E-03	93.9	52.116+/-.097	51.551+/-.085	C.125+/-.117	
94240	6.3	54133	60	I	8.73E-03	3.7	4.05E-03	81.1	52.169+/-.097	52.035+/-.085	C.050+/-.115	
94240	21.2	54133	51	I	1.20E-01	10.0	7.84E-02	30.7	52.844+/-.096	52.716+/-.074	C.136+/-.122	
95243	6.6	54133	40	I	7.75E-03	7.0	3.13E-03	100.0	52.185+/-.097	51.965+/-.071	C.116+/-.121	
90233	19.9	53134	43	I	1.52E-01	10.0	2.89E-01	14.9	51.930+/-.095	52.202+/-.072	C.073+/-.104	
92234	6.8	52134	40	36	I	5.50E-01	15.0	4.08E-01	9.0	52.309+/-.107	52.710+/-.081	-0.200+/-.123
94240	6.5	53134	39	I	3.35E-02	73.0	3.82E-02	10.2	52.284+/-.108	52.441+/-.065	C.177+/-.123	
94240	6.6	52134	48	C	3.40E-01	10.3	6.05E-01	9.0	52.615+/-.109	52.423+/-.092	C.008+/-.153	
98250	6.6	52134	48	C	2.90E-01	21.0	3.00E-01	18.8	52.810+/-.110	52.773+/-.102	C.037+/-.154	
98252	0.	53134	47	I	2.40E-01	15.0	1.89E-01	10.4	52.154+/-.094	52.081+/-.107	C.047+/-.143	
100234	0.	52134	47	C	3.73E-01	10.0	3.35E-01	23.4	52.481+/-.092	52.804+/-.124	-C.123+/-.149	
90233	8.0	53135	43	I	1.50E-01	20.0	2.19E-01	14.9	51.925+/-.093	52.056+/-.094	-0.131+/-.119	
90233	19.6	53135	43	I	4.70E-01	17.0	5.22E-01	8.5	52.611+/-.159	52.411+/-.070	-C.098+/-.174	
92234	6.8	53135	39	I	6.00E-01	4.0	5.84E-01	8.1	52.820+/-.097	52.544+/-.081	-0.121+/-.126	
92236	6.8	53135	40	60	I	2.20E-01	10.0	1.87E-01	20.2	53.078+/-.076	52.544+/-.081	C.120+/-.097
92236	7.5	54135	60	I	5.00E-02	4.3	4.24E-02	38.6	52.585+/-.077	52.405+/-.066	-C.019+/-.098	
92236	21.3	54135	51	66	I	2.70E-01	9.0	2.97E-01	13.9	53.122+/-.060	53.216+/-.048	C.034+/-.095
92239	6.6	54135	60	I	6.00E-03	12.0	3.99E-03	92.0	54.121+/-.100	51.555+/-.081	C.073+/-.117	
92239	19.5	54135	51	66	I	5.94E-02	8.8	4.94E-02	41.4	52.628+/-.071	52.573+/-.048	C.031+/-.102
94240	6.5	54135	36	I	6.00E-01	2.8	5.50E-01	8.2	52.873+/-.138	52.901+/-.085	-C.065+/-.093	
94240	6.5	54135	48	60	I	1.50E-01	4.0	1.464E-01	23.1	52.940+/-.067	52.901+/-.045	C.039+/-.091
94240	8.3	54135	60	I	1.01E-01	3.8	2.04E-01	19.5	53.016+/-.067	52.582+/-.065	C.037+/-.092	
94240	21.2	54135	51	I	4.00E-01	20.0	4.46E-01	8.9	53.380+/-.178	53.380+/-.073	-C.005+/-.193	
94242	6.3	54135	40	I	3.21E-02	4.7	4.42E-02	46.2	52.465+/-.092	52.715+/-.066	-C.050+/-.107	
95243	6.4	54135	60	I	1.45E-01	3.4	1.22E-01	27.5	52.923+/-.067	52.880+/-.073	C.043+/-.090	
96246	6.4	54135	61	I	1.40E-01	5.5	1.47E-01	27.8	52.573+/-.078	52.884+/-.082	C.109+/-.107	
98250	6.4	54135	61	I	3.00E-01	8.3	3.41E-01	17.6	53.328+/-.070	53.213+/-.102	C.113+/-.128	
100234	0.	53135	61	C	7.10E-01	1.4	6.18E-01	13.2	53.190+/-.064	51.261+/-.124	-0.070+/-.140	
90233	19.5	55136	62	I	7.21E-03	6.7	3.31E-03	96.0	52.908+/-.107	52.690+/-.070	-0.071+/-.128	
92234	6.8	55136	2	I	1.40E-02	20.0	1.40E-02	58.8	53.270+/-.060	53.348+/-.061	-C.058+/-.117	
92234	21.5	55136	10	I	1.74E-01	6.3	1.74E-01	21.9	53.982+/-.069	53.981+/-.048	C.000+/-.047	
92236	20.0	55136	10	I	9.90E-02	6.8	6.18E-02	33.4	53.169+/-.072	53.170+/-.066	C.019+/-.098	
92236	8.7	55136	66	62	I	2.33E-03	12.0	4.43E-03	86.1	53.186+/-.109	51.626+/-.060	-C.134+/-.124
92236	21.7	55136	10	I	1.40E-02	3.6	5.24E-02	42.3	53.570+/-.077	51.905+/-.048	-C.011+/-.112	
92237	19.8	55136	10	I	2.00E-02	9.3	1.90E-02	60.2	53.373+/-.078	53.347+/-.066	C.027+/-.110	
92239	6.6	55136	66	62	I	1.30E-04	10.0	6.60E-05	202.0	52.461+/-.126	52.419+/-.081	D.043+/-.140
92239	19.5	55136	58	I	3.91E-03	6.0	2.93E-03	100.7	53.031+/-.077	52.673+/-.047	C.054+/-.122	
94240	6.5	55136	28	I	1.40E-02	10.0	1.54E-02	64.0	53.208+/-.091	53.121+/-.065	-C.011+/-.112	
94240	8.3	55136	66	62	I	2.64E-02	10.0	2.15E-02	51.1	53.355+/-.089	53.354+/-.065	-C.041+/-.111
94240	21.2	55136	56	64	I	1.52E-01	5.0	1.94E-01	24.8	53.930+/-.068	53.930+/-.072	-C.004+/-.099
94242	0.	55136	15	I	1.10E-01	18.0	8.03E-01	37.1	51.811+/-.091	51.765+/-.077	C.144+/-.119	
96246	0.	55136	23	I	1.40E-02	10.0	2.11E-02	64.2	53.111+/-.075	53.159+/-.081	C.048+/-.124	
96246	6.4	55136	33	I	2.30E-02	17.0	1.33E-02	72.0	51.184+/-.094	51.284+/-.081	C.100+/-.124	
98250	6.6	55136	35	58	I	6.90E-02	17.0	5.17E-02	52.7	53.672+/-.089	51.433+/-.102	C.019+/-.135
98252	0.	55136	36	26	I	4.80E-03	21.0	3.04E-03	111.4	53.050+/-.108	52.587+/-.107	C.060+/-.157
90233	8.0	53137	70	C	7.00E-01	11.0	6.52E-01	4.3	51.048+/-.071	52.418+/-.084	C.134+/-.198	
90233	19.4	53137	70	C	5.00E-01	10.0	6.18E-01	7.8	51.500+/-.076	51.735+/-.068	C.165+/-.145	
90233	19.2	54137	52	I	3.27E-01	13.0	3.54E-01	11.6	53.271+/-.094	51.324+/-.048	-C.054+/-.116	
92234	6.8	54137	70	C	2.80E-01	10.7	2.68E-01	15.6	53.802+/-.080	51.711+/-.061	-C.610+/-.100	
92234	6.8	54137	21	C	6.59E-01	0.6	9.17E-01	3.3	53.745+/-.074	51.733+/-.061	C.018+/-.095	
92234	21.2	54137	52	I	6.00E-01	15.0	5.61E-01	8.0	54.194+/-.231	54.105+/-.061	-C.111+/-.241	
92236	21.0	54137	52	I	6.10E-01	16.0	6.27E-01	8.1	53.845+/-.229	54.105+/-.065	-C.034+/-.239	
92239	19.2	54137	70	I	3.00E-01	7.7	3.35E-01	11.8	53.240+/-.072	51.251+/-.065	-C.091+/-.097	
94240	6.5	54137	70	C	4.20E-01	5.9	2.92E-01	15.4	53.131+/-.067	51.711+/-.065	-C.118+/-.094	
94240	6.5	54137	31	C	6.17E-01	0.5	9.28E-01	3.2	53.724+/-.076	51.711+/-.065	-C.007+/-.100	
90233	19.2	54138	52	I	4.75E-01	22.0	5.53E-01	8.1	53.521+/-.209	51.478+/-.068	-C.156+/-.220	
92234	6.8	54138	70	C	1.00E-01	40.0	5.85E-02	30.8	54.218+/-.412	54.170+/-.061	C.042+/-.416	
92234	6.8	54138	21	C	8.27E-01	1.5	7.60E-01	5.6	53.972+/-.072	54.136+/-.061	-C.201+/-.094	
92234	21.7	54138	52	I	3.74E-01	15.0	3.74E-01	10.6	54.651+/-.112	54.651+/-.065	C.000+/-.149	
92236	1.0	54138	52	I	5.20E-01	17.0	5.77E-01	2.9	54.594+/-.068	54.265+/-.064	C.129+/-.218	
92236	21.1	54138	31	C	7.50E-01	2.7	6.80E-01	5.8	54.122+/-.073	54.268+/-.064	-C.146+/-.097	
92239	19.6	54138	56	I	9.00E-03	75.0	1.03E-02	70.9	53.196+/-.216	53.228+/-.061	-C.032+/-.225	
92239	19.2	54138	30	C	5.00E-01	10.0	3.99E-01	11.5	53.145+/-.100	51.444+/-.064	-C.228+/-.119	
92239	19.2	54138	52	I	4.60E-01	7.1	5.38E-01	8.0	53.505+/-.089	51.444+/-.064	-C.138+/-.107	
92239	19.3	54138	31	C	9.40E-01	2.1	6.36E-01	2.7	53.604+/-.123	53.604+/-.065	-C.018+/-.138	
92239	19.2	55138	30	I	8.30E-02	6.0	6.27E-02	38.6	53.727+/-.073	53.444+/-.064	C.083+/-.098	
94240	6.5	53138	70	C	1.43E-01	7.0	1.10E-01	29.9	54.097+/-.073	54.121+/-.065	-C.034+/-.098	
94240	6.5	54138	31	C	8.51E-01	1.2	7.83E-01	5.6	53.917+/-.073	51.131+/-.048	-C.214+/-.103	
98250	6.6	55138	23	I	3.70E-01	10.0	3.71E-01	16.1	54.363+/-.080	54.422+/-.102	-C.103+/-.133	
98252	0.	55138	42	I	1.10E-01	27.0	1.02E-01	41.9	53.817+/-.114	53.845+/-.107	-C.032+/-.156	
90233	19.2	54139	52	I	5.80E-01	13.0	6.27E-01	8.1	54.247+/-.229	54.041+/-.067	C.027+/-.238	
92234	6.8	54139	31	C	4.70E-01	1.7	5.02E-01	8.6	54.535+/-.061	54.575+/-.061	-0.040+/-.086	
92234	6.8	56139	44	I	8.40E-02	8.3	5.50E-02	40.7	54.731+/-.075	54.577+/-.061	C.152+/-.097	
92234	21.2	54139	52	I	2.00E-01	15.0	1.79E-01	20.7	54.956+/-.089	53.000+/-.044	-C.052+/-.110	
92236	7.5	54139	66	C	7.20E-01	1.4	7.36E-01	5.8	54.744+/-.065	54.720+/-.060	-C.042+/-.088	

COMP. NUCLEUS	FE. INTRIN	PRODUC. NUCLEUS	REF. ENCE	CON. INE	MEAS. MEAS. PR. CHA. VIE	PCT. INE	CALCULATED PR. CHA. VIE	PCT. INE	MEAS. MEAS. PR. CHA. VIE	CALCULATED PR. CHA. VIE	MEAS. CALC. ZP
92238	21.1	54135	31	C	4.25E-01	2.1	4.11E-01	11.0	54.10E-01	54.12E-01	-0.02E-01
92236	21.0	54139	52	I	3.13E-01	17.0	3.90E-01	9.9	54.12E-01	54.12E-01	0.00E-01
92239	6.6	54139	66	C	9.49E-01	0.5	9.49E-01	2.5	53.50E-01	53.50E-01	-0.09E-01
92238	6.6	55135	54	I	6.11E-02	23.0	5.08E-02	41.0	53.61E-01	53.61E-01	0.00E-01
92239	19.2	55135	24	I	1.83E-01	11.0	1.76E-01	20.6	51.59E-01	51.59E-01	-0.00E-01
92239	19.2	54135	31	C	1.45E-01	8.0	1.05E-01	50.0	54.12E-01	54.12E-01	0.00E-01
92239	19.2	55135	24	I	1.83E-01	9.2	1.85E-01	20.0	54.12E-01	54.12E-01	0.00E-01
94240	6.5	55135	20	C	5.44E-02	13.0	2.86E-02	52.8	54.12E-01	54.12E-01	0.00E-01
94240	6.5	54135	31	C	5.44E-01	1.9	5.33E-01	8.7	54.12E-01	54.12E-01	0.00E-01
95243	6.4	54139	50	C	5.00E-01	2.0	4.62E-01	10.5	54.10E-01	54.11E-01	-0.01E-01
98252	0.0	54135	2	C	6.70E-01	1.4	7.00E-01	10.1	54.12E-01	54.12E-01	0.00E-01
98254	0.0	54135	60	C	6.70E-01	1.4	6.93E-01	5.8	53.84E-01	53.84E-01	-0.00E-01
90233	19.2	54140	52	I	5.40E-01	13.0	5.12E-01	6.3	54.12E-01	54.12E-01	0.00E-01
92234	6.6	54140	31	C	2.23E-01	2.7	2.32E-01	18.3	54.12E-01	54.12E-01	0.00E-01
92234	6.6	54140	44	I	2.70E-01	15.0	2.00E-01	19.0	53.17E-01	53.17E-01	-0.00E-01
92234	6.6	57140	14	I	3.80E-03	3.0	2.90E-03	98.0	55.00E-01	55.00E-01	0.00E-01
92234	21.2	54140	52	I	6.70E-02	15.0	5.92E-02	39.4	53.78E-01	53.78E-01	-0.00E-01
92236	7.5	54140	66	C	4.71E-01	2.1	4.71E-01	9.1	54.12E-01	54.12E-01	0.00E-01
92236	21.1	54140	52	I	2.04E-01	2.5	1.90E-01	21.0	54.63E-01	54.63E-01	0.00E-01
92236	21.3	57140	8	I	7.20E-03	7.0	3.63E-03	93.6	54.12E-01	54.12E-01	0.00E-01
92239	6.6	54140	66	C	6.00E-01	1.7	8.31E-01	4.8	53.89E-01	53.89E-01	-0.00E-01
92239	19.1	54140	52	I	5.40E-01	7.0	5.20E-01	8.0	54.12E-01	54.12E-01	0.00E-01
92239	19.3	54140	31	C	6.13E-03	1.0	5.85E-03	7.7	54.12E-01	54.12E-01	0.00E-01
94240	6.5	54140	31	C	3.01E-01	2.7	2.57E-01	17.5	54.12E-01	54.12E-01	0.00E-01
95243	6.4	54140	50	C	2.80E-01	3.0	2.31E-01	20.0	54.12E-01	54.12E-01	0.00E-01
98250	6.6	57140	18	I	1.10E-02	62.0	1.10E-02	62.0	55.48E-01	55.48E-01	0.00E-01
98252	0.0	54140	2	C	4.50E-01	2.2	4.23E-01	17.4	54.12E-01	54.12E-01	0.00E-01
98254	0.0	54140	60	C	6.50E-01	4.3	6.84E-01	11.1	54.12E-01	54.12E-01	0.00E-01
100254	0.0	54140	67	C	5.77E-01	0.4	9.76E-01	1.8	55.18E-01	55.18E-01	0.00E-01
90233	19.2	54141	52	I	2.58E-01	14.0	2.53E-01	13.7	54.65E-01	54.65E-01	0.00E-01
92234	6.6	54141	31	C	5.10E-02	5.9	6.80E-02	38.1	55.41E-01	55.41E-01	0.00E-01
92234	21.2	54141	52	I	2.32E-02	25.0	1.30E-02	67.6	55.61E-01	55.61E-01	0.00E-01
92236	7.5	54141	66	C	1.40E-01	10.7	2.08E-01	19.8	55.10E-01	55.10E-01	0.00E-01
92236	21.1	54141	52	I	5.40E-02	5.4	6.12E-02	39.5	55.30E-01	55.30E-01	0.00E-01
92239	6.6	54141	66	C	5.80E-01	13.0	6.00E-01	7.2	54.18E-01	54.18E-01	0.00E-01
92239	6.6	55141	50	I	3.20E-03	19.0	3.63E-03	10.1	54.25E-01	54.25E-01	0.00E-01
92239	19.2	54141	52	I	2.43E-01	8.0	3.13E-01	12.4	54.19E-01	54.19E-01	0.00E-01
92239	19.3	54141	31	C	2.50E-01	6.9	3.24E-01	13.8	54.18E-01	54.18E-01	0.00E-01
94240	6.5	54141	31	C	7.50E-02	5.1	7.50E-02	30.4	55.39E-01	55.39E-01	0.00E-01
95243	6.4	54141	50	C	8.20E-02	3.7	7.36E-02	36.5	55.27E-01	55.27E-01	0.00E-01
98252	0.0	54141	2	C	1.72E-01	2.5	1.67E-01	31.6	55.30E-01	55.30E-01	0.00E-01
98254	0.0	54141	60	C	3.50E-01	5.7	3.98E-01	19.0	54.71E-01	54.71E-01	0.00E-01
90233	19.2	54142	52	I	1.30E-01	20.0	1.16E-01	28.2	55.10E-01	55.10E-01	0.00E-01
92234	6.6	54142	31	C	9.80E-03	6.8	1.27E-02	68.3	55.80E-01	55.80E-01	0.00E-01
92236	21.0	54142	52	I	2.21E-02	20.0	1.35E-02	66.7	55.82E-01	55.82E-01	0.00E-01
92239	19.2	54142	52	I	1.45E-01	14.0	1.28E-01	26.0	55.03E-01	55.03E-01	0.00E-01
92239	19.2	54142	31	C	1.10E-01	5.5	1.30E-01	23.1	55.18E-01	55.18E-01	0.00E-01
94240	6.5	54142	31	C	1.45E-02	4.9	1.54E-02	65.5	55.84E-01	55.84E-01	0.00E-01
95243	6.4	54142	50	C	2.40E-02	10.0	1.52E-02	66.7	55.60E-01	55.60E-01	0.00E-01
92234	6.6	54143	31	C	2.70E-04	6.3	1.64E-03	117.7	56.28E-01	56.28E-01	0.00E-01
92239	6.6	54143	66	C	8.20E-02	8.0	1.18E-01	29.2	55.13E-01	55.13E-01	0.00E-01
94240	6.5	54143	21	C	2.60E-03	5.8	2.07E-03	111.8	56.06E-01	56.06E-01	0.00E-01
95243	6.4	54143	50	C	3.20E-03	6.3	2.11E-03	111.4	56.02E-01	56.02E-01	0.00E-01
92239	6.6	54144	66	C	2.80E-02	14.0	2.57E-02	54.9	55.57E-01	55.57E-01	0.00E-01
94240	6.5	54144	21	C	2.50E-04	21.0	1.73E-04	180.1	56.47E-01	56.47E-01	0.00E-01
95243	6.4	54144	50	C	1.20E-03	8.3	1.75E-04	176.4	56.20E-01	56.20E-01	0.00E-01
92239	6.6	55145	50	I	1.45E-01	20.0	1.47E-01	22.8	56.08E-01	56.08E-01	0.00E-01
92239	6.6	55146	59	I	3.53E-02	27.0	4.03E-02	45.1	56.11E-01	56.11E-01	0.00E-01
92234	6.6	61150	71	I	1.13E-03	6.0	5.05E-03	85.3	56.79E-01	56.79E-01	0.00E-01
94240	6.5	61150	71	I	1.70E-03	5.0	4.14E-03	90.6	56.86E-01	56.86E-01	0.00E-01
98250	6.6	61150	71	I	8.00E-03	11.3	1.77E-02	72.7	59.15E-01	59.15E-01	0.00E-01
98252	0.0	61150	36	I	8.40E-03	50.0	1.42E-03	133.0	59.16E-01	59.16E-01	0.00E-01
92234	21.5	65100	10	I	4.20E-03	25.0	7.93E-03	83.4	63.02E-01	63.02E-01	0.00E-01
92236	21.2	65100	10	I	2.70E-03	15.0	6.25E-04	136.3	62.94E-01	62.94E-01	0.00E-01

WEIGHTED AVERAGE 0.08E-01
OF ABSOLUTE VALUES

References

1. C. D. Coryell, M. Kaplan, and R. D. Fink, Can J. Chem. **39**, 646 (1961).
2. A. C. Wahl, R. L. Ferguson, D. R. Nethaway, D. E. Troutner, and K. Wolfsberg, Phys. Rev. **126**, 1112 (1962).
3. N. G. Runnalls, D. E. Troutner, and R. L. Ferguson, Phys. Rev. **179**, 1188 (1969).
4. A. C. Wahl, A. E. Norris, R. A. Rouse, and J. C. Williams, Proc. 2nd International Atomic Energy Symposium on Physics and Chemistry of Fission, Vienna, Austria (1969), Paper SM-122/116.
5. S. Amiel and H. Feldstein, Proc. 3rd International Atomic Energy Symposium on Physics and Chemistry of Fission, Rochester, USA (1973), Paper SM-174/25.
6. K. Wolfsberg, Los Alamos Scientific Laboratory, Rept. LA-3189 (1965), unpublished.
7. A. Notea, Phys. Rev. **182**, 1331 (1969).
8. D. R. Nethaway and H. B. Levy, Phys. Rev. **139**, B1505 (1965).
9. J. A. McHugh and M. C. Michel, Phys. Rev. **172**, 1160 (1968).
10. D. R. Nethaway and B. Mendoza, Phys. Rev. C **6**, 1827 (1972).
11. H. Umezawa, J. Inorg. Nucl. Chem. **33**, 2731 (1971).
12. S. C. Burnett, R. L. Ferguson, F. Plasil, and H. W. Schmitt, Phys. Rev. C **3**, 2034 (1971).
13. R. L. Ferguson, F. Plasil, F. Pleasanton, S. C. Burnett, and H. W. Schmitt, Phys. Rev. C **7**, 2510 (1973).
14. G. P. Ford, Los Alamos Scientific Laboratory, Rept. AECD-3597 (1953).
15. E. P. Steinberg and L. E. Glendenin, Phys. Rev. **95**, 431 (1954).
16. A. C. Wahl, Phys. Rev. **99**, 730 (1955).
17. G. P. Ford and J. S. Gilmore, Los Alamos Scientific Laboratory, Rept. LA-1997 (1956), unpublished.
18. W. E. Grummitt and G. M. Milton, J. Inorg. Nucl. Chem. **5**, 93 (1957).
19. D. E. Troutner, Nuclear Charge Distribution in Fission: Independent Yields of Niobium Isotopes from Thermal-Neutron Fission of ^{233}U , ^{235}U , and ^{239}Pu , Thesis, Washington University, St. Louis, Mo. (1959).
20. L. E. Glendenin, E. P. Steinberg, and M. Talat-Erben, private communication to A. C. Wahl (1960), quoted in Ref. 2.
21. L. E. Glendenin, private communication to I. F. Croall, Atomic Energy Research Establishment Rept. AERE-R 3209 (1960), unpublished.
22. W. E. Grummitt, M. Nussis, and G. Lahaie, Proc. 3rd Symposium on Nuclear and Radiochemistry, Chalk River, Ontario (1960), Paper 16.
23. S. Katcoff, Nucleonics **18** (11), 201 (1960).
24. I. T. Krisyuk, G. P. Lepnev, and N. B. Platunova, Radiokhimiya **2**, 743 (1960).
25. I. T. Krisyuk, N. B. Platunova, and A. N. Protopopov, Radiokhimiya **2**, 746 (1960).

26. W. E. Nervik, Phys. Rev. **119**, 1685 (1960).
27. I. F. Croall, J. Inorg. Nucl. Chem. **16**, 358 (1961).
28. W. E. Grummitt and G. M. Milton, J. Inorg. Nucl. Chem. **20**, 6 (1961).
29. A. N. Apollonova, I. T. Krisyuk, and V. N. Ushatskii, Radiokhimiya **4**, 587 (1962).
30. A. N. Apollonova, I. T. Krisyuk, and V. N. Ushatskii, Radiokhimiya **4**, 711 (1962).
31. K. Wolfsberg, Phys. Rev. **137**, B929 (1965).
32. A. Grau, Study of the Distribution of Nuclear Charge in the Fission of ^{238}U , Thesis, Mainz University, Mainz, Germany (1966).
33. H. R. von Gunten, K. F. Flynn, and L. E. Glendenin, Phys. Rev. **161**, 1192 (1967).
34. M. F. Roche, The Independent Yield of ^{112}Ag and the Cumulative Yield of ^{115}Pd in Thermal-Neutron Induced ^{233}U and ^{235}U Fission, Thesis, University of Missouri, Columbia, Mo. (1968).
35. K. F. Flynn and H. R. von Gunten, Helv. Chimica Acta **52**, 2216 (1969).
36. H. R. von Gunten, K. F. Flynn, and L. E. Glendenin, J. Inorg. Nucl. Chem. **31**, 3357 (1969).
37. A. S. Rao, M. N. Rao, and P. K. Kuroda, J. Inorg. Nucl. Chem. **31**, 591 (1969).
38. L. H. Niece, D. E. Troutner, and R. L. Ferguson, Phys. Rev. C **1**, 312 (1970).
39. S. M. Qaim and H. O. Denschlag, J. Inorg. Nucl. Chem. **32**, 1767 (1970).
40. N. G. Runnalls and D. E. Troutner, Phys. Rev. C **1**, 316 (1970).
41. B. L. Tracy and H. G. Thode, Can. J. Phys. **48**, 1708 (1970).
42. D. E. Troutner, M. Eichor, and C. Pace, Phys. Rev. C **1**, 1044 (1970).
43. H. O. Denschlag and S. M. Qaim, J. Inorg. Nucl. Chem. **33**, 3649 (1971).
44. M. Eichor and D. E. Troutner, J. Inorg. Nucl. Chem. **33**, 1543 (1971).
45. R. M. Harbour and D. E. Troutner, J. Inorg. Nucl. Chem. **33**, 1 (1971).
46. R. C. Hawkings, W. J. Edwards, and W. J. Olmstead, Can. J. Phys. **49**, 785 (1971).
47. M. F. Roche, D. E. Troutner, and R. L. Ferguson, Radiochim. Acta **16**, 66 (1971).
48. D. E. Troutner and R. M. Harbour, Phys. Rev. C **4**, 505 (1971).
49. D. E. Troutner and N. G. Runnalls, J. Inorg. Nucl. Chem. **33**, 2271 (1971).
50. K. Wolfsberg and G. P. Ford, Phys. Rev. C **3**, 1333 (1971).
51. P. Alexander, Nucl. Phys. A198, 228 (1972).
52. J. P. Bocquet, R. Brissot, J. Crancon, and A. Moussa, Nucl. Phys. A189, 556 (1972).
53. K. F. Flynn, B. Srinivasan, O. K. Manuel, and L. E. Glendenin, Phys. Rev. C **6**, 2211 (1972).
54. R. Naemann, H. Folger, and H. O. Denschlag, J. Inorg. Nucl. Chem. **34**, 1785 (1972).
55. V. Kurchatov et al., Yad. Fiz. **14**, 943 (1972).

56. A. L. Prindle, Lawrence Livermore Laboratory, private communication (1972).
57. S. A. Rao, Phys. Rev. C **5**, 171 (1972).
58. D. E. Troutner and R. M. Harbour, J. Inorg. Nucl. Chem. **34**, 801 (1972).
59. S. Balestrini and L. Forman, Los Alamos Scientific Laboratory, private communication (1973).
60. G. P. Ford and K. Wolfsberg, Los Alamos Scientific Laboratory, private communication (1973).
61. R. M. Harbour, D. E. Troutner, and K. W. MacMurdo, Abstracts 166th ACS National Meeting, Chicago, Illinois (1973).
62. D. R. Nethaway, Lawrence Livermore Laboratory, unpublished results (1973).
63. S. A. Rao and P. K. Kuroda, J. Inorg. Nucl. Chem. **35**, 1443 (1973).
64. D. E. Troutner and R. M. Harbour, J. Inorg. Nucl. Chem. **35**, 1 (1973).
65. H. Umezawa, J. Inorg. Nucl. Chem. **35**, 353 (1973).
66. K. Wolfsberg, Los Alamos Scientific Laboratory, private communication (1973).
67. R. M. Harbour, K. W. MacMurdo, D. E. Troutner, and M. V. Hoehn, Phys. Rev. C **8**, 1488 (1973).
68. L. Berge, private communication to D. E. Troutner, J. Inorg. Nucl. Chem. **33**, 4327 (1971).
69. L. Berge, Thesis, University of Missouri, Columbia, Mo. (1972).
70. W. Grimm, quoted by H. O. Denschlag, Thesis, Mainz University, Mainz, Germany (1971).
71. H. von Gunten, private communication to K. Wolfsberg, Los Alamos Scientific Laboratory (1973).
72. D. E. Troutner et al., Abstracts 159th ACS National Meeting, Houston, Texas (1970).
73. M. E. Eichor, Thesis, University of Missouri, Columbia, Mo. (1972).