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**Resin Bead U and PU Analysis
of WAK Input Solutions—
A Statistical Summary of
Experiment #1**

C. K. Bayne
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R. L. Walker

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RESIN BEAD U AND PU ANALYSIS OF WAK INPUT SOLUTIONS-
A STATISTICAL SUMMARY OF EXPERIMENT #1

by

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ABSTRACT

A statistical analysis of the resin bead experimental data was made to identify sources of variations among the measurements of isotopic atom ratios and elemental concentrations of plutonium and uranium. Comparisons among treatment means of the analytical laboratory and the resin bead preparation methods are tabulated using Duncan's multiple range test.

1. Introduction

Three spent fuel solutions were provided by GWK (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen, mbH) [1] to test the applicability of isotopic analysis of nanogram-size samples of uranium and plutonium using the resin bead technique. Each spent fuel solution was divided into three subsamples. These subsamples were then prepared for resin beads either in the field by IAEA (International Atomic Energy Agency) at Karlsruhe or in the laboratory from dried samples by IAEA and ORNL (Oak Ridge National Laboratory). Isotopic atom ratios and elemental analysis for plutonium and uranium were made on the field and laboratory prepared resin beads by both IAEA and ORNL. In addition, each subsample was analyzed at IAEA by conventional methods using the AVCO mass spectrometer.

The plutonium measurements made on each resin bead were the isotopic atom ratios: $^{238}\text{Pu}/^{239}\text{Pu}$, $^{240}\text{Pu}/^{239}\text{Pu}$, $^{241}\text{Pu}/^{239}\text{Pu}$, $^{242}\text{Pu}/^{239}\text{Pu}$, and the plutonium concentration ($\mu\text{g/g}$). The uranium measurements were the isotopic atom ratios: $^{234}\text{U}/^{238}\text{U}$, $^{235}\text{U}/^{238}\text{U}$, $^{236}\text{U}/^{238}\text{U}$, and the uranium concentration (mg/g). These measurements were statistically analyzed to identify the sources of measurement variation and those results which exhibit statistical differences. The analysis of the sources of variation found that the variation between the resin bead preparation methods (field or laboratory) and the variation between the analytical laboratories (IAEA or ORNL) were much more important than any variation due to differences among subsamples. To examine significant differences among the results, the resin bead preparation and laboratory analysis were identified as five treatments: $T_1 = \text{IAEA-AVCO}$, $T_2 = \text{IAEA-FIELD}$, $T_3 = \text{IAEA-LAB}$, $T_4 = \text{ORNL-FIELD}$, and $T_5 = \text{ORNL-LAB}$. These five treatments were then compared using Duncan's multiple range test to show significant differences among the treatments.

2. Resin Bead Experimental Data

The data for the isotopic atom ratios of plutonium and plutonium concentrations are tabulated in table A-1 and the isotopic atom ratios of uranium and uranium concentrations are tabulated in table A-2. The data for ^{241}Pu has been corrected for time differences between the date sampled and the date analyzed. The sampling dates are:

<u>Fuel Solution</u>	<u>Sample Date</u>
1	14 February 1978
2	6 June 1978
3	8 June 1978

Let t represent the time difference in years between the sampled date and the analyzed date, then each measured $(^{241}\text{Pu})_0$ value was adjusted to the sampling date by:

$$^{241}\text{Pu} = (^{241}\text{Pu})_0 / \exp(-\lambda t / T_{1/2})$$

where the decay constant is $\lambda = 0.693$ and the half-life is $T_{1/2} = 14.3$ years. The plutonium concentration values in table A-1 are based on the adjusted ^{241}Pu values.

For each of the five treatments (T_1 - T_5), the number of measurements, the average of the measurements, and the standard deviation of the measurements are given in tables A-3, A-4, and A-5 for plutonium and are given in tables A-6, A-7, and A-8 for uranium. Examination of the summary data for plutonium concentrations show large differences between the field prepared resin bead average values and the other treatment average values. In addition, the standard deviations for the field measurements are much larger than those for the other treatments indicating improper equilibration of sample with spike in the field resin bead preparations. For these reasons, the data from field resin beads (IAEA-FIELD and ORNL-FIELD) were not used in the statistical analysis of the plutonium concentrations. A comparison of the average values for the different treatments for the other measurements will be made using Duncan's multiple range test to indicate differences among the treatments.

3. Statistical Analysis and Results

The measurements of the resin bead experiment (either isotopic atom ratios or concentrations of plutonium and uranium) were modelled as a two-way ANOVA (analysis of variance) model [3]. The schematic in figure 1 of the treatments was used to determine possible sources of variation of the measurements and, therefore, the terms to be included in the ANOVA model. The sources of variation are the subsamples (S_i ; $i = 1,2,3$) of the fuel solution and five treatment effects represented by: $T_1 = \text{IAEA-AVCO}$, $T_2 = \text{IAEA-FIELD}$, $T_3 = \text{IAEA-LAB}$, $T_4 = \text{ORNL-FIELD}$, and $T_5 = \text{ORNL-LAB}$. In terms of the subsample effects and the treatment effects, the ANOVA model is:

$$Y_{ijk} = u + S_i + T_j + (ST)_{ij} + e_{ijk}$$

where

- Y_{ijk} = the measured value (isotopic atom ratio or concentration);
- u = the overall mean;
- S_i = the subsample effects, $i = 1,2,3$;
- T_j = the treatment effects, $j = 1,2,\dots,5$;
- $(ST)_{ij}$ = the interaction of the subsample and treatment effects; and
- e_{ijk} = the random error terms assumed to be independent, and identically distributed as a normal distribution with zero mean and constant variance, $k = 1,2,\dots,n_{ij}$.

FIGURE 1. Outline of the treatments and measurements performed on each sample for the resin bead experiment.

The subsample effects are assumed to be random effects and the treatments effects are assumed to be fixed effects. These two assumptions require that the interaction mean squares be used as the error term for testing the significance of the main effects of subsample and treatment. In addition, the mean squares of each main effect were adjusted to account for the unequal number of measurements made on each subsample and treatment before testing for significant effects. The results of testing the significance at the 5% significance level of the sources of variation in the two-way ANOVA model are given in table 1 for plutonium and table 2 for uranium. The results for the plutonium concentration do not include the data for the field-prepared resin beads (IAEA-FIELD and ORNL-FIELD) because these data are obviously outliers.

For both the plutonium and uranium responses, no subsample main effects are significant at the 5% significance level. However, significant interaction for $^{240}\text{Pu}/^{239}\text{Pu}$, $^{234}\text{U}/^{238}\text{U}$, and $^{236}\text{U}/^{238}\text{U}$ indicates variations in the three subsamples within the five treatments. A significant treatment $\times$ subsample interaction means that all five treatments do not increase or decrease in the same manner over the three subsamples. The significant treatment $\times$ subsample interactions from the two-way ANOVA tables are illustrated in figures 2-4 by plotting the average value of each of the five treatments versus the three subsamples. If no interaction was present, the lines connecting the average values would be parallel.

Plutonium Response	Fuel Solution	Sources of Variation			Standard Deviation of Error	Multiple Correlation Coefficient % R ²
		Subsample	Treatment	Interaction		
$\frac{^{238}\text{Pu}}{^{239}\text{Pu}}$	1	NS	S	NS	0.0016	50.4
	2	NS	NS	NS	0.0012	74.9
	3	NS	S	NS	0.0004	65.2
$\frac{^{240}\text{Pu}}{^{239}\text{Pu}}$	1	NS	NS	S	0.0006	74.7
	2	NS	S	NS	0.0009	49.3
	3	NS	NS	S	0.0006	85.0
$\frac{^{241}\text{Pu}}{^{239}\text{Pu}}$	1	NS	S	NS	0.0005	58.9
	2	NS	NS	NS	0.0004	61.5
	3	NS	NS	NS	0.0009	45.5
$\frac{^{242}\text{Pu}}{^{239}\text{Pu}}$	1	NS	NS	NS	0.0003	54.7
	2	NS	S	NS	0.0001	68.1
	3	NS	S	NS	0.0002	52.6
Plutonium* Concentration	1	NS	NS	NS	0.0337	76.8
	2	NS	NS	NS	0.0241	56.1
	3	NS	S	NS	0.0158	73.2

*Does not include the data from field-prepared resin beads.

Table 1. The 5% significant (S) and nonsignificant (NS) sources of variation in the two-way ANOVA model for the plutonium response data.

Uranium Response	Fuel Solution	Sub-Sample	Treatment	Interaction	Standard Deviation of Error	Multiple Correlation Coefficient %R ²
$\frac{^{234}\text{U}}{^{238}\text{U}}$	1	NS	S	S	0.0012	94.0
	2	NS	NS	S	0.0002	80.6
	3	NS	S	NS	0.0007	54.4
$\frac{^{235}\text{U}}{^{238}\text{U}}$	1	NS	S	NS	0.0047	50.3
	2	NS	NS	NS	0.0018	68.0
	3	NS	NS	NS	0.0017	55.4
$\frac{^{236}\text{U}}{^{238}\text{U}}$	1	NS	NS	S	0.0014	68.6
	2	NS	NS	NS	0.0014	51.4
	3	NS	S	NS	0.0006	51.1
Uranium Concentration	1	NS	NS	NS	0.0062	56.4
	2	NS	NS	NS	0.0036	74.4
	3	NS	S	NS	0.0103	49.2

TABLE 2. The 5% significant (S) and nonsignificant (NS) sources of variation in the two-way ANOVA model for the uranium response data.

FIGURE 2: Plot of the $^{240}\text{Pu}/^{239}\text{Pu}$ average values for treatment versus subsample to illustrate treatment $\times$ subsample interaction

FIGURE 3. Plot of the $^{234}\text{U}/^{238}\text{U}$ average values for treatment versus subsample to illustrate treatment $\times$ subsample interaction

FIGURE 4. Plot of the $^{236}\text{U}/^{238}\text{U}$ average values for treatment versus subsample to illustrate treatment $\times$ subsample interaction

For $^{240}\text{Pu}/^{239}\text{Pu}$ in fuel solution 1, the average values of IAEA-FIELD and ORNL-LAB increased from subsample 1 to subsample 2 while ORNL-FIELD, IAEA-LAB, and IAEA-AVCO decreased. From subsample 2 to subsample 3, the average values of ORNL-FIELD AND ORNL-LAB increased, and the average values of IAEA-FIELD, IAEA-LAB, and IAEA-AVCO decreased. No one treatment or subsample can be assigned the cause of the significant interaction for $^{240}\text{Pu}/^{239}\text{Pu}$ in fuel solution 1. For fuel solution 3, the significant treatment $\times$ subsample interaction for $^{240}\text{Pu}/^{239}\text{Pu}$ (figure 2) appears to be due to treatment ORNL-FIELD which rapidly increases over the three subsamples and to treatments IAEA-FIELD and IAEA-AVCO which rapidly decrease from subsample 2 to subsample 3.

Figure 3 shows the significant interaction for $^{234}\text{U}/^{238}\text{U}$ in fuel solution 1 is due to the high average values in subsample 1 of treatments ORNL-FIELD and IAEA-FIELD. In fuel solution 2, the significant interaction is due to the unusual behavior of all the treatments in subsample 2, especially treatments ORNL-FIELD and IAEA-AVCO.

The significant interaction for $^{236}\text{U}/^{238}\text{U}$ in fuel solution 1 is not caused by any one particular treatment or subsample. Figure 4 shows that the average values of $^{236}\text{U}/^{238}\text{U}$ may either increase or decrease depending on both the treatment and subsample considered.

The five cases of significant interaction should be studied if inconsistent results occur when comparing differences among the treatment means. To examine treatment means more closely and because no significant subsample effect exists, a one-way ANOVA model

$$Y_{ij} = u + T_i + e_{ij}; i = 1, 2, \dots, 5; j = 1, 2, \dots, n_i,$$

was used to make treatment comparisons. There were three treatment comparisons made at the 5% significance level using the five treatments:

1. Are the IAEA measurements significantly different from ORNL measurements?

$$H_0: \text{IAEA-FIELD vs. ORNL-FIELD or } T_2 - T_4 = 0.$$

2. Are the measurements of field-prepared resin beads significantly different from those of the laboratory-prepared resin beads irrespective of where they were analyzed?

$$H_0: (\text{IAEA-FIELD} + \text{ORNL-FIELD}) \text{ vs. } (\text{IAEA-LAB} + \text{ORNL-LAB}) \text{ or } T_2 + T_4 - T_3 - T_5 = 0.$$

3. Are the resin bead measurements significantly different from the conventional measurements?

$$H_0: (\text{IAEA-AVCO}) \text{ vs. } (\text{IAEA-FIELD} + \text{IAEA-LAB} + \text{ORNL-FIELD} + \text{ORNL-LAB}) \text{ or } T_1 - 1/4(T_2 + T_3 + T_4 + T_5) = 0.$$

The results of these three treatment comparisons are given in table 3 for plutonium and table 4 for uranium. The test of significance treatment comparisons were based on the estimated standard deviation of the error term for the one-way ANOVA model and these estimated standard deviations are also reported in table 3 and table 4.

Response	Fuel Solution	IAEA-FIELD vs. ORNL-FIELD	FIELD Resin Beads vs. LAB Resin Beads	Resin Beads vs. AVCO	Standard Deviation of Error
$\frac{^{238}\text{Pu}}{^{239}\text{Pu}}$	1	NS	NS	S	0.0015
	2	NS	NS	S	0.0014
	3	NS	S	S	0.0004
$\frac{^{240}\text{Pu}}{^{239}\text{Pu}}$	1	S	NS	NS	0.0008
	2	S	S	NS	0.0008
	3	S	S	S	0.0008
$\frac{^{241}\text{Pu}}{^{239}\text{Pu}}$	1	S	NS	S	0.0005
	2	S	NS	NS	0.0004
	3	NS	NS	NS	0.0009
$\frac{^{242}\text{Pu}}{^{238}\text{Pu}}$	1	S	NS	NS	0.0003
	2	S	S	S	0.0001
	3	NS	S	NS	0.0001
Plutonium* Concen- tration	1	--	--	--	0.0429
	2	--	--	--	0.0254
	3	--	--	--	0.0166

*Does not include the data from field-prepared resin beads.

TABLE 3. The 5% significant (S) and nonsignificant (NS) treatment comparisons using a one-way ANOVA model for the plutonium response data.

Response	Fuel Solution	IAEA-FIELD vs. ORNL-FIELD	FIELD Resin Beads vs. LAB Resin Beads	Resin Beads vs. AVCO	Standard Deviation of Error
$\frac{^{234}\text{U}}{^{238}\text{U}}$	1	S	S	S	0.0021
	2	NS	NS	NS	0.0003
	3	NS	NS	S	0.0006
$\frac{^{235}\text{U}}{^{238}\text{U}}$	1	NS	NS	NS	0.0041
	2	S	NS	NS	0.0020
	3	S	NS	NS	0.0016
$\frac{^{236}\text{U}}{^{238}\text{U}}$	1	NS	NS	NS	0.0017
	2	NS	NS	NS	0.0004
	3	NS	NS	NS	0.0006
Uranium Concen- tration	1	NS	NS	NS	0.0070
	2	NS	S	NS	0.0043
	3	NS	NS	NS	0.0085

TABLE 4. The 5% significant (S) and nonsignificant (NS) treatment comparisons using a one-way ANOVA model for the uranium response data.

In addition to the above treatment comparisons, Duncan's multiple range test [4] with Kramer's adjustment for unequal frequencies [2] was applied to test which of the five treatments were significantly different at the 5% significance level. The treatment means are arranged in order from largest to smallest. The test is then performed for each treatment using the estimated standard deviations from that one-way analysis of variance. The results are presented in table 5 for plutonium and table 6 for uranium by a series of vertical lines to the right of each treatment mean. If two treatment means are connected by the same vertical line, then they are not significantly different. If no line connects the two treatment means, then those two means are significantly different. Caution must be exercised when interpreting those results that have significant interaction terms in the two-way ANOVA ($^{240}\text{Pu}/^{239}\text{Pu}$, $^{234}\text{U}/^{238}\text{U}$, and $^{236}\text{U}/^{238}\text{U}$).

Duncan's multiple range test indicates statistical differences based on the standard deviations of error in tables 3 and 4 and may indicate statistical differences due to the small error term. But in many cases the practical differences among treatment means are not significant. Statistical significant differences among the treatment means (e.g., $^{242}\text{Pu}/^{239}\text{Pu}$ in fuel solution 2) may also be due to unequal sample sizes. These unequal sample sizes affect the standard deviation of each treatment mean and must be considered when comparisons among treatment means are made. The ranking of the treatment means is another important consideration. For example, the ranking of the means for plutonium concentration is always IAEA-LAB, IAEA-AVCO, and ORNL-LAB as the high, middle, and low values in each of the three fuel solutions while for other measurements the treatment means change rankings for the different fuel solutions.

Plutonium Response	TREATMENT MEANS ^(a)					
	Fuel Solution 1		Fuel Solution 2		Fuel Solution 3	
$\frac{^{238}\text{Pu}}{^{239}\text{Pu}}$	IAEA-AVCO	0.0232	IAEA-AVCO	0.0067	IAEA-AVCO	0.0034
	IAEA-FIELD	0.0208	ORNL-LAB	0.0036	IAEA-FIELD	0.0031
	IAEA-LAB	0.0208	IAEA-FIELD	0.0033	ORNL-FIELD	0.0030
	ORNL-FIELD	0.0208	ORNL-FIELD	0.0033	ORNL-LAB	0.0028
	ORNL-LAB	0.0206	IAEA-LAB	0.0030	IAEA-LAB	0.0023
$\frac{^{240}\text{Pu}}{^{239}\text{Pu}}$	ORNL-FIELD	0.3726	ORNL-FIELD	0.3988	ORNL-FIELD	0.4016
	ORNL-LAB	0.3725	ORNL-LAB	0.3981	ORNL-LAB	0.4010
	IAEA-FIELD	0.3715	IAEA-FIELD	0.3978	IAEA-FIELD	0.4003
	IAEA-AVCO	0.3714	IAEA-AVCO	0.3974	IAEA-AVCO	0.3998
	IAEA-LAB	0.3712	IAEA-LAB	0.3972	IAEA-LAB	0.3995
$\frac{^{241}\text{Pu}}{^{239}\text{Pu}}$	IAEA-AVCO	0.1775	ORNL-FIELD	0.0627	IAEA-LAB	0.0649
	ORNL-FIELD	0.1772	ORNL-LAB	0.0625	IAEA-FIELD	0.0648
	ORNL-LAB	0.1769	IAEA-AVCO	0.0623	ORNL-LAB	0.0647
	IAEA-FIELD	0.1766	IAEA-FIELD	0.0623	ORNL-FIELD	0.0647
	IAEA-LAB	0.1766	IAEA-LAB	0.0621	IAEA-AVCO	0.0641
$\frac{^{242}\text{Pu}}{^{239}\text{Pu}}$	ORNL-LAB	0.0633	ORNL-FIELD	0.0255	ORNL-FIELD	0.0228
	ORNL-FIELD	0.0633	ORNL-LAB	0.0253	ORNL-LAB	0.0227
	IAEA-AVCO	0.0631	IAEA-FIELD	0.0253	IAEA-FIELD	0.0227
	IAEA-FIELD	0.0629	IAEA-LAB	0.0252	IAEA-AVCO	0.0226
	IAEA-LAB	0.0628	IAEA-AVCO	0.0252	IAEA-LAB	0.0225
Plutonium Concentration	IAEA-LAB	7.1109	IAEA-LAB	3.6253	IAEA-LAB	3.8654
	IAEA-AVCO	7.0625	IAEA-AVCO	3.6026	IAEA-AVCO	3.8593
	ORNL-LAB	7.0318	ORNL-LAB	3.5944	ORNL-LAB	3.8282
b	WAK	6.7930	WAK	3.5760	WAK	3.8220

^aIf two treatment means are connected by the same vertical line, then they are not significantly different. If no line connects the two treatment means, then those two means are significantly different.

^bField-prepared resin beads and WAK results are not used in this analysis. The sampling dates for the resin bead experiment do not coincide with the WAK sampling dates.

TABLE 5. Duncan's multiple range test at the 5% significance level for treatment means of the plutonium response data.

Uranium Response	TREATMENT MEANS ^(a)					
	Fuel Solution 1		Fuel Solution 2		Fuel Solution 3	
$\frac{^{234}\text{U}}{^{238}\text{U}}$	ORNL-FIELD	0.0283	IAEA-FIELD	0.0047	ORNL-LAB	0.0054
	IAEA-FIELD	0.0242	ORNL-LAB	0.0046	IAEA-FIELD	0.0048
	IAEA-LAB	0.0209	IAEA-LAB	0.0046	ORNL-FIELD	0.0045
	ORNL-LAB	0.0205	IAEA-AVCO	0.0044	IAEA-LAB	0.0045
	IAEA-AVCO	0.0203	ORNL-FIELD	0.0043	IAEA-AVCO	0.0042
$\frac{^{235}\text{U}}{^{238}\text{U}}$	IAEA-LAB	1.1537	IAEA-FIELD	0.2988	IAEA-LAB	0.2507
	IAEA-FIELD	1.1517	IAEA-LAB	0.2977	IAEA-FIELD	0.2582
	IAEA-AVCO	1.1507	IAEA-AVCO	0.2972	ORNL-LAB	0.2580
	ORNL-FIELD	1.1478	ORNL-LAB	0.2958	IAEA-AVCO	0.2567
	ORNL-LAB	1.1450	ORNL-FIELD	0.2955	ORNL-FIELD	0.2559
$\frac{^{236}\text{U}}{^{238}\text{U}}$	IAEA-LAB	0.3793	IAEA-LAB	0.0658	ORNL-LAB	0.0723
	ORNL-FIELD	0.3792	IAEA-FIELD	0.0655	IAEA-FIELD	0.0719
	IAEA-FIELD	0.3782	IAEA-AVCO	0.0655	IAEA-LAB	0.0716
	IAEA-AVCO	0.3774	ORNL-LAB	0.0654	ORNL-FIELD	0.0713
	ORNL-LAB	0.3771	ORNL-FIELD	0.0653	IAEA-AVCO	0.0713
Uranium Concentration	IAEA-FIELD	0.8721	IAEA-FIELD	1.1290	ORNL-FIELD	1.1098
	ORNL-FIELD	0.8721	ORNL-FIELD	1.1284	ORNL-LAB	1.1088
	IAEA-AVCO	0.8698	IAEA-AVCO	1.1281	IAEA-AVCO	1.1054
	ORNL-LAB	0.8695	ORNL-LAB	1.1241	IAEA-FIELD	1.1016
	IAEA-LAB	0.8665	IAEA-LAB	1.1202	IAEA-LAB	1.0917
b	WAK	0.8539	WAK	1.1230	WAK	1.0990

^aIf two treatment means are connected by the same vertical line, then they are not significantly different. If no line connects the two treatment means, then those two means are significantly different.

^bData not used in this analysis.

TABLE 6. Duncan's multiple range test at the 5% significance level for treatment means of the uranium response data.

4. Summary

A statistical analysis of the data from the resin bead experiment has been made to detect sources of variation among the measurements of isotopic atom ratios and elemental concentrations of plutonium and uranium. A two-way analysis of variance indicated no significant differences at the 5% significance level among the three subsamples in each fuel solution but some interactions between subsamples and treatment effects were noted. Additional treatment comparisons were made using a one-way analysis of variance with differences among treatment means tabulated using Duncan's multiple range test.

5. Acknowledgments

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6. References

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7. APPENDIX

TABLE A-- DATA FOR ISOTOPIC ATOM RATIOS OF PLUTONIUM AND PLUTONIUM CONCENTRATIONS
FOR THE RESIN BEAD EXPERIMENT--ADJUSTED TO THE SAMPLING DATE

LAB=IAEA METHOD=AVCO

F U E L	ISOTOPIC		S A M P L E					PLUTONIUM CONCEN- TRATION (μ g/g)	ELEMENTAL	
	M.S. DATE	TEMP ($^{\circ}$ C)		Pu 238 Pu 239	Pu 240 Pu 239	Pu 241 Pu 239	Pu 242 Pu 239		M.S. DATE	TEMP ($^{\circ}$ C)
1	10APR79	.	1	0.0209	0.3721	0.1773	0.0631	7.0679	01MAR79	.
1	31JAN79	.	1	0.0211	0.3724	0.1773	0.0630	7.0659	01JAN79	.
1	10APR79	.	2	0.0286	0.3715	0.1775	0.0633	7.0357	02MAR79	.
1	31JAN79	.	2	0.0210	0.3713	0.1771	0.0631	7.0639	02MAR79	.
1	11APR79	.	3	0.0210	0.3714	0.1778	0.0631	7.0709	05MAR79	.
1	15MAY79	.	3	0.0267	0.3695	0.1782	0.0632	7.0709	05MAR79	.
2	09APR79	.	1	0.0040	0.3972	0.0619	0.0251	3.6111	05MAR79	.
2	14MAY79	.	1	0.0047	0.3978	0.0628	0.0251	3.5981	05MAR79	.
2	10APR79	.	2	0.0061	0.3977	0.0623	0.0252	3.6021	05MAR79	.
2	14MAY79	.	2	0.0120	0.3970	0.0624	0.0252	3.6071	05MAR79	.
2	.	.	3	.	.	.	.	3.5941	06MAR79	.
2	.	.	3	.	.	.	.	3.6031	07MAR79	.
3	11APR79	.	1	0.0031	0.4003	0.0643	0.0226	3.8706	07MAR79	.
3	11MAY79	.	1	0.0040	0.4007	0.0644	0.0226	3.8907	07MAR79	.
3	09APR79	.	2	0.0038	0.4006	0.0640	0.0227	3.9466	08MAR79	.
3	12APR79	.	2	0.0032	0.4000	0.0644	0.0226	3.8486	08MAR79	.
3	10APR79	.	3	0.0029	0.3980	0.0641	0.0226	3.8566	08MAR79	.
3	14MAY79	.	3	0.0032	0.3990	0.0637	0.0226	3.8426	08MAR79	.

TABLE A-1--(Continued)
LAB=IAEA METHOD=FIELD

F U E L	ISOTOPIC		S A M P L E					PLUTONIUM CONCEN- TRATION ($\mu\text{g/g}$)	ELEMENTAL	
	M.S. DATE	TEMP ($^{\circ}\text{C}$)		Pu 238 Pu 239	Pu 240 Pu 239	Pu 241 Pu 239	Pu 242 Pu 239		M.S. DATE	TEMP ($^{\circ}\text{C}$)
1	28NOV78	1500	1	0.0207	0.3712	0.1762	0.0624	9.3014	28NOV78	1490
1	08DEC78	1500	1	0.0207	0.3703	0.1760	0.0627	9.2653	08DEC78	1510
1	28NOV78	1450	2	0.0209	0.3729	0.1770	0.0637	8.8277	30NOV78	1510
1	08DEC78	1480	2	0.0208	0.3711	0.1762	0.0625	8.8337	11DEC78	1490
1	29NOV78	1530	3	0.0208	0.3716	0.1770	0.0631	8.7293	29NOV78	1480
1	11DEC78	1430	3	0.0208	0.3720	0.1773	0.0627	8.7394	11DEC78	1510
2	30NOV78	1500	1	0.0037	0.3983	0.0626	0.0253	3.0982	30NOV78	1470
2	12DEC78	1490	1	0.0031	0.3964	0.0618	0.0251	3.1232	13DEC78	1450
2	25JAN79	1540	1	0.0027	0.3981	0.0622	0.0252	.	.	.
2	12DEC78	1500	2	0.0043	0.3977	0.0627	0.0252	3.0321	04DEC78	1480
2	19DEC78	1550	2	0.0027	0.3973	0.0621	0.0253	3.0451	12DEC78	1540
2	19DEC78	1600	2	0.0026	0.3993	0.0625	0.0255	.	.	.
2	04DEC78	.	3	0.0035	0.3970	0.0618	0.0252	3.0331	05DEC78	1440
2	13DEC78	1530	3	0.0036	0.3981	0.0626	0.0254	3.0812	14DEC78	1500
2	.	.	3	.	.	.	.	3.0291	19DEC78	1500
2	.	.	3	.	.	.	.	3.0351	19DEC78	1490
3	05DEC78	1510	1	0.0035	0.4011	0.0653	0.0230	1.2633	05DEC78	1490
3	14DEC78	1540	1	0.0027	0.4010	0.0642	0.0228	1.3184	15DEC78	1540
3	03JAN79	1500	1	0.0033	0.4002	0.0659	0.0226	1.3094	03JAN79	1490
3	06DEC78	1560	2	0.0031	0.4000	0.0643	0.0224	1.5736	07DEC78	1470
3	07DEC78	1520	2	0.0032	0.4018	0.0648	0.0228	1.5796	04JAN79	1460
3	15DEC78	1540	2	0.0031	0.4004	0.0650	0.0227	1.5516	08JAN79	1455
3	06DEC78	1470	3	0.0032	0.3987	0.0645	0.0227	1.5726	07DEC78	1500
3	18DEC78	1500	3	0.0028	0.3992	0.0645	0.0224	1.5916	18DEC78	1540
3	.	.	3	.	.	.	.	1.5816	04JAN79	1445

TABLE A-1--(Continued)

LAB=IAEA METHOD=LAB

F U E L	ISOTOPIC		S A M P L E	PLUTONIUM				CONCENTRATION (µg/g)	ELEMENTAL	
	M.S. DATE	TEMP (°C)		Pu 238 Pu 239	Pu 240 Pu 239	Pu 241 Pu 239	Pu 242 Pu 239		M.S. DATE	TEMP (°C)
1	05JAN79	1505	1	0.0209	0.3707	0.1761	0.0626	7.0453	11JAN79	1460
1	08JAN79	1450	1	0.0208	0.3705	0.1775	0.0629	7.0523	18JAN79	1540
1	.	.	1	.	.	.	.	7.1256	22JAN79	1515
1	05JAN79	1490	2	0.0208	0.3711	0.1766	0.0630	7.1266	10JAN79	1490
1	09JAN79	1480	2	0.0209	0.3719	0.1757	0.0623	7.2030	18JAN79	1490
1	22JAN79	1590	2	0.0204	0.3724	0.1774	0.0634	7.1768	23JAN79	1500
1	08JAN79	1500	3	0.0207	0.3706	0.1766	0.0629	7.0373	10JAN79	1540
1	09JAN79	1475	3	0.0208	0.3713	0.1761	0.0625	7.1206	18JAN79	1495
2	10JAN79	1470	1	0.0036	0.3967	0.0620	0.0251	3.5892	11JAN79	1500
2	16JAN79	1510	1	0.0028	0.3984	0.0626	0.0252	3.6703	18JAN79	1530
2	.	.	1	.	.	.	.	3.6353	23JAN79	1450
2	11JAN79	1500	2	0.0036	0.3966	0.0617	0.0251	3.5902	11JAN79	1490
2	16JAN79	1530	2	0.0038	0.3975	0.0621	0.0253	3.5812	19JAN79	1490
2	12JAN79	1455	3	0.0031	0.3971	0.0618	0.0252	3.6273	.	1495
2	16JAN79	1495	3	0.0026	0.3967	0.0618	0.0250	3.6203	12JAN79	1490
2	26JAN79	1490	3	0.0016	0.3973	0.0624	0.0252	3.6883	19JAN79	1510
3	12JAN79	1550	1	0.0029	0.4007	0.0644	0.0228	3.8548	12JAN79	1550
3	26JAN79	1470	1	0.0020	0.3991	0.0683	0.0225	3.8898	19JAN79	1460
3	15JAN79	1510	2	0.0029	0.3993	0.0637	0.0225	3.8267	15JAN79	1470
3	26JAN79	1510	2	0.0017	0.3999	0.0639	0.0222	3.8798	22JAN79	1480
3	15JAN79	1510	3	0.0026	0.3989	0.0642	0.0224	3.8698	15JAN79	1530
3	17JAN79	1495	3	0.0017	0.3994	0.0656	0.0227	3.8638	22JAN79	1470
3	26JAN79	1515	3	0.0021	0.3993	0.0645	0.0225	3.8728	26JAN79	1470

TABLE A-1--(Continued)
LAB=ORNL METHOD=FIELD

F U E L	ISOTOPIC		S A M P L E					PLUTONIUM CONCEN- TRATION (μg/g)	ELEMENTAL	
	M.S. DATE	TEMP (°C)		Pu 238 Pu 239	Pu 240 Pu 239	Pu 241 Pu 239	Pu 242 Pu 239		M.S. DATE	TEMP (°C)
1	27SEP78	1420	1	0.0207	0.3721	0.1770	0.0633	8.7496	27SEP78	1415
1	27SEP78	1420	1	0.0206	0.3733	0.1775	0.0634	8.7496	27SEP78	1420
1	01NOV78	1410	1	0.0207	0.3724	0.1768	0.0633	.	.	.
1	01NOV78	1470	1	0.0207	0.3718	0.1773	0.0629	.	.	.
1	06OCT78	1455	2	0.0208	0.3723	0.1771(a)	0.0629	8.6182	06OCT78	1415
1	06OCT78	1470	2	0.0207	0.3723	0.1772	0.0633	8.5861	06OCT78	1435
1	10OCT78	1435	3	0.0208	0.3732	0.1781	0.0636	8.6754	10OCT78	1440
1	10OCT78	1425	3	0.0210	0.3735	0.1768	0.0633	8.7286	10OCT78	1435
2	04OCT78	1620	1	0.0031	0.4005	0.0627	0.0257	3.2012	04OCT78	1410
2	04OCT78	1550	1	0.0023	0.3979	0.0624	0.0253	3.2182	04OCT78	1440
2	13OCT78	1570	2	0.0037	0.3982	0.0623	0.0255	3.0271	16OCT78	1355
2	16OCT78	1575	2	0.0025	0.3994	0.0625	0.0256	3.0041	16OCT78	1365
2	18OCT78	1585	3	0.0042	0.3980	0.0632	0.0254	2.5988	18OCT78	1500
2	18OCT78	1485	3	0.0038	0.3987	0.0634	0.0252	2.5918	18OCT78	1485
3	20OCT78	1540	1	0.0035	0.4017	0.0647	0.0228	1.3891	23OCT78	1435
3	20OCT78	1530	1	0.0033	0.4010	0.0647	0.0228	1.2249	23OCT78	1430
3	.	.	1	.	.	.	.	1.3020	07NOV78	1435
3	.	.	1	.	.	.	.	1.2379	07NOV78	1500
3	26OCT78	1530	2	0.0037	0.4015	0.0647(a)	0.0227	1.6353	26OCT78	1520
3	26OCT78	1560	2	0.0026	0.4010	0.0649	0.0227	1.5382	26OCT78	1460
3	.	.	2	.	.	.	.	1.5592	02NOV78	1440
3	.	.	2	.	.	.	.	1.5522	03NOV78	1440
3	30OCT78	1510	3	0.0022	0.4024	0.0647	0.0229	1.5262	30OCT78	1450
3	30OCT78	1525	3	0.0027	0.4021	0.0645	0.0228	1.5232	30OCT78	1450
3	.	.	3	.	.	.	.	1.5292	02NOV78	1485

TABLE A-1--(Continued)

LAB=ORNLMETHOD=LAB

F U E L	<u>ISOTOPIC</u>		S A M P L E					PLUTONIUM CONCEN- TRATION ($\mu\text{g/g}$)	<u>ELEMENTAL</u>	
	M.S. DATE	TEMP ($^{\circ}\text{C}$)		Pu 238 Pu 239	Pu 240 Pu 239	Pu 241 Pu 239	Pu 242 Pu 239		M.S. DATE	TEMP ($^{\circ}\text{C}$)
1	16NOV78	1450	1	0.0205	0.3728	0.1776	0.0636	7.0135	05DEC78	1455
1	16NOV78	1440	1	0.0207	0.3727	0.1768	0.0634	7.0035	05DEC78	1480
1	16NOV78	1505	2	0.0207	0.3724	0.1761	0.0631	7.0486	05DEC78	1495
1	16NOV78	1520	2	0.0209	0.3711	0.1767	0.0628	7.0637	05DEC78	1480
1	16NOV78	1415	3	0.0207	0.3729	0.1776	0.0635	7.0577	05DEC78	1530
1	20NOV78	1470	3	0.0203	0.3728	0.1768	0.0635	7.0035	07DEC78	1440
2	20NOV78	1455	1	0.0037	0.3986	0.0622	0.0255	3.5922	07DEC78	1420
2	20NOV78	1455	1	0.0037	0.3979	0.0623	0.0254	3.5892	07DEC78	1420
2	20NOV78	1485	2	0.0030	0.3986	0.0622	0.0253	3.5952	07DEC78	1405
2	20NOV78	1445	2	0.0037	0.3985	0.0623	0.0254	3.5942	07DEC78	1420
2	27NOV78	1500	3	0.0036	0.3969	0.0633 ^(a)	0.0252	3.6052	13FEB79	1485
2	27NOV78	1485	3	0.0036	0.3980	0.0625	0.0252	3.5902	13FEB79	1515
3	27NOV78	1465	1	0.0026	0.4001	0.0666	0.0226	3.8196	11DEC78	1485
3	27NOV78	1475	1	0.0028	0.4007	0.0643	0.0228	3.3257	11DEC78	1485
3	30NOV78	1485	2	0.0024	0.4014	0.0644	0.0228	3.3347	13DEC78	1460
3	30NOV78	1525	2	0.0026	0.4011	0.0644	0.0226	3.3277	13DEC78	1425
3	30NOV78	1510	3	0.0035	0.4015	0.0647	0.0228	3.3377	13DEC78	1450
3	30NOV78	1555	3	0.0030	0.4010	0.0640	0.0226	3.3237	13DEC78	1460

(a) Original outlier data point replaced by average value.

TABLE A-2 DATA FOR ISOTOPIC ATOM RATIOS OF URANIUM AND URANIUM CONCENTRATIONS
FOR THE RESIN BEAD EXPERIMENT

LAB=IAEA METHOD=AVCO

F U E L	ISOTOPIC		S A M P L E				URANIUM CONCEN- TRATION (mg/g)	ELEMENTAL	
	M.S. DATE	TEMP (°C)		U 234 U 238	U 235 U 238	U 236 U 238		M.S. DATE	TEMP (°C)
1	12DEC78	.	1	0.0196	1.149	0.3733	0.8706	14MAR79	.
1	13DEC78	.	1	0.0211	1.150	0.3768	0.8665	14MAR79	.
1	13DEC78	.	2	0.0201	1.149	0.3780	0.8701	14MAR79	.
1	13DEC78	.	2	0.0203	1.153	0.3796	0.8689	14MAR79	.
1	13DEC78	.	3	0.0202	1.149	0.3783	0.8709	14MAR79	.
1	14DEC78	.	3	0.0205	1.154	0.3782	0.8716	14MAR79	.
2	14DEC78	.	1	0.0042	0.298	0.0653	1.1229	16MAR79	.
2	14DEC78	.	1	0.0039	0.295	0.0651	1.1296	19MAR79	.
2	14DEC78	.	2	0.0053	0.299	0.0662	1.1288	16MAR79	.
2	14DEC78	.	2	0.0049	0.297	0.0655	1.1284	16MAR79	.
2	14DEC78	.	3	0.0040	0.297	0.0652	1.1307	19MAR79	.
2	15DEC78	.	3	0.0040	0.297	0.0657	1.1307	20MAR79	.
2	.	.	3	.	.	.	1.1258	19MAR79	.
3	18DEC78	.	1	0.0040	0.257	0.0714	1.1013	26MAR79	.
3	18DEC78	.	1	0.0050	0.258	0.0712	1.1046	26MAR79	.
3	18DEC78	.	2	0.0040	0.257	0.0716	1.1065	20MAR79	.
3	18DEC78	.	2	0.0040	0.257	0.0714	1.1098	22MAR79	.
3	18DEC78	.	3	0.0039	0.256	0.0713	1.1027	22MAR79	.
3	18DEC78	.	3	0.0040	0.255	0.0710	1.1075	23MAR79	.

TABLE A-2--(Continued)
LAB=IAEA METHOD=FIELD

F U E L	<u>ISOTOPIC</u>		S A M P L E				URANIUM CONCEN- TRATION (mg/g)	<u>ELEMENTAL</u>	
	M.S. DATE	TEMP (°C)		<u>U 234</u> <u>U 238</u>	<u>U 235</u> <u>U 238</u>	<u>U 236</u> <u>U 238</u>		M.S. DATE	TEMP (°C)
1	.	1790	1	0.0246	1.155	0.3810	0.8729	.	1770
1	.	1830	1	0.0260	1.148	0.3790	0.8792	.	1760
1	.	1720	2	0.0235	1.148	0.3770	0.8790	.	1770
1	.	1740	2	0.0236	1.154	0.3790	0.8629	.	1790
1	.	1780	3	0.0220	1.154	0.3760	0.8784	.	1750
1	.	1800	3	0.0257	1.151	0.3770	0.8603	.	1820
2	.	1730	1	0.0048	0.298	0.0647	1.1345	.	1740
2	.	1720	1	0.0047	0.304	0.0653	1.1309	.	1730
2	.	1770	2	0.0044	0.299	0.0656	1.1327	.	1720
2	.	1730	2	0.0045	0.301	0.0663	1.1199	.	1720
2	.	1730	3	0.0049	0.296	0.0654	1.1282	.	1760
2	.	1730	3	0.0047	0.295	0.0659	1.1276	.	1790
3	.	1760	1	0.0060	0.258	0.0718	1.1115	.	1830
3	.	1770	1	0.0047	0.258	0.0722	1.0849	.	1790
3	.	1730	2	0.0047	0.258	0.0713	1.1215	.	1730
3	.	1780	2	0.0046	0.261	0.0727	1.0884	.	1750
3	.	1720	3	0.0046	0.255	0.0712	1.1166	.	1810
3	.	1740	3	0.0043	0.259	0.0722	1.0869	.	1800

TABLE A-2--(Continued)

LAB=IAEA METHOD=LAB

F U E L	ISOTOPIC		S A M P L E				URANIUM CONCEN- TRATION (mg/g)	ELEMENTAL	
	M.S. DATE	TEMP (°C)		U 234 U 238	U 235 U 238	U 236 U 238		M.S. DATE	TEMP (°C)
1	.	.	1	.	.	.	0.8578	.	1730
1	.	1795	1	0.0205	1.152	0.3770	0.8583	.	1750
1	.	1780	1	0.0215	1.151	0.3780	0.8713	.	1730
1	.	1650	2	0.0210	1.150	0.3790	0.8834	.	1780
1	.	1780	2	0.0209	1.150	0.3790	0.8666	.	1740
1	.	1720	2	0.0206	1.165	0.3810	0.8823	.	1790
1	.	.	3	0.0214	1.157	0.3830	0.8582	.	1775
1	.	1750	3	0.0207	1.151	0.3780	0.8543	.	1820
2	.	1740	1	0.0046	0.299	0.0656	1.1286	.	1790
2	.	1870	1	0.0046	0.297	0.0658	1.1205	.	1720
2	.	1720	2	0.0047	0.299	0.0660	1.1253	.	1710
2	.	1720	2	0.0046	0.298	0.0656	1.1223	.	1650
2	.	1650	3	0.0046	0.296	0.0661	1.1149	.	1820
2	.	1730	3	0.0045	0.297	0.0654	1.1095	.	1790
3	.	1790	1	0.0044	0.258	0.0714	1.0994	.	1800
3	.	1720	1	0.0044	0.258	0.0709	1.0936	.	1740
3	.	1750	2	0.0046	0.259	0.0715	1.0973	.	1780
3	.	1730	2	0.0045	0.257	0.0722	1.0810	.	1725
3	.	1735	3	0.0046	0.260	0.0720	1.0922	.	1750
3	.	1710	3	0.0045	0.260	0.0716	1.0867	.	1760

TABLE A-2--(Continued)
LA3=ORNL METHOD=FIELD

F U E L	<u>ISOTOPIE</u>		S A M P L E				URANIUM CONCEN- TRATION (mg/g)	<u>ELEMENTAL</u>	
	M.S. DATE	TEMP (°C)		<u>U 234</u> <u>U 238</u>	<u>U 235</u> <u>U 238</u>	<u>U 236</u> <u>U 238</u>		M.S. DATE	TEMP (°C)
1	28SEP78	1925	1	0.0339	1.1560	0.3787	0.8719	28SEP78	.
1	28SEP78	1830	1	0.0314	1.1440	0.3812	0.8729	27SEP78	.
1	02NOV78	1755	1	0.0283	1.1450	0.3788	.	.	.
1	02NOV78	1770	1	0.0328	1.1540	0.3808	.	.	.
1	09OCT78	1750	2	0.0251	1.1430	0.3773	0.8688	09OCT78	.
1	09OCT78	1745	2	0.0254	1.1460	0.3794	0.8749	09OCT78	.
1	11OCT78	1760	3	0.0247	1.1500	0.3791	0.8719	11OCT78	.
1	11OCT78	1770	3	0.0246	1.1440	0.3785	0.8719	11OCT78	.
2	05OCT78	1740	1	0.0045	0.2944	0.0656	1.1293	05OCT78	.
2	05OCT78	1745	1	0.0046	0.2940	0.0655	1.1267	05OCT78	.
2	16OCT78	1720	2	0.0035	0.2979	0.0646	1.1259	16OCT78	.
2	16OCT78	1710	2	0.0044	0.2957	0.0654	1.1260	16OCT78	.
2	19OCT78	1775	3	0.0044	0.2960	0.0651	1.1325	19OCT78	.
2	19OCT78	1725	3	0.0045	0.2948	0.0657	1.1299	19OCT78	.
3	23OCT78	1770	1	0.0045	0.2562	0.0714	1.1149	23OCT78	.
3	23OCT78	1805	1	0.0044	0.2554	0.0714	1.1095	23OCT78	.
3	27OCT78	1720	2	0.0048	0.2586	0.0718	1.1143	27OCT78	.
3	27OCT78	1785	2	0.0045	0.2544	0.0711	1.1120	27OCT78	.
3	31OCT78	1750	3	0.0044	0.2575	0.0716	1.1049	31OCT78	.
3	31OCT78	1750	3	0.0045	0.2533	0.0707	1.1033	31OCT78	.

TABLE A-2--(Continued)

LAB=ORNL METHOD=LAB

F U E L	M.S. DATE	TEMP (°C)	S A M P L E				URANIUM CONCEN- TRATION (mg/g)	ELEMENTAL	
				<u>U 234</u> <u>U 238</u>	<u>U 235</u> <u>U 238</u>	<u>U 236</u> <u>U 238</u>		M.S. DATE	TEMP (°C)
1	17NOV78	1715	1	0.0202	1.1410	0.3758	0.8709	06DEC78	1765
1	17NOV78	1725	1	0.0204	1.1450	0.3758	0.8699	06DEC78	1795
1	17NOV78	1700	2	0.0203	1.1420	0.3769	0.8683	06DEC78	1915
1	17NOV78	1745	2	0.0203	1.1450	0.3772	0.8673	06DEC78	1870
1	17NOV78	1700	3	0.0206	1.1460	0.3783	0.8700	06DEC78	1805
1	21NOV78	1780	3	0.0212	1.1510	0.3783	0.8707	08DEC78	1810
2	21NOV78	1775	1	0.0047	0.2967	0.0649	1.1235	08DEC78	1780
2	21NOV78	1805	1	0.0048	0.2971	0.0658	1.1242	08DEC78	1760
2	22NOV78	1695	2	0.0044	0.2972	0.0654	1.1233	08DEC78	1740
2	22NOV78	1810	2	0.0048	0.2921	0.0651	1.1233	08DEC78	1710
2	27NOV78	1755	3	0.0045	0.2953	0.0659	1.1213	13FEB79	1835
2	27NOV78	1730	3	0.0045	0.2962	0.0654	1.1287	13FEB79	1835
3	27NOV78	1715	1	0.0045	0.2571	0.0718	1.1126	12DEC78	1825
3	04DEC78	1785	1	0.0075	0.2614	0.0734	1.1064	12DEC78	1790
3	04DEC78	1815	2	0.0055	0.2577	0.0733	1.1059	14DEC78	1800
3	04DEC78	1870	2	0.0049	0.2562	0.0718	1.1106	14DEC78	1765
3	04DEC78	1745	3	0.0046	0.2576	0.0712	1.1093	14DEC78	1780
3	04DEC78	1830	3	0.0054	0.2579	0.0723	1.1080	14DEC78	1800

TABLE A-3 NUMBER OF OBSERVATIONS FOR THE PLUTONIUM DATA

FUEL SOLUTION	LAB	METHOD	$\frac{\text{Pu } 238}{\text{Pu } 239}$	$\frac{\text{Pu } 240}{\text{Pu } 239}$	$\frac{\text{Pu } 241}{\text{Pu } 239}$	$\frac{\text{Pu } 242}{\text{Pu } 239}$	PLUTONIUM CONCENTRATION
1	IAEA	AVCO	6	6	6	6	6
1	IAEA	FIELD	6	6	6	6	6
1	IAEA	LAB	7	7	7	7	8
1	ORNL	FIELD	8	8	8	8	6
1	ORNL	LAB	6	6	6	6	6
2	IAEA	AVCO	4	4	4	4	6
2	IAEA	FIELD	8	8	8	8	8
2	IAEA	LAB	7	7	7	7	8
2	ORNL	FIELD	6	6	6	6	6
2	ORNL	LAB	6	6	6	6	6
3	IAEA	AVCO	6	6	6	6	6
3	IAEA	FIELD	8	8	8	8	9
3	IAEA	LAB	7	7	7	7	7
3	ORNL	FIELD	6	6	6	6	11
3	ORNL	LAB	6	6	6	6	6

TABLE A-4 AVERAGE VALUES FOR THE PLUTONIUM DATA

FUEL SOLUTION	LAB	METHOD	$\frac{\text{Pu } 238}{\text{Pu } 239}$	$\frac{\text{Pu } 240}{\text{Pu } 239}$	$\frac{\text{Pu } 241}{\text{Pu } 239}$	$\frac{\text{Pu } 242}{\text{Pu } 239}$	PLUTONIUM CONCEN- TRATION
1	IAEA	AVCO	.0232	.3714	.1775	.0631	7.063
1	IAEA	FIELD	.0208	.3715	.1766	.0628	8.949
1	IAEA	LAB	.0208	.3712	.1766	.0628	7.111
1	ORNL	FIELD	.0207	.3726	.1772	.0632	8.685
1	ORNL	LAB	.0206	.3724	.1769	.0633	7.032
2	IAEA	AVCO	.0067	.3974	.0623	.0251	3.603
2	IAEA	FIELD	.0033	.3978	.0623	.0253	3.060
2	IAEA	LAB	.0030	.3972	.0621	.0252	3.625
2	ORNL	FIELD	.0033	.3988	.0627	.0254	2.940
2	ORNL	LAB	.0035	.3981	.0625	.0253	3.594
3	IAEA	AVCO	.0034	.3998	.0641	.0226	3.859
3	IAEA	FIELD	.0031	.4003	.0648	.0227	1.482
3	IAEA	LAB	.0023	.3995	.0649	.0225	3.865
3	ORNL	FIELD	.0030	.4016	.0647	.0228	1.456
3	ORNL	LAB	.0028	.4010	.0647	.0227	3.828

TABLE A-5 STANDARD DEVIATIONS FOR THE PLUTONIUM DATA

FUEL SOLUTION	LAB	METHOD	$\frac{\text{Pu } 238}{\text{Pu } 239}$	$\frac{\text{Pu } 240}{\text{Pu } 239}$	$\frac{\text{Pu } 241}{\text{Pu } 239}$	$\frac{\text{Pu } 242}{\text{Pu } 239}$	PLUTONIUM CONCEN- TRATION
1	IAEA	AVCO	.0035	.0010	.0004	.0001	.0134
1	IAEA	FIELD	.0001	.0009	.0005	.0005	.2625
1	IAEA	LAB	.0002	.0007	.0007	.0004	.0616
1	ORNL	FIELD	.0001	.0006	.0004	.0002	.0701
1	ORNL	LAB	.0002	.0007	.0006	.0003	.0280
2	IAEA	AVCO	.0036	.0004	.0004	.0001	.0061
2	IAEA	FIELD	.0006	.0009	.0004	.0001	.0363
2	IAEA	LAB	.0008	.0006	.0003	.0001	.0389
2	ORNL	FIELD	.0008	.0010	.0005	.0002	.2811
2	ORNL	LAB	.0003	.0007	.0004	.0001	.0058
3	IAEA	AVCO	.0004	.0011	.0003	.0000	.0183
3	IAEA	FIELD	.0003	.0010	.0006	.0002	.1402
3	IAEA	LAB	.0005	.0006	.0016	.0002	.0204
3	ORNL	FIELD	.0006	.0006	.0001	.0001	.1424
3	ORNL	LAB	.0004	.0005	.0009	.0001	.0068

TABLE A-6 NUMBER OF OBSERVATIONS FOR THE URANIUM DATA

FUEL SOLUTION	LAB	METHOD	$\frac{U\ 234}{U\ 238}$	$\frac{U\ 235}{U\ 238}$	$\frac{U\ 236}{U\ 238}$	URANIUM CONCEN- TRATION
1	IAEA	AVCO	6	6	6	6
1	IAEA	FIELD	6	6	6	6
1	IAEA	LAB	7	7	7	8
1	ORNL	FIELD	8	8	8	6
1	ORNL	LAB	6	6	6	6
2	IAEA	AVCO	6	6	6	7
2	IAEA	FIELD	6	6	6	6
2	IAEA	LAB	6	6	6	6
2	ORNL	FIELD	6	6	6	6
2	ORNL	LAB	6	6	6	6
3	IAEA	AVCO	6	6	6	6
3	IAEA	FIELD	6	6	6	6
3	IAEA	LAB	6	6	6	6
3	ORNL	FIELD	6	6	6	6
3	ORNL	LAB	6	6	6	6

TABLE A-7 AVERAGE VALUES FOR THE URANIUM DATA

FUEL SOLUTION	LAB	METHOD	$\frac{U\ 234}{U\ 238}$	$\frac{U\ 235}{U\ 238}$	$\frac{U\ 236}{U\ 238}$	URANIUM CONCEN- TRATION
1	IAEA	AVCO	.0203	1.151	.3774	.8698
1	IAEA	FIELD	.0242	1.152	.3782	.8721
1	IAEA	LAB	.0209	1.154	.3793	.8665
1	ORNL	FIELD	.0283	1.148	.3792	.8720
1	ORNL	LAB	.0205	1.145	.3770	.8695
2	IAEA	AVCO	.0044	.2972	.0655	1.128
2	IAEA	FIELD	.0047	.2988	.0655	1.129
2	IAEA	LAB	.0046	.2977	.0657	1.120
2	ORNL	FIELD	.0043	.2955	.0653	1.128
2	ORNL	LAB	.0046	.2958	.0654	1.124
3	IAEA	AVCO	.0041	.2567	.0713	1.105
3	IAEA	FIELD	.0048	.2582	.0719	1.102
3	IAEA	LAB	.0045	.2587	.0716	1.092
3	ORNL	FIELD	.0045	.2559	.0713	1.110
3	ORNL	LAB	.0054	.2580	.0723	1.109

TABLE A-8 STANDARD DEVIATIONS FOR THE URANIUM DATA

FJEL SOLUTION	LAB	METHOD	$\frac{U\ 234}{U\ 238}$	$\frac{U\ 235}{U\ 238}$	$\frac{U\ 236}{U\ 238}$	URANIUM CONCEN- TRATION
1	IAEA	AVCO	.0005	.0023	.0022	.0018
1	IAEA	FIELD	.0015	.0031	.0018	.0085
1	IAEA	LAB	.0004	.0055	.0021	.0115
1	ORNL	FIELD	.0039	.0050	.0013	.0020
1	ORNL	LAB	.0004	.0035	.0011	.0014
2	IAEA	AVCO	.0006	.0013	.0004	.0028
2	IAEA	FIELD	.0002	.0033	.0005	.0052
2	IAEA	IAB	.0001	.0012	.0003	.0070
2	ORNL	FIELD	.0004	.0014	.0004	.0026
2	ORNL	LAB	.0002	.0019	.0004	.0025
3	IAEA	AVCO	.0004	.0010	.0002	.0032
3	IAEA	FIELD	.0006	.0019	.0006	.0167
3	IAEA	LAB	.0001	.0012	.0005	.0068
3	ORNL	FIELD	.0001	.0020	.0004	.0048
3	ORNL	LAB	.0011	.0018	.0009	.0026

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