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AEC Research and Development Report

PLUTONIUM RECYCLE
BURNUP DATA AND RESULTS
FROM THE BATCH CORE EXPERIMENT

JULY 1972

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PLUTONIUM RECYCLE
BURNUP DATA AND RESULTS FROM THE
BATCH CORE EXPERIMENT

By

D. E. Christensen

D. A. Kottwitz

D. R. Oden

R. P. Matsen

Reactor Physics Department

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BATTELLE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

PLUTONIUM RECYCLE
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ABSTRACT

As a result of the Batch Core Experiment which was conducted in the Plutonium Recycle Test Reactor, a large amount of burnup data and gamma-ray data was made available for analysis. The data represented plutonium recycle fuel in that the fuel composition was initially UO_2 -2 wt% PuO_2 .

A maximum burnup of 9485 MWD/MTM was determined from the fuel samples analyzed. The burnup data were then used to derive effective cross section ratios utilizing a least-squares fitting code. The results indicate exposure averaged values of 0.2240 ± 0.0009 and 0.5159 ± 0.0106 for $\hat{\alpha}^{25}$ and $\hat{\alpha}^{49}$, respectively (capture to fission ratio of ^{235}U and ^{239}Pu) for the mixed oxide fuel.

The gamma-ray data were analyzed to determine power distributions and effects of fission product migration. The results indicated localized regions of fission product concentrations due to the migrations of ^{106}Ru - ^{106}Rh , ^{134}Cs and ^{137}Cs .

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PLUTONIUM RECYCLE
BURNUP DATA AND RESULTS FROM THE
BATCH CORE EXPERIMENT

I. INTRODUCTION

Fuel assembly irradiation tests were conducted during 1967 and 1968 in the Plutonium Recycle Test Reactor (PRTR)⁽¹⁾ through the use of a high power density core.^(2,3,4) The average power density of the PRTR was increased above previous core loadings by shortening the fuel assemblies and reducing the total number of fueled tubes. The tests were designated as the Batch Core Experiment and were designed to determine the excess reactivity, fuel isotopic composition and fuel operational characteristics as functions of time for a mixed uranium oxide-two weight percent plutonium oxide (UO_2 -2 wt% PuO_2) fueled reactor as an example of plutonium recycle.

The purpose of this report is to present burnup data collected from several UO_2 -2 wt% PuO_2 fuel rods and assemblies irradiated during the Batch Core Experiment. The data represent fuel isotopic composition data as a function of increasing exposure (to 9485 MWD/MTM) determined by destructive sampling of the fuel rods and nondestructive gamma-ray data collected to indicate the relative burnup distributions of various rods and assemblies of the Batch Core. The analysis of the burnup sample data included determining effective cross-section ratios from the measured isotopic data. To aid the presentation of data and results, a description of the Batch Core is given after which the isotopic composition data and analysis are presented. The nondestructive data are presented last.

II. BATCH CORE EXPERIMENT DESCRIPTION

The Batch Core Experiment was a physics-fuels experiment which involved the operation of the PRTR loaded with 66 new 19-rod fuel assemblies containing about 2.3 tons of pneumatically impacted UO_2 -2 wt.% PuO_2 , a plutonium recycle fuel.^(4,5) Assembly dimensions are given in Reference 4 and 5. For normal power operation, the central channel of the reactor, see Reference 6, pp 5, was connected to the Fuel Element Rupture Test Facility (FERTF). The central channel and 54 assemblies surrounding the central channel constituted the basic core. Twelve additional UO_2 -2 wt.% PuO_2 assemblies formed a buffer region separating the basic 55 assembly core and selected assemblies previously irradiated in the PRTR which were charged as special irradiation tests in the peripheral positions of the core. Some of the special test assemblies were also UO_2 -2 wt.% PuO_2 assemblies and a listing of the various assembly types charged in the periphery of the PRTR is given in Reference 2, pp 7.

A. Core Configurations

The above assemblies are identified by number and their core positions as shown in Figure 1. The core configuration diagram represents the core loading as of April 14, 1967, at the beginning of power operation of the Batch Core. Significant events and daily MWd operation to June 30, 1967, are given in Reference 7, pp 5.4. An operation power histogram covering the entire operation of the PRTR to July 14, 1968, is given in Reference 8, pp. 15.

FIGURE 1. PRTR CORE LOADING AS OF APRIL 14, 1967

Every effort was made to minimize fuel shuffling in the Batch Core and the configuration given in Figure 1 was generally maintained until January, 1968. Adjustments occurred during June-July, 1967, when assembly 6700 in process channel 1550 was discharged, assembly 6508 from channel 1243 was charged to channel 1550 and assemblies 6052 in channel 1651 and 6063 in channel 1451 were interchanged (assembly 6021 was charged to channel 1243). However, assembly 6700 was recharged to channel 1550 during August, 1967, and assemblies 6508, 6052 and 6063 were returned to their original positions. During September, 1967, permanent changes were made in that assembly 6701 was charged to channel 1542, displacing assembly 6510 which was charged to channel 1459, displacing assembly 6053 which was in turn charged to channel 1051, displacing assembly 6501 which was discharged. An additional assembly, 6521, was charged to channel 1342 in December, 1967. These changes all occurred in the periphery of the core.

The first permanent change in the center of the core occurred in January, 1968, when assembly 6700 was moved to channel 1649 to permit an 8-rod FERTF assembly to be charged in channel 1550. This move displaced assembly 6062 which was recharged in channel 1051 and assembly 6053 was subsequently discharged. These changes are reflected in the core configuration as of January 2, 1968, as shown in Figure 2.

Only one assembly, 6066, from the basic 55 assembly core was discharged prior to termination of the Batch Core for the purpose of cutting burnup samples from fuel rods in the assembly. Assembly 6066 was discharged in March, 1968, after the 2nd interim Batch Core critical tests⁽⁹⁾ (the 1st interim critical tests were done during

FIGURE 2. PRTR LOADING AS OF JANUARY 2, 1968

September, 1967). This change was compensated for by charging assembly 6035 in channel 1352 in place of 6066, and subsequently assemblies 6511, 6062 and 6053 were removed from their original positions and were charged in channels 1247, 1146 and 1051, respectively, to minimize any perturbations to the basic core caused by the removal of assembly 6066. These changes are reflected in the core configuration diagram as of March 8, 1968, shown in Figure 3. The last changes occurred in June and July when assemblies 6519 and 5227 were discharged (June 6, 1968), and assembly 6700 failed (June 27, 1968). Assembly 6508 was charged in channel 1245 in place of 6519 and 6007 was charged to channel 1243. Assembly 5222 was charged to channel 1659 in place of assembly 5227. When assembly 6700 was discharged from channel 1649, assembly 6061 was charged in its place. Subsequently, assemblies 6065, 6043, 6062, 6013 and 6008 were charged to channels 1447, 1554, 1346, 1146 and 1049, respectively, to minimize any perturbations due to the failure of assembly 6700. These changes are reflected in the core configuration diagram shown in Figure 4. The power operation of the Batch Core was terminated two week later on July 14, 1968.

B. Orientation of Assemblies and Removable Rods

A specified orientation of each assembly within its process channel was done when each assembly was charged to the PRTR during the Batch Core Experiment. The orientation is shown in Figure 5. Also, certain assemblies of the basic core and buffer region were equipped with removable fuel rods. Those assemblies so designed have been indicated in Figures 1 through 4 and the positions of the removable rods within an assembly are shown in Figure 5.

FIGURE 3. PRTR CORE LOADING AS OF MARCH 8, 1968

FIGURE 4. PRTR CORE LOADING AS OF JULY 1, 1968

FIGURE 5. ORIENTATION OF 19-ROD FUEL ASSEMBLIES WHICH MADE UP THE BATCH CORE IN THE PRTR. ALL BATCH CORE ASSEMBLIES WERE ORIENTED ACCORDING TO THIS DIAGRAM.

To meet the need of obtaining burnup samples as a function of increasing exposure, several rods were removed from various assemblies as the experiment progressed.

A summary of position and rod changes for all Batch Core assemblies is given in Table I. The ring designation in Table I is the ring of fuel assemblies in the core as shown in Figure 6 (see Reference 8 pp. 14 for the radius of each ring). The ring designation in the reactor core is not to be confused with the rings of rods in each fuel assembly, see Figure 5. The rods from which burnup samples have been cut are described as coming from the center position or "a" position, the 6-rod ring or "b" through "g" positions and the 12-rod ring or "h" through "s" positions of the fuel assembly. Removable rods were available from the 12-rod ring at positions "j", "n" and "r". Not all the replaceable rods indicated as having been removed from the core in Table I were removed for the purpose of obtaining isotopic composition data from burnup samples. However, only those that were removed for that purpose⁽⁵⁾ are considered in the next section of this paper. Assemblies from which rods were taken both during operation and after shutdown to obtain burnup samples from were 6520, 6063, 6065, 6066, 6067, 6058, 6516, and 6519.

The total MWd exposure accumulated by each assembly during the Batch Core operation is listed in Table I. Where the position of the assembly remained unchanged during its residence time in the core is also indicated. As mentioned earlier, several assemblies were moved and the accumulated exposure in MWd for each position occupied in the core by these assemblies is listed. When a rod was removed from an assembly, the history of the rod replacing it is also given.

TABLE I

EXPOSURE AND HISTORY SUMMARY OF BATCH CORE ASSEMBLIES

<u>Ring</u>	<u>PC</u>	<u>FE</u>	<u>MWd</u>	<u>Position and Rod Changes</u>
0	1550	6700	194.7	122.8 MWd in PC 1550 71.9 MWd in PC 1649
1	1548	6520	215.5	Fission gas sensing assembly. Unchanged
	1649	6061 ^R	202.0	{ 194.8 MWd in PC-1447 (Ring 2) 7.2 MWd in PC-1649 (Ring 1).
	1651	6052	206.1	Had 2.7 MWd in PC-1451
	1552	6507 ^R	204.7	{ 1 new rod 6-26-67 (28.1 MWd). 2 new rods 7-16-67 (37.1 MWd).
	1451	6063 ^R	207.7	{ Had 2.7 MWd in PC-1651 1 rod 7-17-67 (36.0 MWd) brought from FE 6508 (19.6 MWd: 9.6 in PC-1243, 10.0 in PC-1550). 2 rods 6-5-68 (192.0 MWd) brought from FE 6067 (165.9 MWd in PC-1348).
	1449	6055	212.2	Unchanged
2	1647	6049	189.8	Unchanged
	1750	6048	189.9	Unchanged
	1653	6060 ^R	195.3	Unchanged
	1453	6050	208.0	Unchanged
	1350	6051	204.9	Unchanged
	1447	6065 ^R	197.3	{ 189.6 MWd in PC-1554 (Ring 3) 7.7 MWd in PC-1447 (Ring 2) 1 rod 9-14-67 (61.2 MWd) brought from FE 6514 (23.6 MWd in PC-1954)

PC - Process Channel

FE - Fuel Assembly

MWd - Total Exposure

R - Assembly with 3 replaceable rods

TABLE I (Continued)

Ring	PC	FE	MWd	Position and Rod Changes
3	1546	6068 ^R	191.0	Unchanged
	1748	6069 ^R	191.7	Unchanged
	1752	6064 ^R	172.5	Unchanged
	1554	6043	181.9	{ 174.3 MWd in PC-1346 (Ring 4) 7.6 MWd in PC-1554 (Ring 3)
	1352	6035	188.5	{ 122.0 MWd in PC-1247 (Ring 5) 66.5 MWd in PC-1352 (Ring 3)
	1348	6067 ^R	181.3	{ 1 rod 6-5-68 (165.9 MWd) brought from FE 6514 (75.2 MWd in PC-1954). 2 rods 6-5-68 (165.9 MWd) brought from FE 6515 (81.9 MWd in PC-1946).
	1352	6066 ^R	121.9	Unchanged (Discharged Feb. 6, 1968)
4	1645	6041	160.5	Unchanged
	1746	6040	164.8	Unchanged
	1849	6039	170.6	Unchanged
	1851	6059 ^R	155.6	Unchanged
	1754	6038	165.3	Unchanged
	1655	6037	167.9	Unchanged
	1455	6044	170.4	Unchanged
	1354	6045	184.6	Unchanged
	1251	6046	156.1	Unchanged
	1249	6047	156.9	Unchanged
	1346	6062 ^R	179.1	{ 129.7 MWd in PC-1649 (Ring 1) 7.2 MWd in PC-1051 (Ring 9) 35.2 MWd in PC-1146 (Ring 8) 7.0 MWd in PC-1346 (Ring 4) 1 rod 6-26-67 (30.7 MWd) which had 21.8 MWd in this assembly previously 1 new rod 7-17-67 (39.7 MWd).
	1445	6042	163.4	Unchanged

TABLE I (Continued)

<u>Ring</u>	<u>PC</u>	<u>FE</u>	<u>MWd</u>	<u>Position and Rod Changes</u>
5	1544	6034	160.7	Unchanged
	1847	6033	146.9	Unchanged
	1853	6032	132.7	Unchanged
	1556	6036	158.5	Unchanged
	1253	6058 ^R	142.7	{ 1 rod 6-4-68 (128.4 MWd) brought from FE 6515 (81.9 MWd in PC-1946).
	1247	6511 ^R	130.6	{ 73.9 MWd in PC-1146 (Ring 8) 56.7 MWd in PC-1247 (Ring 5)
6	1744	6027	129.5	Unchanged
	1950	6028	109.1	Unchanged
	1756	6518 ^R	127.6	Unchanged
	1356	6029	143.5	Unchanged
	1150	6031	144.3	Unchanged
	1344	6517 ^R	128.5	Unchanged
7	1643	6023	114.4	Unchanged
	1845	6015	112.3	Unchanged
	1948	6024	117.8	Unchanged
	1952	6016	110.7	Unchanged
	1855	6025	110.9	Unchanged
	1657	6017	108.3	Unchanged
	1456	6026	129.6	Unchanged
	1255	6018	131.6	Unchanged
	1152	6516 ^R	130.3	1 new rod 6-3-68 (119.1 MWd).
	1148	6019	121.5	Unchanged

TABLE I (Continued)

Ring	PC	FE	MWd	Position and Rod Changes
7	1245	6508 ^R	99.0	$\left\{ \begin{array}{l} 9.6 \text{ MWd in PC-1243 (Ring 9)} \\ 10.0 \text{ MWd in PC-1550 (Ring 0)} \\ 68.4 \text{ MWd in PC-1243 (Ring 9)} \\ 11.0 \text{ MWd in PC-1245 (Ring 7)} \\ 2 \text{ new rods 7-17-67 (19.6 MWd)} \end{array} \right.$
	1443	6022	119.2	Unchanged
8	1542	6701	78.1	Pellet assembly, unchanged
	1946	6515 ^R	90.5	3 new rods 6-4-68 (81.9 MWd)
	1954	6514 ^R	83.3	$\left\{ \begin{array}{l} 1 \text{ rod 9-14-67 (23.6 MWd) brought} \\ \text{from FE 6512 (31.0 MWd in PC-1154).} \\ 1 \text{ new rod 6-3-68 (75.2 MWd)} \end{array} \right.$
	1558	6513 ^R	98.4	Unchanged
	1154	6512 ^R	108.8	Zr coupons in place of one fuel rod
	1146	6013	86.2	$\left\{ \begin{array}{l} 81.3 \text{ MWd in PC-1049 (Ring 9)} \\ 4.9 \text{ MWd in PC-1146 (Ring 8)} \end{array} \right.$
9*	1843	6509 ^R	83.7	Unchanged
	2051	6014	88.2	Unchanged
	1857	6056	90.5	Unchanged
	1257	6012	97.4	Unchanged
	1051	6053	86.1	$\left\{ \begin{array}{l} 0.2 \text{ MWd in PC-1552 (Ring 1)} \\ 22.9 \text{ MWd in PC-1459 (Ring 10)} \\ 63.0 \text{ MWd in PC-1051 (Ring 9)} \end{array} \right.$
10*	1459	6510 ^R	88.6	$\left\{ \begin{array}{l} 28.7 \text{ MWd in PC-1542 (Ring 8)} \\ 59.9 \text{ MWd in PC-1459 (Ring 10)} \end{array} \right.$
	1053	6054	89.8	$\left\{ \begin{array}{l} 0.2 \text{ MWd in PC-1548 (Ring 1)} \\ 89.6 \text{ MWd in PC-1053 (Ring 10)} \end{array} \right.$

* No assemblies listed were in PRTR prior to Batch Core.

FIGURE 6. RING NUMBER PRTR LOADING CHART

III. BATCH CORE BURNUP DATA FROM DESTRUCTIVE ANALYSIS

In this section the results of the isotopic dilution measurements made on 36 samples taken throughout the core in the PRTR Batch Core Experiment are presented. The location and irradiation history of each of the samples are provided first followed by a tabulation of the fuel isotopic compositions, burnup, and other pertinent results from the analyses of the isotopic dilution data. Plots of selected fuel isotopic ratios are also presented to afford a basis for a judgement on the internal consistency of the data and to aid in determining which data points should be fit as a set for the purposes of determining cross section ratios.

A. Burnup Sample Identification

The location and irradiation history of the samples from the PRTR Batch Core Experiment are provided in Table II. The assembly numbers from which the rods were obtained and the primary ring designation (assembly 6065 resided most of its times in ring 3, see Table I) of the assembly in the core are listed. Within an assembly, positions j, n, and r listed in Table II are from the 12-rod or exterior ring, positions c and f are from the 6-rod or middle ring, and position a is the center rod of the 19-rod assembly. The date irradiation was terminated and the location of each sample with respect to the top of the fuel (including the UO_2 pellet) are also indicated. The plutonium fuel lots from which the rods were fabricated are listed in Table II and the initial composition of the various fuel lots are shown in Table III. Several

TABLE II
LOCATION AND IRRADIATION HISTORY OF
BATCH CORE SAMPLES

Fuel Assembly No.	Position in Reactor (Ring)	Rod No.	Position in Assembly	Plutonium Fuel Lot	Irradiation Terminated on	Removal During	Position* in Rod, in.	Approximate Date that Samples Analyzed
6065	3	FS12	r	62-23	9-10-67	Interim Test 1	6.5	9-10-68
						↓	10.4	9-10-68
							29.4	9-10-68
							41.3	9-10-68
							47.5	9-10-68
6066	3	FS16	r	62-23	1-28-68	Interim Test 2	6.5	6-15-69
						↓	9.6	6-15-69
							28.9	6-15-69
							43.6	6-15-69
							48.1	6-15-69
		F079	c	62-22	1-28-68		6.5	6-15-69
							10.4	6-15-69
							30.9	6-15-69
							47.3	6-15-69
		FE77	a	62-23	1-28-68	↓	6.5	6-15-69
							30.3	6-15-69
							47.6	6-15-69

* Length of Fuel = 58.675 ± 0.125 in. which includes 57.837 ± 0.125 in. of UO_2 - PuO_2 and a UO_2 pellet on each end.

TABLE II (Continued)
LOCATION AND IRRADIATION HISTORY OF
BATCH CORE SAMPLES

Fuel Assembly No.	Position in Reactor (Ring)	Rod No.	Position in Assembly	Plutonium Fuel Lot	Irradiation Terminated on	Removal During	Position in Rod, in.	Approximate Date That Samples Analyzed	
6063	1	FS01	n	62-23	6-1-68	Interim Test 3 ↓	28.9	6-15-69	
6067	3	FS23	r	62-23	6-1-68		6.5	6-15-69	
							9.7	6-15-69	
							29.1	6-15-69	
							43.5	6-15-69	
							48.5	6-15-69	
6058	5	FS08	j	62-23	6-1-68		29.9	6-15-69	
6516	7	FR64	j	62-6	6-1-68	↓	30.5	6-15-69	
6520	1	FR78	n	62-18	7-14-68	Interim Test 4 (Reactor Shutdown) ↓	30.4	4-1-70	
6065	3	FS07	j	62-23	7-14-68		30.4	4-1-70	
		F017	c	62-22	7-14-68		10.0	4-1-70	
							30.4	4-1-70	
		FE74	a	62-23	7-14-68		10.0	4-1-70	
							30.4	4-1-70	
6519	7	FN86	f	62-18	7-14-68		7.8	4-1-70	
							30.4	4-1-70	
		FE69	a	62-10	7-14-68		7.8	4-1-70	
							30.4	4-1-70	
6519		# 4	r	62-18	7-14-68		↓	30.0	6-18-70

TABLE III

INITIAL COMPOSITION (a/o) OF PLUTONIUM FUEL LOTS

<u>Fuel Lot</u>	<u>^{238}Pu</u>	<u>^{239}Pu</u>	<u>^{240}Pu</u>	<u>^{241}Pu</u>	<u>^{242}Pu</u>
62-23	0.026	90.518	8.228	1.148	0.080
62-22	unknown	91.128	8.086	0.745	0.041
62-6	unknown	91.050	8.087	0.811	0.052
62-10					
62-18					

samples of unirradiated fuel were submitted for analysis in order to ensure that the data for the zero burnup point was as reliable as that from the other samples.

B. Tabulated Burnup Sample Results

Results of the isotopic dilution measurements made on the burnup samples are tabulated in Appendix A. For the purpose of explaining these results, the tabulated results of one sample is given in Table IV. The table is a reproduction of computer output from program ISODIL⁽¹⁰⁾ which processes data from the isotopic dilution measurements for each irradiated fuel sample to provide information descriptive of the nuclear transformations that have occurred within the sample. The equations used in the ISODIL code as well as references to the isotopic dilution technique are given in Reference 10 and will not be duplicated here. The format and contents of the ISODIL output (Appendix A and Table IV) are described below.

The first line of Table IV provides information descriptive of the fuel samples location in the reactor. This information includes the fuel assembly number, the rod identification number and its location in the 19-rod assembly. The distance from the top of the fuel at which the sample was cut is also indicated.

The next line of output lists the input values required for corrections for radioactive decay occurring during and after the irradiation. Neodymium isotopic ratios for the spike, sample and mixture are given on the next line. Throughout the table, values in parentheses following a table entry are standard deviation uncertainties based on propagation of error techniques.

TABLE IV

TYPICAL LISTING OF RESULTS OBTAINED FROM THE ANALYSES OF A BURNUP SAMPLE

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 10.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .1724+02(.17-00)--SAMPLE--ND50/48 .5531-00(.28-02) MIXTURE--ND42/50 .1433-01(.15-03)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2 .9777-00(.29-02)	PU239 .9868+19(.12+18)
U-233 .5146+19(.50+17)	U 8/3 .2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3 .1126+01(.30-02)	U-238 .5846+21(.76+19)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0 .1446-00(.14-02)	ND148 .1837+17(.31+15)

BOL U+PU=.2376(.0031)GM/ML AS CALCULATED BY ISOTOPIIC DILUTION .68% SAMPLE---ND CONTAMINATION---MIXTURE 1.08%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5400-04(.200-05)	.0054(.0002)	.5163-04(.195-05)	-.3300-05(.201-05)
U-235	.6971-02(.691-05)	.6835-02(.300-04)	.6788(.0029)	.6563-02(.290-04)	-.4081-03(.299-04)
U-236	.0000 (.000)	.8100-04(.300-05)	.0080(.0003)	.7810-04(.292-05)	.7810-04(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3078(.0398)	.9724-00(.429-03)	-.5395-03(.380-03)
TOTALS	.9800-00(.200-03)			.9791-00(.200-03)	-.8699-03(.379-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.4180-03(.800-05)	.0361(.0007)	.6861-05(.174-06)	.5244-05(.137-06)	.1617-05(.222-06)
PU239	.90.5182(.0375)	1.0000	.86.3973(.0312)	.1648-01(.275-03)	.1810-01(.181-03)	-.1613-02(.329-03)
PU240	8.2281(.0374)	.1326-00(.400-03)	11.4963(.0306)	.2195-02(.372-04)	.1652-02(.181-04)	.5429-03(.414-04)
PU241	1.1478(.0070)	.2175-01(.110-03)	1.9712(.0101)	.3792-03(.663-05)	.2314-03(.271-05)	.1478-03(.716-05)
PU242	.0796(.0018)	.1610-02(.200-04)	.1391(.0017)	.2687-04(.559-06)	.1611-04(.396-06)	.1076-04(.685-06)
TOTALS				.1909-01(.319-03)	.2000-01(.200-03)	-.9101-03(.376-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3298-03(.3005-04)	316.1	.0169(.0001)	.0491(.0049)	201.7
U-236	.9295-04(.9298-05)	90.9	.0193(.0010)		208.5
PU239	.1333-02(.5300-04)	1306.9	.0170(.0003)	.0563(.0056)	210.7
PU241	.2937-04(.2005-05)	29.0	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.1785-02(.4479-04)	1743.0			

U235/U235BOL=.941(.004) ALPHA235=.2372(.0241) U238 INTO PU239=.4484-03(.38-03)GM U236 INTO NP237=.476-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .9192+01(.46-00)--SAMPLE--ND50/48 .5569-00(.28-02) MIXTURE--ND42/50 .1226-01(.18-03)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2 .7179-00(.22-02)	PU239 .7242+19(.92+17)
U-233 .5146+19(.50+17)	U 8/3 .2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3 .8254-00(.25-02)	U-238 .4282+21(.60+19)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0 .9811-01(.49-03)	ND148 .1176+17(.16+15)

BOL U+PU=.1740(.0024)GM/ML AS CALCULATED BY ISOTOPIIC DILUTION 1.30% SAMPLE---ND CONTAMINATION---MIXTURE 1.10%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5126-04(.130-05)	.0051(.0001)	.4897-04(.127-05)	-.5961-05(.136-05)
U-235	.6971-02(.691-05)	.6869-02(.275-04)	.6821(.0027)	.6598-02(.266-04)	-.3732-03(.276-04)
U-236	.0000 (.000)	.6600-04(.150-05)	.0066(.0001)	.6366-04(.146-05)	.6366-04(.146-05)
U-238	.9730-00(.199-03)	1.0000	.99.3062(.0398)	.9728-00(.437-03)	-.2151-03(.389-03)
TOTALS	.9800-00(.200-03)			.9795-00(.200-03)	-.5250-03(.388-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.3840-03(.800-05)	.0335(.0007)	.6317-05(.172-06)	.5244-05(.137-06)	.1073-05(.220-06)
PU239	.90.5182(.0375)	1.0000	.87.1444(.0315)	.1652-01(.288-03)	.1810-01(.181-03)	-.1576-02(.340-03)
PU240	8.2281(.0374)	.1252-00(.400-03)	10.9105(.0311)	.2077-02(.368-04)	.1652-02(.181-04)	.4251-03(.410-04)
PU241	1.1478(.0070)	.1953-01(.100-03)	1.7853(.0093)	.3413-03(.622-05)	.2314-03(.271-05)	.1099-03(.678-05)
PU242	.0796(.0018)	.1450-02(.200-04)	.1264(.0017)	.2425-04(.539-06)	.1611-04(.396-06)	.8148-05(.669-06)
TOTALS				.1897-01(.331-03)	.2000-01(.200-03)	-.1032-02(.387-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3095-03(.2761-04)	296.6	.0169(.0001)	.0491(.0049)	201.7
U-236	.0111-04(.8097-05)	79.3	.0193(.0010)		208.5
PU239	.1148-02(.4542-04)	1125.1	.0170(.0003)	.0563(.0056)	210.7
PU241	.2223-04(.1906-05)	21.9	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.1560-02(.3688-04)	1523.0			

U235/U235BOL=.946(.004) ALPHA235=.2060(.0192) U238 INTO PU239=.1346-03(.39-03)GM U236 INTO NP237=.354-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

The next three lines list the results of the isotopic dilution analysis. The beginning of life (BOL) U + Pu, in grams per ml of sample, is given next as calculated either by isotopic dilution or by fuel weight and solution volume (where input). The Nd contamination of the sample and mixture is also provided on this line.

The isotopic inventory for the uranium and plutonium isotopes and their respective totals are tabulated next. Table entries with the units of grams are normalized to one gram of the U + Pu initially in the sample. Results are also quoted in terms of mass ratios and atom percentages. The mass ratios are relative to ^{238}U and ^{239}Pu for the uranium and plutonium isotopes respectively.

The next section of the table indicates the number of fissions which have occurred in each isotope and the total fissions as determined by ^{148}Nd . Here again the entries in units of grams are relative to one gram of U + Pu initially. The fission yields of ^{148}Nd used for each of the fuel isotopes in this determination are listed. The DEL values shown are the calculated (input) ratios of fissions in U^{238} per fission in the other fuel isotopes and are used to determine the number of fissions in ^{238}U . The burnup by isotope, the total burnup, and the energy release per fission used to determine these quantities are also tabulated.

The last line in the table indicates the ratio of final to initial atoms of ^{235}U in the fuel, the average capture to fission ratio for ^{235}U (ALPHA 235), the grams of ^{238}U converted to ^{239}Pu per initial gram of U + Pu, and the grams of ^{236}U converted to ^{237}Np per initial gram of U + Pu.

C. Plotted Results

Results of the isotopic dilution measurements are also shown in Figures 7 through 18 which are plots of the atom ratios for the various fuel isotopes as a function of the U^{235}/U^{238} and Pu^{240}/Pu^{239} atom ratios. The error bars associated with each data point are indicated on the figures and the plotting symbols used define both rod position in an assembly and plutonium fuel lot numbers from which the rods were fabricated.

The major data sets for the central rod ($\diamond$), 6-rod ring ($\times$) and 12-rod ring ($\circ$) locations in an assembly contain 5, 6 and 18 data points respectively. An eyeball fit of these three sets of data in Figures 7 through 18 indicates that the three sets should be fitted separately for purposes of determining cross section ratios. These three apparently different burnup paths for the central rod, 6-rod and 12-rod ring locations may be due, in part, to the differences in plutonium lots as well as to differences in neutronic characteristics attributable to the three different locations in the assembly. The fitted cross section ratios will aid in determining the cause of this apparent difference in burnup paths. As a matter of interest in comparison to slightly enriched ^{235}U systems and as seen in Figures 13 and 18, the U^{235}/U^{238} atom ratio is essentially linear with burnup while the Pu^{240}/Pu^{239} atom ratio shows a second order dependence.

FIGURE 7. $^{236}\text{U}/^{238}\text{U}$ ATOM RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 8. $^{238}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 9. $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 10. $^{241}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 11. $^{242}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 12. Pu/U RATIO VERSUS $^{235}\text{U}/^{238}\text{U}$ ATOM RATIO

FIGURE 13. BURNUP (GWD/MTM) VERSUS $^{235}\text{U}/^{238}\text{U}$ RATIO

FIGURE 14. $^{238}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO

FIGURE 15. $^{241}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO

FIGURE 16. $^{242}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO VERSUS $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO

FIGURE 17. Pu/U RATIO VERSUS $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO

FIGURE 18. BURNUP (GWD/MTM) VERSUS $^{240}\text{Pu}/^{239}\text{Pu}$ ATOM RATIO

IV. DERIVATION OF EFFECTIVE CROSS SECTION RATIOS

A. Least-Squares Method: Program DBUFIT-I

The Batch Core isotopic concentration data have been fitted by means of the nonlinear least-squares method embodied in computer program DBUFIT-I.⁽¹¹⁾ The principles and characteristics of the method have been discussed at length by Matsen in earlier reports.^(12,13) We shall confine ourselves to a brief description only.

By assuming a particular functional form for the ratios of effective cross sections, it is possible to integrate the coupled differential equations of the burnup chain in closed form with the time variable eliminated.⁽¹¹⁾ For the isotopes of interest here - ^{235}U , ^{238}U , ^{236}U , ^{239}Pu , ^{240}Pu , ^{241}Pu and ^{242}Pu - these integrated equations are

$$N^{28} - K_8 (N^{25})^A = 0$$

$$N^{26} + \frac{\beta}{1-b} N^{25} + \frac{bb}{b} - K_6 (N^{25})^b = 0$$

$$N^{49} + \frac{BK_8}{A-C} (N^{25})^A - K_9 (N^{25})^C + \frac{CC}{C} = 0$$

$$N_f^{49} - \frac{(1-\epsilon)BCK_8}{(A-C)A} (N^{25})^A + (1-\epsilon) K_9 (N^{25})^C - K_{9f} = 0$$

$$N^{40} - \frac{\epsilon BCK_8}{(A-C)(A-D)} (N^{25})^A + \frac{\epsilon CK_9}{C-D} (N^{25})^C - K_0 (N^{25})^D + \frac{DD}{D} = 0$$

$$\begin{aligned}
 N^{41} + \frac{\epsilon_{BCDK_8}}{(A-C)(A-D)(A-E)} (N^{25})^A - \frac{\epsilon_{CDK_9}}{(C-D)(C-E)} (N^{25})^C + \frac{DK_0}{D-E} (N^{25})^D - K_1 (N^{25})^E &= 0 \\
 N^{42} - \frac{\epsilon_{\gamma BCDEK_8}}{(A-C)(A-D)(A-E)(A-F)} (N^{25})^A + \frac{\epsilon_{\gamma CDEK_9}}{(C-D)(C-E)(C-F)} (N^{25})^C - \frac{\gamma_{DEK_0}}{(D-E)(D-F)} (N^{25})^D \\
 + \frac{\gamma_{EK_1}}{E-F} (N^{25})^E - K_2 (N^{25})^F &= 0,
 \end{aligned}$$

where the cross section ratios are represented by

$$\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25} = A, \hat{\sigma}_c^{25}/\hat{\sigma}_a^{25} = \beta, \hat{\sigma}_a^{26}/\hat{\sigma}_a^{25} = b + bb/N^{26},$$

$$\hat{\sigma}_c^{28}/\hat{\sigma}_a^{25} = B, \hat{\sigma}_a^{49}/\hat{\sigma}_a^{25} = C + CC/N^{49}, \hat{\sigma}_c^{49}/\hat{\sigma}_a^{49} = \epsilon, \hat{\sigma}_a^{40}/\hat{\sigma}_a^{25} = D + DD/N^{40},$$

$$(\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25})(1 + \lambda^{41}/\hat{\sigma}_a^{41} \phi) = E, (\hat{\sigma}_c^{41}/\hat{\sigma}_a^{41})/(1 + \lambda^{41}/\hat{\sigma}_a^{41} \phi) = \gamma, \hat{\sigma}_a^{42}/\hat{\sigma}_a^{25} = F.$$

The K's are constants of integration, the N's are isotopic concentrations (where the superscript 25 represents ^{235}U , 49 represents ^{239}Pu , etc.), λ^{41} is the radioactive decay constant of ^{241}Pu , and ϕ is the neutron flux. Note that N_f^{49} is the concentration of fissioned nuclei of ^{239}Pu . The factor $\lambda^{41}/\hat{\sigma}_a^{41} \phi$ is included to correct for the radioactive decay of ^{241}Pu during burnup. It is independently calculated prior to the least-squares fit.

The values of the 7 initial concentrations, which are related to the constants of integration, and the 13 parameters defining the cross-section ratios are in principle determinable by the least-squares fitting process.

However, as we shall see later, it is usually necessary to fix one or more of the parameters by means of independent information. Note that 3 of the 10 cross-section ratios depend formally on isotopic concentrations and thus indirectly on exposure.

B. Previous Reactor Burnup Calculations

Burnup calculations for the PRTR Batch Core Experiment have been done previously by Matsuura and Prezbindowski.⁽¹⁴⁾ In the course of that work, they calculated ratios of effective one-group cross sections for two reactor regions: region #2, a non-central high-temperature section containing 18 fuel clusters, and region #3, a non-central low-temperature section containing 36 fuel clusters. Their results (previously unpublished) for region #2, which is the region from which most of the isotopic samples were taken, are shown in Table V. Note that the ratio displayed for the fissile isotopes is $\hat{\alpha} \equiv \hat{\sigma}_c / \hat{\sigma}_f = (\hat{\sigma}_c / \hat{\sigma}_a) / (1 - \hat{\sigma}_c / \hat{\sigma}_a)$.

C. Least-Squares Fitting to Burnup Data

In the fitting of burnup data it is important that all of the data being fitted at the same time lie along the same burnup path (see Figures 7 through 18). In particular, the initial isotopic composition and the neutron spectrum should be identical for all samples included in a single fit. For this reason, data from only 29 of the 36 exposed samples were used in least-squares fits. These data were grouped into 3 sets according to both the position of the fuel rod in its assembly and the fuel lot number, as shown in Table VI.

TABLE V

CROSS-SECTION RATIOS FROM REACTOR BURNUP
CALCULATIONS BY MATSUURA AND PREZBINDOWSKI (unpublished)

Exposure Ratio	0 (MWD/MTM)	3060 (MWD/MTM)	6490 (MWD/MTM)	Percent Change
$\hat{\alpha}^{25}$	0.2433	0.2388	0.2340	-3.8
$\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$	0.2167	0.2024	0.1871	-14.0
$\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25}$	0.01238	0.01184	0.01125	- 9.1
$\hat{\sigma}_c^{28}/\hat{\sigma}_a^{25}$	0.01192	0.01140	0.01085	- 9.0
$\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$	2.0082	2.022	2.039	1.5
$\hat{\alpha}^{49}$	0.4865	0.4853	0.4843	- 0.45
$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$	1.426	1.2106	1.0605	-26.0
$\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25}$	2.349	2.3586	2.3701	0.90
$\hat{\alpha}^{41}$	0.3782	0.3788	0.3795	0.34
$\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$	0.6817	0.6378	0.5905	-13.0

TABLE VI
SETS OF SAMPLE DATA USED IN LEAST-SQUARES FITS

<u>Set</u>	<u>Number of Samples</u>	<u>Rod Assembly Position</u>	<u>Fuel Lot Number</u>
1	18	12-Rod Ring	62-23
2	6	6-Rod Ring	62-22
3	5	Central	62-23

Since burnup data are usually not extensive or accurate enough to permit a unique least-squares determination of all the cross-section ratios, it is necessary to constrain the parameters by means of independent information. In program DBUFIT-I this may be done by holding any subset of the parameters fixed at appropriate values. For this purpose, the calculated values in Table V have been extremely useful.

In all of the fits reported here, three of the cross-section ratios have been held fixed: $\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$, $\hat{\alpha}^{41}$, and $\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$.

For the first two quantities we have chosen values corresponding to the intermediate exposure (3060 MWD/MTM, Table V) while for the last we have chosen a value more strongly weighted toward the highest exposure at which calculations were done (6490 MWD/MTM).

The fitting of data for each set of samples is done in three stages. The single equations for ^{238}U and ^{236}U are each fitted separately, and then the remaining 5 equations for ^{239}Pu , ^{239}Pu fissions, ^{240}Pu , ^{241}Pu and ^{242}Pu are all fitted simultaneously. The results for the fuel rods

in the three positions are given in Table VII, where the uncertainty for each adjusted quantity is the computed estimate of the standard deviation. It should be noted that the data for the 6-rod ring and central rods are not extensive enough to determine an exposure dependence of the ratio $\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$. A satisfactory solution is obtained by fixing the parameter CC at zero, thus forcing the ratio to be constant (but still adjustable).

Plots of the burnup data and the fitted curves for the 12-rod ring data are given in Figures 19, 20, 21 and 22. The error flags on the data points indicate one-standard-deviation estimates, while the one-standard-deviation uncertainty error bands of the fitted curves are indicated by the outer two lines that are shown with the least-squares fitted curve (middle). The fitted curves are seen to represent the data points adequately.

D. Sensitivity Tests

Since the values of the least-squares adjusted cross-section ratios depend on the input values of the fixed ratios, it is important to determine the sensitivity of the results to the assumed values. For this purpose the three fixed ratios $\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$, $\hat{\sigma}_c^{41}/\hat{\sigma}_a^{41}$ and $\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$ were each separately perturbed by 10% for the case of the exterior rods, and three additional runs were made. The results are given in Table VIII.

One of the most significant features of the calculated cross-section ratios in Table V and the fitted ratios in Table VII is the great dependence of $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ on exposure. Since there is some question about the adequacy of the assumed functional form of this ratio,^(11, 12, 13) it is

TABLE VII

CROSS-SECTION RATIOS DETERMINED BY LEAST-SQUARES
FITS FOR FUEL RODS IN THREE POSITIONS IN A 19-ROD ASSEMBLY

Rod Position Ratio	12-Rod Ring (Max. Exposure) (9200 MWD/MTM)	6-Rod Ring (Max. Exposure) (5700 MWD/MTM)	Central (Max. Exposure) (4800 MWD/MTM)
$\hat{\alpha}^{25}$	0.2240 $\pm$ 0.0009	0.2442 $\pm$ 0.0032	0.2536 $\pm$ 0.0086
$\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$	0.2020 (fixed)	0.2020 (fixed)	0.2020 (fixed)
$\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25}$	0.01586 $\pm$ 0.00052	0.01823 $\pm$ 0.00144	0.02042 $\pm$ 0.00094
$\hat{\sigma}_c^{28}/\hat{\sigma}_a^{25}$	0.01399 $\pm$ 0.00119	0.01635 $\pm$ 0.00218	0.01818 $\pm$ 0.00543
$\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$ (initial)	2.120 $\pm$ 0.039	2.056 $\pm$ 0.038	2.008 $\pm$ 0.086
$\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$ (final)	2.281 $\pm$ 0.067	(constant)	(constant)
$\hat{\alpha}^{49}$	0.5159 $\pm$ 0.0106	0.4976 $\pm$ 0.0173	0.4830 $\pm$ 0.0388
$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ (initial)	1.963 $\pm$ 0.042	1.878 $\pm$ 0.046	1.863 $\pm$ 0.120
$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ (final)	1.284 $\pm$ 0.029	1.170 $\pm$ 0.046	1.215 $\pm$ 0.125
$\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25}$	2.4885 $\pm$ 0.0735	2.2247 $\pm$ 0.0781	2.1129 $\pm$ 0.1226
$\hat{\alpha}^{41}$	0.3788 (fixed)	0.3787 (fixed)	0.3787 (fixed)
$\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$	0.600 (fixed)	0.600 (fixed)	0.600 (fixed)

FIGURE 19. ^{238}U VERSUS ^{235}U AND LEAST-SQUARES FITTING RESULT FOR 12-ROD RING DATA

FIGURE 20. ^{236}U VERSUS ^{235}U AND LEAST-SQUARES FITTING RESULT FOR 12-ROD RING DATA

FIGURE 21. ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{242}Pu AND ^{239}Pu FISSIONS VERSUS ^{235}U AND LEAST-SQUARES FITTING RESULTS FOR 12-ROD RING DATA

FIGURE 22. ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{242}Pu AND ^{239}Pu FISSIONS VERSUS BURNUP AND LEAST-SQUARES FITTING RESULTS FOR 12-ROD RING DATA

TABLE VIII

RESULTS OF SENSITIVITY TESTS ON CROSS-SECTION

RATIOS FOR THE 12-ROD RING RODS

Perturbed Ratio	$\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$	$\hat{\sigma}_c^{41}/\hat{\sigma}_a^{41}$	$\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$
$\hat{\sigma}_a^{25}$	0.2234 $\pm$ 0.0009	0.2240 $\pm$ 0.0009	0.2240 $\pm$ 0.0009
$\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$	0.1820 (fixed)	0.2020 (fixed)	0.2020 (fixed)
$\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25}$	0.01586 $\pm$ 0.00052	0.01586 $\pm$ 0.00052	0.01586 $\pm$ 0.00052
$\hat{\sigma}_c^{28}/\hat{\sigma}_a^{25}$	0.01399 $\pm$ 0.00119	0.01385 $\pm$ 0.00119	0.01400 $\pm$ 0.00118
$\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$ (initial)	2.120 $\pm$ 0.039	2.121 $\pm$ 0.039	2.117 $\pm$ 0.038
$\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$ (final)	2.281 $\pm$ 0.067	2.253 $\pm$ 0.067	2.283 $\pm$ 0.067
$\hat{\sigma}_a^{49}$	0.5159 $\pm$ 0.0106	0.5096 $\pm$ 0.0106	0.5154 $\pm$ 0.0106
$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ (initial)	1.963 $\pm$ 0.042	1.932 $\pm$ 0.042	1.956 $\pm$ 0.041
$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ (final)	1.284 $\pm$ 0.029	1.223 $\pm$ 0.029	1.280 $\pm$ 0.029
$\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25}$	2.4885 $\pm$ 0.0735	2.2630 $\pm$ 0.0668	2.4682 $\pm$ 0.0729
$\hat{\sigma}_a^{41}$	0.3787 (fixed)	0.4330 (fixed)	0.3787 (fixed)
$\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$	0.600 (fixed)	0.600 (fixed)	0.540 (fixed)

worthwhile to investigate this point further. For this purpose the extensive data for the 12-rod ring rods were grouped into three parts covering approximately equal intervals of exposure. The three partial sets of data for the plutonium isotopes were then refit separately, with all exposure dependence suppressed by fixing the parameters CC and DD at zero. The results of these runs are given in Table IX and are discussed at the end of the following subsection.

E. Discussion of Cross-Section Ratios

Inspection of Table V shows that the calculated cross-section ratios depend approximately linearly on the exposure. Three of them - $\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$, $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$, and $\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$ - change by more than 10% during an exposure of 6490 MWD/MTM. The first and third of these are constant in the least-squares fits and, in fact, must be fixed at input values to get satisfactory iterative convergence. The fitted values of $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ in Table VII show an even greater exposure dependence than the calculated values for all types of fuel rods. Similarly, the fitted values of $\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$ for the 12-rod ring rods have a somewhat greater exposure dependence than the calculated values.

The fitted ratios in Table VII indicate systematic differences among the rods in different positions, although the picture is confused by the various exposure intervals and the large uncertainties for the central rod. Nevertheless, there appear to be real differences in $\hat{\alpha}^{25}$, $\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25}$, $\hat{\sigma}_a^{49}/\hat{\sigma}_a^{25}$, $\hat{\alpha}^{49}$, $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$, and $\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25}$.

TABLE IX

RESULTS OF LEAST-SQUARES FITS OF PARTIAL
SETS OF DATA FOR THE 12-ROD RING RODS

Exposure Range Ratio	0-3200 (MWD/MTM)	3900-5900 (MWD/MTM)	6500-9000 (MWD/MTM)
$\hat{\sigma}_c^{28} / \hat{\sigma}_a^{25}$	0.01736 ± 0.00673	0.01222 ± 0.01005	0.01227 ± 0.00452
$\hat{\sigma}_a^{49} / \hat{\sigma}_a^{25}$	2.101 ± 0.088	2.115 ± 0.274	2.188 ± 0.185
$\hat{\alpha}^{49}$	0.5302 ± 0.0362	0.5226 ± 0.1199	0.5523 ± 0.0837
$\hat{\sigma}_a^{40} / \hat{\sigma}_a^{25}$	1.655 ± 0.070	1.493 ± 0.188	1.367 ± 0.099
$\hat{\sigma}_a^{41} / \hat{\sigma}_a^{25}$	2.3698 ± 0.1265	2.5034 ± 0.2632	2.6109 ± 0.1603
$\hat{\alpha}^{41}$	0.3787 (fixed)	0.3787 (fixed)	0.3787 (fixed)
$\hat{\sigma}_a^{42} / \hat{\sigma}_a^{25}$	0.600 (fixed)	0.600 (fixed)	0.600 (fixed)

There is, of course, considerable interest in a comparison of the calculated and fitted ratios. Unfortunately, a straightforward comparison of the calculated values in Table V and the fitted values in Table VII is not possible. The reactor calculations were done for smeared cells, while the least-squares fits were done for separate fuel rods. Furthermore, the exposure intervals do not coincide.

Nevertheless, we shall present comparisons for the purpose of example. The calculated ratios in the second column of Table V (3060 MWD/MTM) may be considered to be average values appropriate over an exposure interval of 0-6000 MWD/MTM. To get comparable fitted values we must do averaging over the same exposure and mass-weighted averaging over the fuel rod positions. The results of this process are given in Table X. The differences in 4 of the ratios appear to be reasonably small (<5%). However, 3 of them - $\hat{\sigma}_a^{28}/\hat{\sigma}_a^{25}$, $\hat{\sigma}_c^{28}/\hat{\sigma}_a^{25}$, and $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ - differ by 22% to 30%. All of these ratios involve cross sections having substantial resonance contributions. This suggests the possibility of difficulties in the calculation of resonance integrals or the ratio of fast to thermal flux components.

The sensitivity test results in Table VIII show that the fitted cross-section ratios are insensitive to the assumed values of $\hat{\sigma}_a^{26}/\hat{\sigma}_a^{25}$ and $\hat{\sigma}_a^{42}/\hat{\sigma}_a^{25}$. In particular the adjusted values for the 12-rod ring change by less than 1% when the fixed values are perturbed by 10%. However, there is some sensitivity to the assumed value of $\hat{\sigma}_c^{41}/\hat{\sigma}_a^{41}$. When it changes by 10%, the value of $\hat{\sigma}_a^{41}/\hat{\sigma}_a^{25}$ and the final value of

TABLE X
COMPARISON OF CALCULATED AND FITTED VALUES
OF CROSS-SECTION RATIOS

Ratio	Average Fitted Values	Central Calculated Values	Percent Difference
$\hat{\alpha}$	0.2319	0.2388	3.0
$\hat{\sigma}_a^{26} / \hat{\sigma}_a^{25}$	0.2020 (fixed)	0.2024	--
$\hat{\sigma}_a^{28} / \hat{\sigma}_a^{25}$	0.01685	0.01184	-30.0
$\hat{\sigma}_c^{28} / \hat{\sigma}_a^{25}$	0.01496	0.01140	-24.0
$\hat{\sigma}_a^{49} / \hat{\sigma}_a^{25}$	2.121	2.022	- 4.7
$\hat{\alpha}^{49}$	0.5084	0.4853	- 4.5
$\hat{\sigma}_a^{40} / \hat{\sigma}_a^{25}$	1.560	1.2106	-22.0
$\hat{\sigma}_a^{41} / \hat{\sigma}_a^{25}$	2.385	2.3586	- 1.1
$\hat{\alpha}^{41}$	0.3787 (fixed)	0.3788	--
$\hat{\sigma}_a^{42} / \hat{\sigma}_a^{25}$	0.600 (fixed)	0.6378	--

$\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ change by 9% and 5%, respectively. Note that the preceding discussion of relatively large discrepancies in some of the cross sections is not sensitive to the assumed values of the fixed ratios.

Finally, we come to a discussion of the functional form of the exposure dependence of the ratio $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$. In Figure 23 the values of $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$ obtained from the fits of the partial sets of 12-rod ring data (Table IX) have been plotted in histogram form as a function of exposure. The dashed straight line may then be drawn as a smooth approximation to the discontinuous histogram. Also plotted is the curved function (and its error band) for $\hat{\sigma}_a^{40}/\hat{\sigma}_a^{25}$, which is used by DBUFIT-I. Note that within the limits of its shape, the curve is a rough approximation of the dashed line. Its most serious weakness is to overestimate the initial value of the cross-section ratio by about 16%. Of course, it must be remembered that the curved shape of the cross-section ratio is the price that has been paid to obtain closed form solutions involving only a few elementary functions. (11, 12, 13)

In addition to the comparison of calculated and measured cross section ratios shown above, Matsuura and Prezbindowski compared calculated and measured isotopic data for the 12-rod ring position. These results are given in Reference 14, pp 30-37.

FIGURE 23. $\hat{\sigma}_a^{40} / \hat{\sigma}_a^{25}$ CROSS-SECTION RATIO VERSUS BURNUP

V. BATCH CORE DATA FROM NONDESTRUCTIVE ANALYSIS

Since October, 1967, a large amount of fission product gamma-ray data has been collected from fuel rods and intact fuel assemblies irradiated during the Batch Core Experiment. Fuel rods, sleeves and inserts comprising the FERTF fuel assemblies,^(4,9) irradiated assemblies and rods from the basic core, and rods from special irradiation tests in the periphery of the core have been gamma scanned. In general, measurements were made to determine the relative power generation profiles of fuel rods along their lengths or at a point as inferred from the measured gamma-ray activity levels. For several fuel rods, including those listed in Table II, activity profiles were then used to identify positions at which gamma-ray spectra were obtained to investigate fission product migration and to identify the location of fuel samples to be cut for radiometallurgical and radiochemical analyses.

A summary of the gamma-ray measurements accomplished is listed in Table XI. Many of the entries of Table XI pertain to the data collected from fuel rods, sleeves and inserts which were components of FERTF fuel assemblies. These tests and their purposes have been discussed in several reports.^(16-19, 21) Summaries of the gamma scanning results have also been presented. However, the details of the measurements and how the results were arrived at have not been presented. These details for test 35 are included in this report in Appendix B and the details illustrate the type of measurements done and results obtained for FERTF fuel rods.

TABLE X1
SUMMARY OF PRTR FUELS AND HARDWARE ANALYZED BY GAMMA SCANNING SINCE START OF BATCH
CORE EXPERIMENT

DATE	MATERIAL IDENTIFICATION	PURPOSE OF MEASUREMENTS AND REFERENCE TO REPORTS PRESENTING RESULTS OF MEASUREMENTS	DETECTOR USED	
			NAI (TL) & Number of Spectra	Ge (Li) & Number of Spectra
Oct 17, 1968	PRTR Rod FS12	Data taken to indicate relative burnup distribution in first rod removed from Batch Core to obtain burnup data.	X	
Feb 21-23, 1968	Assemblies 6047 6019, 6031, 6035 6067, 6051, 6055 & 6066	Data taken to indicate relative power profile of assemblies (15) in the Batch Core at its midplane during the 2nd interim critical tests (Reactor shutdown, Jan 28, 1968)	X 23	
Mar 4, 5, 1968	FERTF Rods FR90 FR93, FR91, FR94 & FR95	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #28 (16,17)	X 1	
Mar 8, 1968	Rods 101 and B15	Data taken to determine whether either rod had a greater burnup than the other. (18)	X 2	
April 11, 1968	FERTF Rods FS30 FR77, FR99, FR59 FR75, FR28, FR98 & FS69	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #29. (16,17)	X 1	

TABLE XI (CONTINUED)
SUMMARY OF PRTR FUELS AND HARDWARE ANALYZED BY GAMMA SCANNING SINCE START OF BATCH
CORE EXPERIMENT IN APRIL, 1967

DATE	MATERIAL IDENTIFICATION	PURPOSE OF MEASUREMENTS AND REFERENCE TO REPORTS PRESENTING RESULTS OF MEASUREMENTS	DETECTOR USED	
			NAI (TL) & Number of Spectra	Ge (Li) & Number of Spectra
April 20-22, 1968	FERTF Rods FS31, FS32, FS33, FS34, FS35, FS36, FS37 & FS38	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #30 (16,17)	X 2	
April 23, 1968	FERTF Rods FS30 FR75, FR28, FS31 FS33 & FS34	Data repeated from FERTF tests #29 & #30. (16,17)	X 6	
April 30- May 1, 1968	FERTF Sleeves	Data taken to indicate symmetry of stainless steel & Zircaloy gamma-ray activity around the stainless steel and Zircaloy sleeves. (16,17)	X 2	
May 17-21, 1968	FERTF Rod FS34	Data taken to indicate distribution of individual fission products. (16,17)	X	X 9
May 23-27, 1968	FERTF Rods FS34 & FR28	Rods re-scanned to verify earlier data. (16,17)	X	
June 10, 1968 June 11, 1968	FERTF Sleeve FERTF Insert	The stainless steel sleeve & insert were scanned axially & around their circumference to determine gamma activity distributions in greater detail. (16,17)	X X	

TABLE XI (CONTINUED)
SUMMARY OF PRTR FUELS AND HARDWARE ANALYZED BY GAMMA SCANNING SINCE START OF BATCH
CORE EXPERIMENT IN APRIL, 1967

DATE	MATERIAL IDENTIFICATION	PURPOSE OF MEASUREMENTS AND REFERENCE TO REPORTS PRESENTING RESULTS OF MEASUREMENTS	DETECTOR USED	
			NaI (TL) & Number of Spectra	Ge (Li) & Number of Spectra
June 12, 1968	FERTF Rods FR91, FR90, FR59, FR69, FR92, FR77, FR98 & FR99	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #31 (16,17)	X	
June 13, 1968	FERTF Rods FS31, FS32, FS33, FS34, FS35, FS36, FS37, FS38	Re-scanned FERTF Test #30 (16,17)	X	
June 20, 1968	PRTR Rod FR62	Data taken to indicate relative burnup distribution of Rod. (20)	X	
June 24, 1968	FERTF Rod FR59	Rod re-scanned to obtain data with Ge (Li) detector. (16,17)	X	
July 18,19,1968	FERTF Rods FR91, FR59, FR69, FR92, FR90, FR77, FR98 & FR99	Re-scanned FERTF Test #31. (16, 17, 19)	X	
July 22,23, 1968	FERTF Rods FS31, FS32, FS33, FS34, FS35, FS36, FS37 & FS38	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #33. (17,19)	X	

TABLE XI (CONTINUED)
SUMMARY OF PRTR FUELS AND HARDWARE ANALYZED BY GAMMA SCANNING SINCE START OF BATCH
CORE EXPERIMENT IN APRIL, 1967

DATE	MATERIAL IDENTIFICATION	PURPOSE OF MEASUREMENTS AND REFERENCE TO REPORTS PRESENTING RESULTS OF MEASUREMENTS	DETECTOR USED	
			NIA (TL) & Number of Spectra	Ge (Li) & Number of Spectra
Aug 12, 1968	FERTF Rods FS41, FS42, FS43, FS44, FS45, FS46, FS47 & FS48	Data taken to indicate symmetry of power distribution around the FERTF fuel assembly--FERTF test #35. Continuous scans were done over a 6 inch portion of each rod. (17,19,21)	X	
Jan 14-24, 1969	Assemblies 6055, 6051, 6066, 6067, 6047, 6035, 6031, & 6019	Data taken to indicate relative burnup profile of Batch Core assemblies at the core midplane after the final burnup step. (Core shutdown July 14, 1968)		X 20
Feb. 18- March 7, 1969	PRTR Rods FR64, FS01, FS23, FS08, F079, FE77, & FS16	Data taken to indicate burnup profiles of Batch Core rods removed from core Jan 28 and June 4, 1968. Rods were later destructively analyzed. (This report)		X 28
Mar3, 1969	FERTF Rods FS41, FS42, FS43, FS45, FS46 & FS48	Repeat of FERTF test #35 using 6 of the 8 rods and scanning entire rod lengths. (17,19,21)		X 8
Mar 11, 1969	FERTF Rods FS41, FS42, FS43, FS45, FS46, & FS48	Repeat of FERTF test #35 using 6 of the 8 rods & scanning over the identical 6 inch portion of each rod as was done on Aug 12, 1968. (17,19,21)		X

TABLE XI (CONTINUED)
SUMMARY OF PRTR FUELS AND HARDWARE ANALYZED BY GAMMA SCANNING SINCE START OF BATCH
CORE EXPERIMENT IN APRIL, 1967

DATE	MATERIAL IDENTIFICATION	PURPOSE OF MEASUREMENTS AND REFERENCE TO REPORTS PRESENTING RESULTS OF MEASUREMENTS	DETECTOR USED	
			NIA (TL) & Number of Spectra	Ge (Li) & Number of Spectra
Sept 2-18, 1969	PRTR Rods FS07, FE74, FE69, FR78, FN86, & F017	Data taken to indicate burnup profiles of Batch Core rods removed from core after final burnup step. Reactor shutdown July 14, 1968. (This report)	X 1	X 13
Aug 27- Nov 13, 1969	PRTR Rods A102, #6, A23, FR72, 5C27, 5F36, DF80, ZZ7, ZZ12, ZZ17, DB63 CN5, CS27, 1330 1377 & 1398.	Data taken to indicate burnup profiles of Batch Core rods & PRTR peripheral rods removed from the core after final burnup step. Reactor shutdown July 14, 1968. (21)	X 3	X 43
Jan 12,13, 1970	PRTR Rods 1325 & 1807	Data taken to determine which rod had the highest gamma ray activity at the center of the fuel and therefore was an outer ring rod of PRTR assembly 1037. (Rod 1325 was the outer ring rod.) (21)		X
Sept 17,18,1970	ETR Rods F10, F11, & F12	Data taken to determine gamma activity profiles. (22)		X 9

Two entries of Table XI pertain to the scanning of intact 19-rod fuel assemblies to determine the midplane radial power distributions of the Batch Core at two different exposure levels. The first measurements were done when the assemblies had reached an average exposure of 4,000 MWD/MTM. Preliminary results from these measurements were summarized in Reference 15 and the detailed measurement procedures plus final results are given in Appendix C. The second measurements were taken after the termination of the Batch Core. These data have not been analyzed. The remaining entries of Table XI pertain to the scanning of special irradiation test rods and Batch Core rods. Rods 101, B15, FR62, A102, A1330, A1377, A1398, A1325, DB63, ZZ17, ZZ7, ZZ12, CN5, CS27, DF80, 5C27, 5F36 and #6 listed in Table XI were gamma scanned in support of either post irradiation measurements by the Fuels Research Section of the Materials Department or other burnup experiments. Summaries of the evaluations done by Fuels Research are given in References 18, 20, 21, 23, 24, and 25. Three of the rods, A1330, A1377, and A1398 were part of another burnup experiment and the gamma ray measurements made for these rods were reported in Reference 26.

From the basic core, fuel rod FS12, (average assembly exposure at 2,000 MWD/MTM), rods FS16, F079, FE77 (average assembly exposure at 4,000 MWD/MTM), and rods FR78, FS07, F017, FE74, FN86, and FE69 (Batch Core termination) were gamma scanned to determine the gamma-ray activity profiles of each rod and to collect gamma-ray spectra at specified rod positions. These measurement procedures and results are discussed in the remaining subsections of this report.

A. Procedures

All the gamma-ray measurements indicated in Table XI were done in the PNL Underwater Gamma Scan Facility. In the case of the Batch Core fuel rods (FS12 through FE69 above), the details of the facility have been reported previously^(8,26) and scanning procedures for the measurements discussed here were essentially the same as has been described.⁽⁸⁾ An exception was the procedure used to scan rod FS12 which was done before a Ge(Li) detector was available to the facility and before the x-y movement of the facility was automated. In the case of rod FS12, the scanning along the length of the rod to determine the relative activity profile was done by moving the detector housing and collimator at inch (or less) increments instead of the automated continuous movement of the detector housing and collimator as was the procedure for the rest of the rods scanned.

All rods were rotated before being scanned to determine the rod orientation of maximum activity since the rods did not rotate during measurement. Automated continuous scans to determine the relative activity profiles of each rod were made over the active fuel length using a Ge(Li) detector in conjunction with a single channel analyzer (SCA), a linear rate meter and a strip-chart recorder. Due to the long cooling times of the fuel and the low efficiency of a Ge(Li) detector, the SCA was set to accept all gamma-ray contributions with energies greater than 30 KeV to drive the ratemeter in a range that would give statistical significance to any structure in the activity profiles. A rate of travel of approximately one inch per two minutes was used.

As indicated by the last columns of Table XI, gamma-ray spectra were also collected using either a NaI(Tl) or a Ge(Li) detector and the number of spectra collected is listed in Table XI. When the activity profiles had been determined, they were used to identify rod positions at which the gamma-ray spectra were obtained. Also the activity profiles served to identify the rod locations of fuel samples to be cut for burnup and radio metallurgical analysis. The results from the burnup analyses were discussed earlier in this report and the final radiometallurgy results are presented in References 24 and 25. The gamma-ray data taken to indicate the relative activity profiles of the Batch Core rods are presented in the next section after which some of the results determined from the spectra are discussed. The Ge(Li) spectra collected from the Batch Core fuel rods are tabulated in Appendix D.

B. Relative Measurement Results

The relative axial gamma-ray activity profiles obtained by automated continuous scans of fuel rods indicated several features of interest. In general, the profiles of all rods showed a continuous distribution of fission product activity peaked at the center and ends of the $\text{UO}_2\text{-PuO}_2$ fuel which was directly related to the axial power profile. The activity peaking at the ends of the $\text{UO}_2\text{-PuO}_2$ fuel was always more pronounced for fuel rods which were from the center or 6-rod ring positions of the 19-rod assembly. Also, activity peaking at the ends of the $\text{UO}_2\text{-PuO}_2$ fuel was more evident for fuel rods from the 12-rod ring of an assembly when the assembly had been

positioned in the fifth and seventh ring of fuel channels of the core. A common feature of all rods was that the activity of the depleted UO_2 pellet at each end of the UO_2 - PuO_2 fuel evidenced much lower activity as well as evidencing some activity peaking at the pellet edge opposite to the pellet and UO_2 - PuO_2 fuel interface.

One feature noted from several of the gamma-ray activity profiles involved only those rods that were from the 12-rod ring of an assembly which had been positioned in the first and third ring of fuel channels of the core. These rods experienced higher power generation rates and as a result substantial localized concentrations of various fission products were formed. When the continuous scans were made, these localized high activity regions appeared as peaks superimposed upon the relative gamma-ray activity profiles. The width of these activity peaks indicated that the concentrations were generally less than 1/8 of an inch long and probably due to fission product migration.

To illustrate these features, the activity profiles determined for rods FS16, F079 and FE77 are shown in Figure 24. The dimensions of each rod are given in the figure and the positions of the two UO_2 pellets are also indicated. The zero on the x-scale is with reference to the beginning of the UO_2 - PuO_2 fuel at the top of the rod. The three activity profiles shown are of rods which were from assembly 6066. Assembly 6066 was irradiated in the third ring of fuel channels in the core. High activity regions appeared superimposed on the relative gamma-ray activity profile in the case of rod FS16 which was from

FIGURE 24. GAMMA-RAY ACTIVITY PROFILES OF RODS FROM POSITION r, FS16, POSITION c, F079 AND POSITION a, FE77, OF ASSEMBLY 6066 WHICH WAS IRRADIATED IN CORE RING POSITION 3.

the 12-rod ring of assembly 6066. Rod F079 was from the 6-rod ring and rod FE77 was the center rod of the assembly. The peaking at the ends of the $\text{UO}_2\text{-PuO}_2$ fuel of these latter two rods can be seen to be more pronounced than for rod FS16.

Gamma-ray activity profiles of fuel rods from the 12-rod ring of four assemblies are shown in Figure 25. Each of the assemblies had been irradiated in a different ring of fuel channels in the core. Assembly 6063 from which rod FS01 was taken was irradiated in the first ring of fuel channels. It is seen that several regions of high activity were evident in the rod over an approximate 15 inch length of the fuel which had experienced maximum power generation for the rod. A repeat scan over the 15 inch length gave identical results. Rod FS01 was then rotated 90° and rescanned over the 15 inches. This procedure was repeated three more times and except for a variation in activity as a function of rod orientation, all the structure seen in Figure 25, for rod FS01, was reproduced for each scan.

Assembly 6067 from which rod FS23 was taken was irradiated in the third ring of fuel channels and high activity regions were also evident from the gamma-ray activity profile of rod FS23. Rods FS08 and FR64 were from assemblies 6058 and 6516 which were irradiated in the fifth and seventh ring of fuel channels, respectively. The profiles for these rods showed continuous distributions of fission product activity, except for one region of low activity noted to be present in rod FR64. As indicated earlier, the activity peaking at

FIGURE 25. GAMMA-RAY ACTIVITY PROFILES OF FUEL RODS FS01, FS23, FS09 AND FR64 FROM THE 12-ROD RING POSITIONS OF ASSEMBLIES 6063, 6067, 6058 AND 6516 WHICH WERE IRRADIATED IN CORE RING POSITIONS 1, 3, 5 AND 7 RESPECTIVELY.

the ends of the $\text{UO}_2\text{-PuO}_2$ fuel is seen to be more pronounced for fuel rods further removed from the center of the core as in the case of rod FR64.

The average assembly exposure was at 4,000 MWD/MTU in the case of the rods shown in Figure 24 and at 6,000 MWD/MTU for the rods shown in Figure 25. Gamma-ray activity profiles of three rods removed at the termination of the Batch Core are shown in Figure 26. Rod FS07 from the 12-rod ring, rod F017 from the 6-rod ring and the center rod FE74 of assembly 6065 which was irradiated in the third ring of fuel channels of the core show the same features discussed above for rods from similar assembly and core positions.

The gamma-ray activity profile features of rod FN86 and FE69 (from the 6-rod ring and the center rod, respectively) of assembly 6519 were also consistent with the features described and are not presented. Assembly 6519 was removed from the seventh ring of fuel channels at the termination of the Batch Core. The profile for rod FR78 from the 12-rod ring of assembly 6520 has been presented in Reference 21, pp 3.6. Assembly 6520 was irradiated in the first ring of fuel channels of the core. All profile features of rod FR78 were consistent with those explained except that concentrations of migrating fission products were not substantial enough to result in high activity peaks superimposed upon the activity profile. Instead, the effect of migrating fission products can best be described as resulting in a nonuniform distribution over the length of the rod that experienced maximum power generation.

FIGURE 26. GAMMA-RAY ACTIVITY PROFILES OF RODS FROM THE 12-ROD RING, FS07, THE 6-ROD RING, FO17 AND THE CENTER ROD, FE74, OF ASSEMBLY 6065 WHICH WAS IRRADIATED IN THE THIRD RING OF FUEL CHANNELS

C. Gamma-Ray Spectra Results

High resolution gamma-ray spectra were collected from several of the fuel rods discussed above and these spectra are listed in Table XII. A total of 33 Ge(Li) spectra were collected and the position of 18 of these coincided with the positions of burnup samples which were later cut from the rods. The exposure of these 18 samples are also listed in Table XII and were obtained from the data tabulated in Appendix A. The remaining gamma-ray spectra were obtained from positions selected either because burnup samples were cut from the rods (but were not analyzed) or to investigate the fission product composition of high (or low) activity points as noted from the gamma-ray activity profiles determined for each rod.

It was determined from the spectra collected that fission product isotopes ^{95}Zr - ^{95}Nb , ^{106}Ru - ^{106}Rh , ^{133}Cs (by neutron capture to ^{134}Cs), ^{137}Cs and ^{144}Ce - ^{144}Pr contributed gamma rays of sufficient intensity to be readily observed. Due to the longer cooling times of the fuels involved, the short half-lived fission products had decayed away and low intensity long lived isotopes such as ^{154}Eu were beginning to become discernable (only for those rods which had cooled 430 days). Of the above isotopes it was determined that ^{106}Ru - ^{106}Rh , ^{134}Cs and ^{137}Cs contributed to the high activity points which were observed from the activity profiles. Not all three isotopes were detected concentrated at every high activity point, however, as ^{106}Ru - ^{106}Rh was generally concentrated at higher activity points by itself while

TABLE XII

SUMMARY OF HIGH RESOLUTION GAMMA-RAY SPECTRA COLLECTED FROM BATCH
CORE FUEL RODS AND PHOTOPEAK AREAS DETERMINED FROM THE SPECTRA

Fuel Assembly No.	Ring Position in Reactor (Channel No.)	Fuel Rod No.	Position in Assembly	Spectrum No.	Position in Rod (inch)	Date Taken	Live Time (hours)	Cooling Time (Days)	Exposure (MWD/MTM)	^{106}Rh @ 512 KeV	^{137}Cs @ 662 KeV	^{95}Zr @ 724 KeV	^{134}Cs @ 796 KeV	^{144}Pr @ 2186 KeV
6066	3 (1352)	FS16	r	14	{Top UO ₂ Pellet	3-2-69	12.217	398		898	709	155	18274	--
				15		3-2-69	10.000	398		2137	1960	730	293	42
				13		3-1-69	11.667	397		32195	17899	5516	1152	309
				9		2-27-69	15.000	395	3319	43559	20999	7681	2239	429
				10		2-28-69	5.500	396	5878	75444	31551	13140	5321	739
				11		2-28-69	14.500	396	4587	59541	28059	10340	3901	565
		F079 FE77	c a	12	56.30	3-1-69	10.833	397		43066	20487	7596	1874	431
				8	29.75	2-27-69	5.167	395	3800	47628	24666	8741	3403	483
				7	29.75	2-27-69	16.000	395	3238	38623	19905	7299	2605	418
6063	1 (1451)	FS01	n	25	26.56	3-7-69	18.783	279		121257	52786	45282	13460	1181
				26	26.75	3-9-69	19.867	281		106984	40263	39210	9262	1119
				23	27.31	3-7-69	3.500	279		370534	36932	46279	9026	1206
				24	29.40	3-7-69	5.833	279	8789	121828	36042	45809	8917	1254
				28	{Bottom UO ₂ Pellet	3-9-69	1.500	281		11043	7637	6247	1843	173
				27		3-9-69	1.000	281		50090	22355	19252	4880	504
6067	3 (1348)	FS23	t	22	61.00	3-6-69	14.500	278	4461	66142	28261	26342	4154	664
				21	9.20	3-6-69	5.500	278	5268	79571	32316	30900	5555	826
				18	28.60	3-5-69	5.000	277	7932	115414	38882	45740	9700	1138
				19	43.00	3-5-69	5.167	277	7148	107040	35321	41193	7966	1077
				20	48.00	3-5-69	8.833	277	6496	90227	35238	35468	6752	921
6058	5 (1253)	FS08	j	16	29.40	3-2-69	4.000	274	7032	104035	30167	40864	6591	1014
6520	1 (1548)	FR78	n	15	30.00	9-17-69	3.000	430	9485	108285	44428	9453	10332	1008
6065	3 (1554)	FS07	j	2	30.00	9-8-69	14.333	421	9039	101532	45170	9397	10614	947
				7	38.80	9-10-69	2.000	423		96563	49994	9495	11470	987
				3	39.40	9-9-69	3.000	422		176515	51341	9033	11190	923
				4	40.60	9-9-69	2.000	422		409386	48111	8827	10338	913
				6	44.20	9-10-69	1.500	423		229588	55877	8597	11765	894
				8	44.80	9-10-69	2.000	423		82477	46784	7641	10294	803
		F017 FE74	c a	5	53.60	9-9-69	15.250	422		42494	31543	4300	5518	387
				17	30.00	9-18-69	8.000	431	5778	62120	34804	5883	6724	638
				12	30.00	9-15-69	14.000	428	4817	50693	29541	4916	5223	531
6519	7 (1245)	FN86 FE69	f a	16	30.00	9-17-69	14.000	430	3266	35860	21862	2600	2232	341
				13	30.00	9-17-69	14.000	430	2860	32300	19666	2362	1963	306

^{134}Cs and ^{137}Cs were sometimes detected concentrated together.

To illustrate the localized concentrations of the various isotopes, photopeak areas of one gamma ray emitted by each of the five radioactive isotopes are tabulated in Table XII. The areas are given in counts/hour and the area for ^{134}Cs represents the sum of the 796 and the 801 KeV gamma rays. Of the spectra collected to investigate higher activity regions, spectra 14 and 15 were measured immediately above the top UO_2 pellet (at the activity peak observed from the activity profile, Figure 24) and on the UO_2 pellet, respectively, (at the valley between the activity peak and the beginning of the $\text{UO}_2\text{-PuO}_2$ fuel) of rod FS16. The activity peak was determined to consist principally of ^{134}Cs which was concentrated by a factor of 3.4 over the highest ^{134}Cs activity in the $\text{UO}_2\text{-PuO}_2$ fuel of the rod (spectrum 10). Also, ^{60}Co activity from neutron activation of the spring in the plenum contributed to the peak. The 1333 KeV gamma-ray activity had increased by a factor of 15 over the background rate of 229 ± 12 counts/hour. The background value represents the average of all ^{60}Co determination at 1333 KeV made from all spectra and the one standard deviation of the average.

Spectra 28 and 27 were measured on the bottom UO_2 pellet of rod FS01 and it was determined that the bottom activity peak, see Figure 25, was contributed to in this case by all five isotopes (spectrum 27). The isotopes ^{106}Ru - ^{106}Rh , ^{95}Zr and ^{144}Ce - ^{144}Pr were 2.4 to 2.5 times less concentrated compared to the activity at the

center of the fuel, spectrum 24, and ^{137}Ce and ^{134}Cs were 1.7 and 1.8 times less concentrated than at the center of the rod. The presence of all five isotopes may have indicated the movement of particles of $\text{UO}_2\text{-PuO}_2$ fuel to the point while the larger concentrations of ^{137}Cs and ^{134}Cs relative to $^{106}\text{Ru-}^{106}\text{Rh}$, ^{95}Zr and $^{144}\text{Ce-}^{144}\text{Pr}$ also indicated fission product migration. The lower activity of all five isotopes as seen from spectrum 28 which was measured in the valley between the bottom activity peak and the bottom of the $\text{UO}_2\text{-PuO}_2$ fuel was indicative of the expected activity of the UO_2 pellet.

Spectrum 23 of rod FS01 was measured at the center of the most prominent high activity peak (27.3 inches from the top of the $\text{UO}_2\text{-PuO}_2$ fuel) as seen from the activity profile of rod FS01 in Figure 25. The photopeak areas determined from spectrum 23 and listed in Table XII indicated that $^{106}\text{Ru-}^{106}\text{Rh}$ had concentrated at the point by a factor of 3.0 over its concentration two inches further down the rod as represented by spectrum 24. It appeared also, from spectrum 26, that there may have been a slight decrease in fuel concentration at 26.75 inches and the decrease in $^{106}\text{Ru-}^{106}\text{Rh}$, ^{95}Zr and $^{144}\text{Ce-}^{144}\text{Pr}$ activity was compensated for by the migration of ^{137}Cs and ^{134}Cs . At 3/16 of an inch away (26.56), the concentrations of ^{137}Cs and ^{134}Cs had increased even more contributing to a small activity peak while the concentrations of $^{106}\text{Ru-}^{106}\text{Rh}$, ^{95}Zr and $^{144}\text{Ce-}^{144}\text{Pr}$ were similar to their concentrations at 29.40 inches, spectrum 24.

The migration of $^{106}\text{Ru-}^{106}\text{Rh}$ was determined to be the principle cause of three high activity peaks observed from the activity profile

of fuel rod FS07 (see Figure 26). The photopeak areas listed in Table XII for spectra 3, 4, and 6 show an increase in ^{106}Ru - ^{106}Rh activity of 1.7, 4.0, and 2.2, respectively, over the ^{106}Ru - ^{106}Rh activity at the center of the fuel as represented by spectrum 2. The variation in activity of ^{137}Cs also evidenced a nonuniform distribution due to migration. However, the variations were not large as in the case of ^{106}Ru - ^{106}Rh . Spectrum 5 was measured at the point of low activity (53.6 inches) as observed from the activity profile of rod FS07.

The lower activity of all isotopes as indicated by the photopeak areas suggested a possible lower concentration of UO_2 - PuO_2 fuel at that point.

The migration of ^{106}Ru - ^{106}Rh , ^{137}Cs and ^{134}Cs were thus seen to be the causes of the high activity peaks superimposed on the activity profiles of the UO_2 - PuO_2 fuel of rods FS16, FS01, and FS07. The migration of ^{106}Ru - ^{106}Rh was somewhat independent of the migration of ^{137}Cs and ^{134}Cs although the three isotopes were determined to be concentrated together at certain points. Two isotopes, ^{134}Cs and ^{137}Cs , tended to follow the same distributions except that ^{134}Cs was found concentrated at the top of the UO_2 pellet while ^{137}Cs was not.

D. Photopeak Areas Normalized to Burnup

The normalization of the gamma-ray photopeak areas to measured burnup values for 18 of the spectra listed in Table XII remains to be done. The isotopes that appear applicable in the normalization are ^{144}Ce - ^{144}Pr and ^{95}Zr - ^{95}Nb . These isotopes did not appear to migrate

as did ^{106}Ru - ^{106}Rh , ^{134}Cs and ^{137}Cs . All the spectra are tabulated in Appendix D and decay correction data are presented throughout the report in order that the normalization can be done should the opportunity arise in the future.

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APPENDIX A

APPENDIX ATABULATION OF BURNUP SAMPLE DATA

The data obtained from measurements made on 36 burnup samples are tabulated in Table A-I on the pages that follow. The data have been processed by program ISODIL and values which result from the data processing are tabulated also. An explanation of the entries for each sample is given in the body of the report. Table IV shown there is the first page of tabulated data in this appendix. The order of the burnup samples is the same order as the listing given in Table II.

TABLE A-I

BURNUP DATA AND RESULTS AS LISTED BY PROGRAM ISODIL

pp. A-2 to A-19

A-2

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 10.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .1724+02(.17-00)--SAMPLE--ND50/48 .5531-00(.28-02) MIXTURE--ND42/50 .1433-01(.15-03)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2 .9777-00(.29-02)	PU239 .9868+19(.12+18)
U-233 .5146+19(.50+17)	U 8/3 .2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3 .1126+01(.30-02)	U-238 .5846+21(.76+19)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0 .1446-00(.14-02)	ND148 .1837+17(.31+15)

BOL U+PU=.2376(.0031)GM/ML AS CALCULATED BY ISOTOPIC DILUTION .68% SAMPLE---ND CONTAMINATION---MIXTURE 1.08%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5400-04(.200-05)	.0054(.0002)	.5163-04(.195-05)	-.3300-05(.201-05)
U-235	.6971-02(.691-05)	.6835-02(.300-04)	.6788(.0029)	.6563-02(.290-04)	-.4081-03(.299-04)
U-236	.0000(.000)	.6100-04(.300-05)	.0080(.0003)	.7810-04(.292-05)	.7810-04(.292-05)
U-238	.9730-00(.199-03)	1.0000	99.3078(.0398)	.9724-00(.429-03)	-.5395-03(.380-03)
TOTALS	.9800-00(.200-03)			.9791-00(.200-03)	-.8699-03(.379-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU239	.0263(.0006)	.4180-03(.800-05)	.0361(.0007)	.6861-05(.174-06)	.5244-05(.137-06)	.1617-05(.222-06)
PU239	90.5182(.0375)	1.0000	86.3973(.0312)	.1648-01(.275-03)	.1810-01(.181-03)	-.1613-02(.329-03)
PU240	8.2281(.0374)	.1326-00(.400-03)	11.4563(.0306)	.2195-02(.372-04)	.1652-02(.181-04)	.5429-03(.414-04)
PU241	1.1478(.0070)	.2175-01(.110-03)	1.9712(.0101)	.3792-03(.663-05)	.2314-03(.271-05)	.1478-03(.716-05)
PU242	.0796(.0018)	.1610-02(.200-04)	.1391(.0017)	.2687-04(.559-06)	.1611-04(.396-06)	.1076-04(.685-06)
TOTALS				.1909-01(.319-03)	.2000-01(.200-03)	-.9101-03(.376-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3298-03(.3005-04)	316.1	.0169(.0001)	.0491(.0049)	201.7
U-238	.9295-04(.9298-05)	90.9	.0193(.0010)		208.5
PU239	.1333-02(.5300-04)	1306.9	.0170(.0003)	.0563(.0056)	210.7
PU241	.2937-04(.2605-05)	29.0	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.1785-02(.4479-04)	1743.0			

U235/U238BOL=.941(.004) ALPHA235=.2372(.0241) U238 INTO PU239=.4484-03(.38-03)GM U236 INTO NP237=.476-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .9192+01(.46-00)--SAMPLE--ND50/48 .5569-00(.28-02) MIXTURE--ND42/50 .1226-01(.18-03)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2 .7179-00(.22-02)	PU239 .7242+19(.92+17)
U-233 .5146+19(.50+17)	U 8/3 .2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3 .8254-00(.25-02)	U-238 .4282+21(.60+19)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0 .9811-01(.49-03)	ND148 .1176+17(.16+15)

BOL U+PU=.1740(.0024)GM/ML AS CALCULATED BY ISOTOPIC DILUTION 1.30% SAMPLE---ND CONTAMINATION---MIXTURE 1.10%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5120-04(.130-05)	.0051(.0001)	.4897-04(.127-05)	-.5961-05(.136-05)
U-235	.6971-02(.691-05)	.6669-02(.275-04)	.6821(.0027)	.6598-02(.266-04)	-.3732-03(.276-04)
U-236	.0000(.000)	.6600-04(.150-05)	.0066(.0001)	.6366-04(.146-05)	.6366-04(.146-05)
U-238	.9730-00(.199-03)	1.0000	99.3062(.0398)	.9728-00(.437-03)	-.2151-03(.389-03)
TOTALS	.9800-00(.200-03)			.9795-00(.200-03)	-.5250-03(.388-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU239	.0263(.0006)	.3840-03(.800-05)	.0335(.0007)	.6317-05(.172-06)	.5244-05(.137-06)	.1073-05(.220-06)
PU239	90.5182(.0375)	1.0000	87.1444(.0315)	.1852-01(.288-03)	.1810-01(.181-03)	-.1576-02(.340-03)
PU240	8.2281(.0374)	.1252-00(.400-03)	10.9105(.0311)	.2077-02(.368-04)	.1652-02(.181-04)	.4251-03(.410-04)
PU241	1.1478(.0070)	.1953-01(.100-03)	1.7653(.0093)	.3413-03(.622-05)	.2314-03(.271-05)	.1099-03(.678-05)
PU242	.0796(.0018)	.1450-02(.200-04)	.1264(.0017)	.2425-04(.539-06)	.1611-04(.396-06)	.8148-05(.669-06)
TOTALS				.1897-01(.331-03)	.2000-01(.200-03)	-.1032-02(.387-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3095-03(.2761-04)	296.6	.0169(.0001)	.0491(.0049)	201.7
U-238	.0111-04(.6097-05)	79.3	.0193(.0010)		208.5
PU239	.1148-02(.4942-04)	1125.1	.0170(.0003)	.0563(.0056)	210.7
PU241	.2223-04(.1906-05)	21.9	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.1560-02(.3688-04)	1523.0			

U235/U238BOL=.946(.004) ALPHA235=.2060(.0192) U238 INTO PU239=.1346-03(.39-03)GM U236 INTO NP237=.354-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-3

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 29.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .1518+02(.76-00)--SAMPLE--ND50/48 .5490-00(.27-02) MIXTURE--ND42/50 .1814-01(.18-03)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4987+17(.50+15)	PU9/2	.1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2	.6970-00(.21-02)	PU239	.7034+19(.89+17)		
U-233	.5146+19(.50+17)	U 8/3	.2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3	.8325-00(.25-02)	U-238	.4319+21(.60+19)		
ND150	.7640+16(.78+14)	ND8/0	.8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0	.1716-00(.90-03)	ND148	.2230+17(.31+15)		

BOL U+PU=.1757(.0024)GM/ML AS CALCULATED BY ISOTOPIC DILUTION .77% SAMPLE---NO CONTAMINATION---MIXTURE 1.42%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.200-05)	.0053(.0002)	.5063-04(.195-05)	-.4294-05(.201-05)
U-235	.6971-02(.691-05)	.6632-02(.300-04)	.6587(.0029)	.6363-02(.290-04)	-.6077-03(.299-04)
U-236	.0000 (.000)	.1120-03(.300-05)	.0111(.0003)	.1079-03(.292-05)	.1079-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3249(.0398)	.9717-00(.439-03)	-.1263-02(.392-03)
TOTALS	.9800-00(.200-03)			.9782-00(.200-03)	-.1764-02(.390-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.5260-03(.100-04)	.0444(.0008)	.8324-05(.215-06)	.5244-05(.137-06)	.3080-05(.255-06)
PU239	.90.5182(.0375)	1.0000	.64.4033(.0373)	.1589-01(.276-03)	.1610-01(.181-03)	-.2204-02(.330-03)
PU240	.8.2281(.0374)	.1529-00(.500-03)	.12.9053(.0368)	.2440-02(.432-04)	.1652-02(.181-04)	.7882-03(.468-04)
PU241	.1.1478(.0070)	.2781-01(.140-03)	.2.4622(.0125)	.4675-03(.849-05)	.2314-03(.271-05)	.2361-03(.891-05)
PU242	.0796(.0018)	.2190-02(.200-04)	.1848(.0017)	.3524-04(.693-06)	.1611-04(.396-06)	.1913-04(.798-06)
TOTALS				.1884-01(.328-03)	.2000-01(.200-03)	-.1158-02(.384-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	F I S S I O N S (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.4993-03(.3005-04)	.478.6	.0169(.0001)	.0491(.0049)	201.7
U-236	.1529-03(.1508-04)	.149.5	.0193(.0010)		208.5
PU239	.2226-02(.7467-04)	.2182.7	.0170(.0003)	.0563(.0056)	210.7
PU241	.5220-04(.2529-05)	.51.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.2931-02(.6998-04)	.2862.3			

U235/U238BOL=.913(.004) ALPHA235=.2172(.0148) U238 INTO PU239=.1115-02(.39-03)GM U236 INTO NP237=.999-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 41.3 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .1554+02(.30-00)--SAMPLE--ND50/48 .5548-00(.28-02) MIXTURE--ND42/50 .1429-01(.29-03)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4987+17(.50+15)	PU9/2	.1031-03(.66-05)	.1499-00(.75-03)	.7420-03(.37-05)	PU9/2	.7934-00(.24-02)	PU239	.8008+19(.10+18)		
U-233	.5146+19(.50+17)	U 8/3	.2404-02(.12-04)	.7503-01(.37-03)	.7420-03(.37-05)	U 8/3	.9316-00(.28-02)	U-238	.4835+21(.65+19)		
ND150	.7640+16(.78+14)	ND8/0	.8679-02(.16-03)	.3997-00(.20-02)	.2494-01(.13-03)	ND8/0	.1650-00(.80-03)	ND148	.2142+17(.29+15)		

BOL U+PU=.1966(.0027)GM/ML AS CALCULATED BY ISOTOPIC DILUTION .76% SAMPLE---NO CONTAMINATION---MIXTURE .94%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5400-04(.200-05)	.0054(.0002)	.5160-04(.195-05)	-.3329-05(.201-05)
U-235	.6971-02(.691-05)	.6692-02(.300-04)	.6646(.0029)	.6422-02(.290-04)	-.5490-03(.299-04)
U-236	.0000 (.000)	.1060-03(.300-05)	.0105(.0003)	.1022-03(.292-05)	.1022-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3195(.0398)	.9719-00(.436-03)	-.1090-02(.388-03)
TOTALS	.9800-00(.200-03)			.9785-00(.200-03)	-.1538-02(.387-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.4740-03(.900-05)	.0423(.0008)	.7630-05(.195-06)	.5244-05(.137-06)	.2386-05(.238-06)
PU239	.90.5182(.0375)	1.0000	.65.0025(.0307)	.1616-01(.277-03)	.1810-01(.181-03)	-.1931-02(.331-03)
PU240	.8.2281(.0374)	.1467-00(.400-03)	.12.4699(.0298)	.2381-02(.413-04)	.1652-02(.181-04)	.7295-03(.451-04)
PU241	.1.1478(.0070)	.2599-01(.130-03)	.2.3174(.0117)	.4444-03(.794-05)	.2314-03(.271-05)	.2130-03(.839-05)
PU242	.0796(.0018)	.2000-02(.200-04)	.1700(.0017)	.3274-04(.649-06)	.1611-04(.396-06)	.1663-04(.760-06)
TOTALS				.1903-01(.326-03)	.2000-01(.200-03)	-.9698-03(.382-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	F I S S I O N S (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.4404-03(.3005-04)	.427.9	.0169(.0001)	.0491(.0049)	201.7
U-236	.1311-03(.1295-04)	.126.3	.0193(.0010)		208.5
PU239	.1895-02(.6511-04)	.1855.6	.0170(.0003)	.0563(.0056)	210.7
PU241	.4537-04(.2357-05)	.44.8	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.2516-02(.5906-04)	.2456.6			

U235/U238BOL=.921(.004) ALPHA235=.2297(.0174) U238 INTO PU239=.9629-03(.39-03)GM U236 INTO NP237=.849-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-4

ELEMENT 6065 ROD FS12(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 47.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.000YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .1736-02(.17-00)--SAMPLE--ND50/48 .5568-00(.28-02) MIXTURE--ND42/50 .1038-01(.52-03)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4987+17(.50+15)	PU9/2	.1031-03(.66-05)		.1499-00(.75-03)		.7420-03(.37-05)	PU9/2	.8059-00(.24-02)	PU239	.8132+19(.10+18)
U-233	.5146+19(.50+17)	U 8/3	.2404-02(.12-04)		.7503-01(.37-03)		.7420-03(.37-05)	U 8/3	.9235-00(.28-02)	U-238	.4793+21(.65+19)
ND150	.7840+16(.78+14)	ND8/0	.8679-02(.16-03)		.3997-00(.20-02)		.2494-01(.13-03)	ND8/0	.1428-00(.70-03)	ND148	.1822+17(.25+15)

BOL U+PU=.1949(.0026)GM/ML AS CALCULATED BY ISOTOPIIC DILUTION

.68% SAMPLE---ND CONTAMINATION---MIXTURE .46%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5200-04(.130-05)	.0052(.0001)	.4969-04(.127-05)	-.5238-05(.136-05)
U-235	.6971-02(.691-05)	.0761-02(.170-04)	.6715(.0016)	.6488-02(.165-04)	-.4824-03(.180-04)
U-236	.0000(.000)	.9100-04(.200-05)	.0090(.0002)	.8770-04(.195-05)	.8770-04(.195-05)
U-238	.9730-00(.199-03)	1.0000	99.3143(.0398)	.9719-00(.438-03)	-.1038-02(.390-03)
TOTALS	.9800-00(.200-03)			.9786-00(.200-03)	-.1433-02(.389-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.4490-03(.900-05)	.0386(.0008)	.7405-05(.195-06)	.5244-05(.137-06)	.2161-05(.239-06)
PU239	90.5182(.0375)	1.0000	85.9472(.0311)	.1656-01(.284-03)	.1810-01(.181-03)	-.1534-02(.337-03)
PU240	8.2281(.0374)	.1370-00(.400-03)	11.7748(.0304)	.2278-02(.396-04)	.1652-02(.181-04)	.6266-03(.435-04)
PU241	1.1478(.0070)	.2319-01(.120-03)	2.0907(.0110)	.4062-03(.729-05)	.2314-03(.271-05)	.1749-03(.777-05)
PU242	.0796(.0018)	.1730-02(.200-04)	.1487(.0017)	.2901-04(.600-06)	.1611-04(.396-06)	.1290-04(.719-06)
TOTALS				.1928-01(.330-03)	.2000-01(.200-03)	-.7179-03(.386-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3945-03(.1809-04)	378.1	.0169(.0001)	.0491(.0049)	201.7
U-238	.1124-03(.1106-04)	110.0	.0193(.0010)		208.5
PU239	.1617-02(.5278-04)	1585.1	.0170(.0003)	.0563(.0056)	210.7
PU241	.3521-04(.2145-05)	34.7	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.2159-02(.5069-04)	2108.0			

U235/U235BOL=.931(.003) ALPHA235=.2230(.0118) U238 INTO PU239=.9296-03(.39-03)GM U236 INTO NP237=.637-066M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD FS16(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL=.2909GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4845+02(.24-00)--SAMPLE--ND50/48 .5515-00(.20-02) MIXTURE--ND42/50 .7980-02(.40-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4987+17(.50+15)	PU9/2	.1031-03(.66-05)		.2500-00(.12-02)		.9905-03(.50-05)	PU9/2	.8037-00(.40-02)	PU239	.1013+20(.13+18)
ND150	.7840+16(.78+14)	ND8/0	.8679-02(.16-03)		.5997-00(.30-02)		.7428-02(.37-04)	ND8/0	.6617-01(.20-03)	ND148	.3774+17(.49+15)

BOL U+PU=.2564(.0026)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME

.24% SAMPLE---ND CONTAMINATION---MIXTURE .07%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.250-05)	.0053(.0002)	.5061-04(.243-05)	-.4313-05(.248-05)
U-235	.6971-02(.691-05)	.6514-02(.300-04)	.6471(.0029)	.6247-02(.290-04)	-.7232-03(.299-04)
U-236	.0000(.000)	.1350-03(.250-05)	.0134(.0002)	.1300-03(.243-05)	.1300-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	99.3343(.0398)	.9714-00(.429-03)	-.1623-02(.380-03)
TOTALS	.9800-00(.200-03)			.9778-00(.200-03)	-.2218-02(.378-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.6210-03(.120-04)	.0518(.0010)	.9701-05(.247-06)	.5244-05(.137-06)	.4457-05(.283-06)
PU239	90.5182(.0375)	1.0000	83.3764(.0569)	.1569-01(.261-03)	.1810-01(.181-03)	-.2409-02(.317-03)
PU240	8.2281(.0374)	.1649-00(.800-03)	13.7488(.0576)	.2598-02(.449-04)	.1652-02(.181-04)	.9458-03(.485-04)
PU241	1.1478(.0070)	.2935-01(.150-03)	2.6137(.0139)	.4959-03(.866-05)	.2314-03(.271-05)	.2645-03(.908-05)
PU242	.0796(.0018)	.2510-02(.250-04)	.2093(.0021)	.3987-04(.773-06)	.1611-04(.396-06)	.2376-04(.868-06)
TOTALS				.1883-01(.313-03)	.2000-01(.200-03)	-.1170-02(.371-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5923-03(.3001-04)	567.8	.0169(.0001)	.0491(.0049)	201.7
U-238	.1772-03(.1735-04)	173.4	.0193(.0010)		208.5
PU239	.2564-02(.7749-04)	2513.9	.0170(.0003)	.0563(.0056)	210.7
PU241	.6464-04(.2858-05)	64.0	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.3398-02(.7261-04)	3319.0			

U235/U235BOL=.896(.004) ALPHA235=.2210(.0122) U238 INTO PU239=.1452-02(.38-03)GM U236 INTO NP237=.145-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-5

ELEMENT 6066 ROD FS16(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 9.6 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2731GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4662+02(.23-00)--SAMPLE--ND50/48 .5487-00(.20-02) MIXTURE--ND42/50 .7720-02(.40-04)

ISOTOPIC DILUTION ANALYSIS
 ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .7378-00(.37-02) PU239 .9305+19(.12+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .7428-02(.37-04) ND8/0 .7205-01(.20-03) ND148 .4177+17(.54+15)
 BOL U+PU=.2407(.0024)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .25% SAMPLE---ND CONTAMINATION---MIXTURE -.02%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5206-04(.250-05)	.0052(.0002)	.4964-04(.243-05)	.5289-05(.248-05)
U-235	.6971-02(.691-05)	.6393-02(.300-04)	.6351(.0029)	.6129-02(.290-04)	.8419-03(.299-04)
U-236	.0000 (.000)	.1610-03(.300-05)	.0160(.0003)	.1550-03(.292-05)	.1550-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3437(.0398)	.9709-00(.430-03)	.2040-02(.381-03)
TOTALS	.9800-00(.200-03)			.9773-00(.199-03)	.2729-02(.380-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.7200-03(.140-04)	.0590(.0011)	.1100-04(.281-06)	.5244-05(.137-06)	.5757-05(.313-06)
PU239	.90.5182(.0375)	1.0000	.81.9588(.0623)	.1534-01(.255-03)	.1810-01(.181-03)	.2753-02(.313-03)
PU240	8.2281(.0374)	.1798-00(.900-03)	14.7362(.0630)	.2770-02(.481-04)	.1652-02(.181-04)	.1118-02(.514-04)
PU241	1.1478(.0070)	.3420-01(.200-03)	2.9938(.0179)	.5652-03(.100-04)	.2314-03(.271-05)	.3338-03(.104-04)
PU242	.0796(.0018)	.3077-02(.310-04)	.2522(.0025)	.4780-04(.930-06)	.1611-04(.396-06)	.3170-04(.101-05)
TOTALS				.1874-01(.312-03)	.2000-01(.200-03)	.1263-02(.370-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.6856-03(.3006-04)	657.1	.0169(.0001)	.0491(.0049)	201.7
U-238	.2089-03(.2042-04)	204.4	.0193(.0010)		208.5
PU239	.3024-02(.8914-04)	2965.0	.0170(.0003)	.0563(.0056)	210.7
PU241	.8648-04(.3486-05)	85.3	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.4005-02(.8527-04)	3911.8			

U235/U235BOL=.879(.004) ALPHA235=.2281(.0112) U238 INTO PU239=.1839-02(.38-03)GM U236 INTO NP237=.204-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD FS16(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 28.9 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4637+02(.23-00)--SAMPLE--ND50/48 .5511-00(.20-02) MIXTURE--ND42/50 .8090-02(.40-04)

ISOTOPIC DILUTION ANALYSIS
 ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .6654-00(.33-02) PU239 .8404+19(.11+18)
 U-233 .5146+19(.50+17) U 8/3 .2404-02(.12-04) .1499-00(.75-03) .9905-03(.50-05) U 8/3 .7530-00(.23-02) U-238 .5847+21(.84+19)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .7428-02(.37-04) ND8/0 .1015+00(.30-03) ND148 .6217+17(.80+15)
 BOL U+PU=.2383(.0034)GM/ML AS CALCULATED BY ISOTOPIC DILUTION .25% SAMPLE---ND CONTAMINATION---MIXTURE .10%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.250-05)	.0051(.0002)	.4863-04(.243-05)	.6294-05(.248-05)
U-235	.6971-02(.691-05)	.5955-02(.300-04)	.5918(.0029)	.5703-02(.291-04)	.1268-02(.299-04)
U-236	.0000 (.000)	.2370-03(.350-05)	.0236(.0003)	.2279-03(.341-05)	.2279-03(.341-05)
U-238	.9730-00(.199-03)	1.0000	.99.3796(.0398)	.9699-00(.457-03)	.3051-02(.412-03)
TOTALS	.9800-00(.200-03)			.9759-00(.199-03)	.4096-02(.411-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.1002-02(.200-04)	.0776(.0015)	.1397-04(.377-06)	.5244-05(.137-06)	.8725-05(.401-06)
PU239	.90.5182(.0375)	1.0000	.77.4600(.0741)	.1400-01(.255-03)	.1810-01(.181-03)	.4096-02(.312-03)
PU240	8.2281(.0374)	.2301-00(.120-02)	17.8235(.0765)	.3235-02(.612-04)	.1652-02(.181-04)	.1583-02(.638-04)
PU241	1.1478(.0070)	.5088-01(.250-03)	4.2095(.0215)	.7672-03(.145-04)	.2314-03(.271-05)	.5358-03(.148-04)
PU242	.0796(.0018)	.5543-02(.420-04)	.4294(.0033)	.7857-04(.155-05)	.1611-04(.396-06)	.6247-04(.160-05)
TOTALS				.1809-01(.329-03)	.2000-01(.200-03)	.1906-02(.385-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1036-02(.3013-04)	993.1	.0169(.0001)	.0491(.0049)	201.7
U-238	.3141-03(.3081-04)	307.3	.0193(.0010)		208.5
PU239	.4498-02(.1418-03)	4409.7	.0170(.0003)	.0563(.0056)	210.7
PU241	.1704-03(.6056-05)	168.2	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.6018-02(.1417-03)	5878.3			

U235/U235BOL=.818(.004) ALPHA235=.2236(.0076) U238 INTO PU239=.2749-02(.41-03)GM U236 INTO NP237=.473-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-6

ELEMENT 6066 ROD FS16(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 43.6 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .25216GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4589+02(.23-00)--SAMPLE--ND50/48 .5490-00(.20-02) MIXTURE--ND42/50 .8120-02(.40-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .6519-00(.33-02) PU239 .8227+19(.11+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .7428-02(.37-04) ND8/0 .8617-01(.25-03) ND148 .5142+17(.66+15)

BOL U+PU=.2222(.0022)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .25% SAMPLE---ND CONTAMINATION---MIXTURE .11%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5106-04(.250-05)	.0051(.0002)	.4864-04(.243-05)	-.6290-05(.248-05)
U-235	.6971-02(.691-05)	.6126-02(.300-04)	.6087(.0029)	.5867-02(.291-04)	-.1104-02(.299-04)
U-236	.0000 (.000)	.2106-03(.300-05)	.0209(.0003)	.2020-03(.292-05)	.2020-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3654(.0398)	.9700-00(.434-03)	-.2971-02(.386-03)
TOTALS	.9800-00(.200-03)			.9761-00(.199-03)	-.3876-02(.385-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.8890-03(.180-04)	.0705(.0014)	.1301-04(.341-06)	.5244-05(.137-06)	.7765-05(.367-06)
PU239	90.5182(.0375)	1.0000	79.2899(.0648)	.1469-01(.244-03)	.1810-01(.181-03)	-.3401-02(.304-03)
PU240	8.2281(.0374)	.2093-00(.100-02)	16.5954(.0662)	.3088-02(.535-04)	.1652-02(.181-04)	.1437-02(.565-04)
PU241	1.1478(.0070)	.4362-01(.220-03)	3.6941(.0193)	.6904-03(.121-04)	.2314-03(.271-05)	.4590-03(.124-04)
PU242	.0796(.0018)	.4415-02(.330-04)	.3501(.0026)	.6569-04(.120-05)	.1611-04(.396-06)	.4959-04(.126-05)
TOTALS				.1855-01(.309-03)	.2000-01(.200-03)	-.1448-02(.368-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.8988-03(.3007-04)	861.6	.0169(.0001)	.0491(.0049)	201.7
U-236	.2787-03(.2720-04)	272.7	.0193(.0010)		208.5
PU239	.4027-02(.1157-03)	3948.5	.0170(.0003)	.0563(.0056)	210.7
PU241	.1353-03(.4795-05)	133.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.5340-02(.1135-03)	5216.2			

U235/U235BOL=.842(.004) ALPHA235=.2277(.0086) U238 INTO PU239=.2703-02(.39-03)GM U236 INTO NP237=.358-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD FS16(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 48.1 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .26386GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4807+02(.24-00)--SAMPLE--ND50/48 .5492-00(.20-02) MIXTURE--ND42/50 .8340-02(.60-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .7003-00(.35-02) PU239 .8835+19(.12+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .7428-02(.37-04) ND8/0 .8029-01(.40-03) ND148 .4733+17(.65+15)

BOL U+PU=.2325(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .24% SAMPLE---ND CONTAMINATION---MIXTURE .18%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.250-05)	.0053(.0002)	.5056-04(.243-05)	-.4362-05(.248-05)
U-235	.6971-02(.691-05)	.6216-02(.300-04)	.6176(.0029)	.5956-02(.291-04)	-.1015-02(.299-04)
U-236	.0000 (.000)	.1886-03(.250-05)	.0187(.0002)	.1809-03(.243-05)	.1809-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3584(.0398)	.9704-00(.433-03)	-.2576-02(.385-03)
TOTALS	.9800-00(.200-03)			.9766-00(.199-03)	-.3413-02(.384-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.7790-03(.160-04)	.0628(.0013)	.1170-04(.309-06)	.5244-05(.137-06)	.6455-05(.338-06)
PU239	90.5182(.0375)	1.0000	80.5956(.0665)	.1508-01(.251-03)	.1810-01(.181-03)	-.3015-02(.309-03)
PU240	8.2281(.0374)	.1950-00(.100-02)	15.7161(.0680)	.2953-02(.514-04)	.1652-02(.181-04)	.1301-02(.545-04)
PU241	1.1478(.0070)	.3868-01(.190-03)	3.3297(.0171)	.6283-03(.109-04)	.2314-03(.271-05)	.3969-03(.113-04)
PU242	.0796(.0018)	.3670-02(.280-04)	.2958(.0023)	.5604-04(.103-05)	.1611-04(.396-06)	.3994-04(.110-05)
TOTALS				.1873-01(.312-03)	.2000-01(.200-03)	-.1270-02(.370-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3319-03(.3002-04)	797.4	.0169(.0001)	.0491(.0049)	201.7
U-236	.2449-03(.2394-04)	239.6	.0193(.0010)		208.5
PU239	.3512-02(.1047-03)	3443.4	.0170(.0003)	.0563(.0056)	210.7
PU241	.1090-03(.4026-05)	107.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.4698-02(.1021-03)	4587.9			

U235/U235BOL=.854(.004) ALPHA235=.2200(.0087) U238 INTO PU239=.2341-02(.38-03)GM U236 INTO NP237=.292-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-7

ELEMENT 6066 ROD F079(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .26016M/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .5778+02(.30-00)--SAMPLE--ND50/48 .5530-00(.22-02) MIXTURE--ND42/50 .8200-02(.40-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.2500-00(.12-02)	.9904-03(.50-05)	PU9/2 .7698-00(.38-02)	PU239 .9696+19(.13+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.5997-00(.30-02)	.1483-01(.74-04)	ND8/0 .7337-01(.20-03)	ND148 .2135+17(.27+15)

BOL U+PU=.2293(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .20% SAMPLE---ND CONTAMINATION---MIXTURE .14%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5400-04(.250-05)	.0054(.0002)	.5160-04(.243-05)	-.3332-05(.248-05)
U-235	.6971-02(.691-05)	.6792-02(.350-04)	.6745(.0034)	.6517-02(.339-04)	-.4533-03(.346-04)
U-236	.0000 (.000)	.9500-04(.250-05)	.0094(.0002)	.9155-04(.243-05)	.9155-04(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99,3107(.0399)	.9718-00(.431-03)	-.1135-02(.383-03)
TOTALS	.9800-00(.200-03)			.9785-00(.200-03)	-.1497-02(.381-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0000(.0000)	.3320-03(.700-05)	.0288(.0006)	.5549-05(.149-06)	.0000 (.000)	.5549-05(.149-06)
PU239	91.1282(.0370)	1.0000	86.7663(.0533)	.1679-01(.279-03)	.1822-01(.182-03)	-.1433-02(.333-03)
PU240	8.0858(.0369)	.1322-00(.700-03)	11.4705(.0538)	.2228-02(.388-04)	.1623-02(.178-04)	.6051-03(.427-04)
PU241	.7450(.0065)	.1773-01(.900-04)	1.6431(.0088)	.3205-03(.559-05)	.1502-03(.199-05)	.1704-03(.594-05)
PU242	.0410(.0009)	.1052-02(.110-04)	.0913(.0010)	.1788-04(.351-06)	.8301-05(.200-06)	.9579-05(.404-06)
TOTALS				.1936-01(.321-03)	.2000-01(.200-03)	-.6420-03(.379-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3616-03(.3470-04)	346.6	.0169(.0001)	.0609(.0061)	201.7
U-238	.1472-03(.1437-04)	144.0	.0193(.0010)		208.5
PU239	.1612-02(.5709-04)	1580.0	.0170(.0003)	.0766(.0077)	210.7
PU241	.2614-04(.1277-05)	25.8	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.2147-02(.4575-04)	2096.4			

U235/U238BOL=.935(.005) ALPHA235=.2538(.0257) U238 INTO PU239=.9915-03(.38-03)GM U236 INTO NP237=.623-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD F079(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 10.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .24926M/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .5735+02(.30-00)--SAMPLE--ND50/48 .5501-00(.20-02) MIXTURE--ND42/50 .7910-02(.60-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.2500-00(.12-02)	.9904-03(.50-05)	PU9/2 .7240-00(.36-02)	PU239 .9120+19(.12+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.5997-00(.30-02)	.1483-01(.74-04)	ND8/0 .8534-01(.42-03)	ND148 .2549+17(.35+15)

BOL U+PU=.2197(.0022)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .20% SAMPLE---ND CONTAMINATION---MIXTURE .05%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.250-05)	.0053(.0002)	.5062-04(.243-05)	-.4305-05(.248-05)
U-235	.6971-02(.691-05)	.6684-02(.350-04)	.6638(.0034)	.6411-02(.339-04)	-.5592-03(.346-04)
U-236	.0000 (.000)	.1190-03(.250-05)	.0118(.0002)	.1146-03(.243-05)	.1146-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99,3191(.0399)	.9715-00(.432-03)	-.1477-02(.383-03)
TOTALS	.9800-00(.200-03)			.9781-00(.200-03)	-.1922-02(.382-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.3610-03(.700-05)	.0309(.0006)	.5924-05(.151-06)	.0000 (.000)	.5924-05(.151-06)
PU239	91.1282(.0370)	1.0000	85.6352(.0520)	.1648-01(.274-03)	.1822-01(.182-03)	-.1739-02(.329-03)
PU240	8.0858(.0369)	.1437-00(.700-03)	12.3058(.0526)	.2378-02(.412-04)	.1623-02(.178-04)	.7547-03(.449-04)
PU241	.7450(.0065)	.2098-01(.100-03)	1.9190(.0097)	.3724-03(.647-05)	.1502-03(.199-05)	.2222-03(.677-05)
PU242	.0410(.0009)	.1275-02(.186-04)	.1092(.0015)	.2128-04(.464-06)	.8301-05(.200-06)	.1297-04(.385-06)
TOTALS				.1926-01(.320-03)	.2000-01(.200-03)	-.7432-03(.377-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.4441-03(.3470-04)	425.7	.0169(.0001)	.0609(.0061)	201.7
U-238	.1835-03(.1782-04)	179.6	.0193(.0010)		208.5
PU239	.2012-02(.6728-04)	1972.2	.0170(.0003)	.0766(.0077)	210.7
PU241	.3540-04(.1632-05)	34.9	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.2675-02(.5633-04)	2612.4			

U235/U238BOL=.920(.005) ALPHA235=.2592(.0213) U238 INTO PU239=.1298-02(.38-03)GM U236 INTO NP237=.972-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-8

ELEMENT 6066 ROD F079(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.9 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.200YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .27196M/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .5678+02(.10+00)--SAMPLE--ND50/48 .5481-00(.26-02) MIXTURE--ND42/50 .8150-02(.80-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .2500-00(.12-02) .9904-03(.50-05) PU9/2 .7392-00(.43-02) PU239 .9305+19(.13+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .1483-01(.74-04) ND8/0 .1273-00(.60-03) ND148 .4038+17(.54+15)

BOL U+PU=.2397(.0024)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .20% SAMPLE---ND CONTAMINATION---MIXTURE .11%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5200-04(.150-05)	.0052(.0001)	.4965-04(.146-05)	-.5273-05(.154-05)
U-235	.6971-02(.691-05)	.6375-02(.315-04)	.6333(.0030)	.6113-02(.305-04)	-.8573-03(.313-04)
U-236	.0000(.000)	.1700-03(.250-05)	.0169(.0002)	.1637-03(.243-05)	.1637-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3446(.0399)	.9712-00(.431-03)	-.1739-02(.383-03)
TOTALS	.9800-00(.200-03)			.9776-00(.200-03)	-.2434-02(.381-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0000(.0000)	.4920-03(.100-04)	.0409(.0008)	.7550-05(.200-06)	.0000(.000)	.7550-05(.200-06)
PU239	.91.1282(.0370)	1.0000	.83.1215(.0631)	.1541-01(.260-03)	.1822-01(.182-03)	-.2809-02(.318-03)
PU240	.8.0856(.0369)	.1703-00(.900-03)	.14.1556(.0642)	.2635-02(.466-04)	.1623-02(.178-04)	.1012-02(.499-04)
PU241	.7450(.0065)	.2655-01(.140-03)	.2.5132(.0128)	.4698-03(.830-05)	.1502-03(.199-05)	.3196-03(.853-05)
PU242	.0410(.0009)	.2031-02(.240-04)	.1688(.0020)	.3169-04(.654-06)	.8301-05(.200-06)	.2339-04(.684-06)
TOTALS				.1855-01(.314-03)	.2000-01(.200-03)	-.1446-02(.372-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.6921-03(.3142-04)	663.4	.0169(.0001)	.0491(.0049)	201.7
U-238	.2028-03(.1984-04)	198.4	.0193(.0010)		208.5
PU239	.2933-02(.8834-04)	2875.1	.0170(.0003)	.0563(.0056)	210.7
PU241	.6381-04(.2440-05)	63.0	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.3891-02(.8401-04)	3799.8			

U235/U235BOL=.877(.004) ALPHA235=.2387(.0117) U238 INTO PU239=.1542-02(.38-03)GM U236 INTO NP237=.220-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD F079(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 47.3 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .29346M/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .7324+02(.70-00)--SAMPLE--ND50/48 .5480-00(.20-02) MIXTURE--ND42/50 .8220-02(.40-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9904-03(.50-05) PU9/2 .8493-00(.42-02) PU239 .1070+20(.14+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .1483-01(.74-04) ND8/0 .1116+00(.30-03) ND148 .3471+17(.44+15)

BOL U+PU=.2566(.0026)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .16% SAMPLE---ND CONTAMINATION---MIXTURE .13%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.250-05)	.0051(.0002)	.4869-04(.243-05)	-.6238-05(.248-05)
U-235	.6971-02(.691-05)	.6587-02(.350-04)	.6543(.0034)	.6316-02(.339-04)	-.6552-03(.346-04)
U-236	.0000(.000)	.1340-03(.250-05)	.0133(.0002)	.1290-03(.243-05)	.1290-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3274(.0399)	.9711-00(.434-03)	-.1924-02(.386-03)
TOTALS	.9800-00(.200-03)			.9775-00(.199-03)	-.2452-02(.385-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0000(.0000)	.3950-03(.800-05)	.0335(.0007)	.6461-05(.169-06)	.0000(.000)	.6461-05(.169-06)
PU239	.91.1282(.0370)	1.0000	.84.8587(.0586)	.1642-01(.273-03)	.1822-01(.182-03)	-.1793-02(.328-03)
PU240	.8.0858(.0369)	.1517-00(.800-03)	.12.8731(.0592)	.2502-02(.436-04)	.1623-02(.178-04)	.8788-03(.471-04)
PU241	.7450(.0065)	.2328-01(.130-03)	.2.1100(.0122)	.4118-03(.725-05)	.1502-03(.199-05)	.2617-03(.752-05)
PU242	.0410(.0009)	.1470-02(.176-04)	.1247(.0014)	.2445-04(.495-06)	.8301-05(.200-06)	.1615-04(.534-06)
TOTALS				.1937-01(.322-03)	.2000-01(.200-03)	-.6304-03(.379-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5254-03(.3471-04)	503.6	.0169(.0001)	.0609(.0061)	201.7
U-238	.2121-03(.2051-04)	207.5	.0193(.0010)		208.5
PU239	.2312-02(.7363-04)	2266.7	.0170(.0003)	.0766(.0077)	210.7
PU241	.4405-04(.1617-05)	43.5	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.3094-02(.6549-04)	3021.3			

U235/U235BOL=.906(.005) ALPHA235=.2470(.0173) U238 INTO PU239=.1719-02(.39-03)GM U236 INTO NP237=.129-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-9

ELEMENT 6066 ROD FE77(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .16146GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3457+02(.17-00)--SAMPLE--ND50/48 .5537-00(.20-02) MIXTURE--ND42/50 .9170-02(.50-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.2500-00(.12-02)	.1981-02(.10-04)	PU9/2 .9600-00(.48-02)	PU239 .6049+19(.80+17)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.2996-00(.15-02)	.1463-01(.74-04)	ND8/0 .7738-01(.20-03)	ND148 .1132+17(.15+15)

BOL U+PU=.1423(.0014)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .34% SAMPLE---ND CONTAMINATION---MIXTURE .44%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5260-04(.260-05)	.0052(.0003)	.5027-04(.253-05)	-.4658-05(.258-05)
U-235	.6971-02(.691-05)	.6858-02(.340-04)	.6810(.0033)	.6582-02(.329-04)	-.3885-03(.337-04)
U-236	.0000 (.000)	.8200-04(.400-05)	.0081(.0004)	.7904-04(.389-05)	.7904-04(.389-05)
U-238	.9730-00(.199-03)	1.0000	.99.3056(.0399)	.9721-00(.431-03)	-.9151-03(.383-03)
TOTALS	.9800-00(.200-03)			.9788-00(.200-03)	-.1225-02(.381-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU230	.0263(.0006)	.4690-03(.110-04)	.0408(.0010)	.7882-05(.227-06)	.5244-05(.137-06)	.2638-05(.265-06)
PU239	.90.5182(.0375)	1.0000	.87.0536(.0463)	.1688-01(.280-03)	.1810-01(.181-03)	-.1219-02(.334-03)
PU240	.8.2281(.0374)	.1254-00(.600-03)	10.9165(.0465)	.2125-02(.367-04)	.1652-02(.181-04)	.4734-03(.410-04)
PU241	1.1478(.0070)	.2001-01(.100-03)	1.8606(.0098)	.3637-03(.635-05)	.2314-03(.271-05)	.1323-03(.690-05)
PU242	.0796(.0018)	.1476-02(.230-04)	.1285(.0020)	.2522-04(.575-06)	.1611-04(.396-06)	.9116-05(.698-06)
TOTALS				.1940-01(.322-03)	.2000-01(.200-03)	-.6020-03(.379-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3094-03(.3389-04)	296.5	.0169(.0001)	.0636(.0064)	201.7
U-238	.1343-03(.1312-04)	131.4	.0193(.0010)		208.5
PU239	.1365-02(.5148-04)	1337.8	.0170(.0003)	.0826(.0083)	210.7
PU241	.2487-04(.2001-05)	24.5	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.1833-02(.3895-04)	1790.3			

U235/U235BOL=.944(.005) ALPHA235=.2559(.0320) U238 INTO PU239=.7840-03(.38-03)GM U236 INTO NP237=.458-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6066 ROD FE77(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 30.3 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .28906GM/ML
 SPIKE--ND42/50 .6056-02(.24-03) ND50/42 .4664+02(.22-00)--SAMPLE--ND50/48 .5522-00(.20-02) MIXTURE--ND42/50 .8020-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.2500-00(.12-02)	.9905-03(.50-05)	PU9/2 .8317-00(.42-02)	PU239 .1049+20(.14+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.5997-00(.30-02)	.1483-01(.74-04)	ND8/0 .1170+00(.34-03)	ND148 .3668+17(.47+15)

BOL U+PU=.2548(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .25% SAMPLE---ND CONTAMINATION---MIXTURE .09%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5400-04(.250-05)	.0054(.0002)	.5154-04(.243-05)	-.3388-05(.248-05)
U-235	.6971-02(.691-05)	.6542-02(.300-04)	.6498(.0029)	.6271-02(.290-04)	-.7002-03(.299-04)
U-236	.0000 (.000)	.1540-03(.200-05)	.0153(.0002)	.1482-03(.195-05)	.1482-03(.195-05)
U-238	.9730-00(.199-03)	1.0000	.99.3295(.0398)	.9708-00(.436-03)	-.2204-02(.388-03)
TOTALS	.9800-00(.200-03)			.9772-00(.199-03)	-.2757-02(.387-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU230	.0263(.0006)	.6530-03(.130-04)	.0549(.0011)	.1062-04(.276-06)	.5244-05(.137-06)	.5381-05(.308-06)
PU239	.90.5182(.0375)	1.0000	.84.0514(.0578)	.1634-01(.272-03)	.1810-01(.181-03)	-.1757-02(.327-03)
PU240	.8.2281(.0374)	.1555-00(.800-03)	13.0700(.0585)	.2551-02(.444-04)	.1652-02(.181-04)	.8995-03(.480-04)
PU241	1.1478(.0070)	.2928-01(.150-03)	2.6286(.0140)	.5153-03(.902-05)	.2314-03(.271-05)	.2839-03(.941-05)
PU242	.0796(.0018)	.2322-02(.230-04)	.1952(.0019)	.3842-04(.744-06)	.1611-04(.396-06)	.2231-04(.843-06)
TOTALS				.1945-01(.324-03)	.2000-01(.200-03)	-.5456-03(.381-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5510-03(.2998-04)	528.1	.0169(.0001)	.0636(.0064)	201.7
U-238	.2431-03(.2333-04)	237.8	.0193(.0010)		208.5
PU239	.2400-02(.7604-04)	2412.2	.0170(.0003)	.0826(.0083)	210.7
PU241	.6087-04(.2746-05)	60.1	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.3315-02(.7024-04)	3238.2			

U235/U235BOL=.900(.004) ALPHA235=.2708(.0154) U238 INTO PU239=.1969-02(.39-03)GM U236 INTO NP237=.160-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-10

ELEMENT 6066 ROD FE77(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 47.6 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.378YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2661GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .6605+02(.33-00)--SAMPLE--ND50/48 .5522-00(.20-02) MIXTURE--ND42/50 .8000-02(.40-04)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4967+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9904-03(.50-05) PU9/2 .7766-00(.39-02) PU239 .9788+19(.13+18)
ND150 .7640+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .1483-01(.74-04) ND8/0 .9223-01(.30-03) ND148 .2769+17(.36+15)

BOL U+PU=.2346(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .18% SAMPLE---ND CONTAMINATION---MIXTURE .08%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5306-04(.250-05)	.0053(.0002)	.5061-04(.243-05)	-.4319-05(.248-05)
U-235	.6971-02(.691-05)	.6709-02(.350-04)	.6663(.0034)	.6434-02(.339-04)	-.5371-03(.346-04)
U-236	.0000 (.000)	.1256-03(.200-05)	.0124(.0002)	.1204-03(.195-05)	-.1204-03(.195-05)
U-238	.9730-08(.199-03)	1.0000	.99.3160(.0399)	.9712-00(.434-03)	-.1753-02(.386-03)
TOTALS	.9800-00(.200-03)			.9778-00(.200-03)	-.2170-02(.385-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.6030-03(.140-04)	.0514(.0012)	.9946-05(.284-06)	.5244-05(.137-06)	.4702-05(.315-06)
PU239	90.5182(.0375)	1.0000	85.2554(.0520)	.1656-01(.275-03)	.1810-01(.181-03)	-.1532-02(.330-03)
PU240	8.2281(.0374)	.1432-00(.700-03)	12.2086(.0524)	.2382-02(.413-04)	.1652-02(.181-04)	.7301-03(.451-04)
PU241	1.1478(.0070)	.2547-01(.130-03)	2.3193(.0124)	.4544-03(.794-05)	.2314-03(.271-05)	.2230-03(.839-05)
PU242	.0796(.0018)	.1939-02(.190-04)	.1653(.0016)	.3252-04(.628-06)	.1611-04(.396-06)	.1641-04(.742-06)
TOTALS				.1944-01(.323-03)	.2000-01(.200-03)	-.5576-03(.380-03)

ISOTOPE	FISSIONS (GM)	FISSIONS BY BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.4162-03(.3467-04)	399.0	.0169(.0001)	.0636(.0064)	201.7
U-238	.2014-03(.1945-04)	197.0	.0193(.0010)		208.5
PU239	.2076-02(.6791-04)	2035.3	.0170(.0003)	.0826(.0083)	210.7
PU241	.4479-04(.2307-05)	44.2	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.2738-02(.5878-04)	2675.6			

U235/U238BOL=.923(.005) ALPHA235=.2903(.0249) U238 INTO PU239=.1558-02(.39-03)GM U236 INTO NP237=.978-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6063 ROD FS01(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 28.9 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.038YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2697GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4047+02(.16-00)--SAMPLE--ND50/48 .5502-00(.25-02) MIXTURE--ND42/50 .8590-02(.10-03)

ISOTOPIIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4967+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .5870-00(.29-02) PU239 .7436+19(.99+17)
ND150 .7640+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .6923-02(.35-04) ND8/0 .1354-00(.60-03) ND148 .9281+17(.12+16)

BOL U+PU=.2377(.0024)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .29% SAMPLE---ND CONTAMINATION---MIXTURE .18%

ISOTOPIIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5106-04(.250-05)	.0051(.0002)	.4854-04(.244-05)	-.6388-05(.248-05)
U-235	.6971-02(.691-05)	.5345-02(.250-04)	.5314(.0024)	.5109-02(.243-04)	-.1862-02(.253-04)
U-236	.0000 (.000)	.3456-03(.450-05)	.0343(.0004)	.3312-03(.438-05)	.3312-03(.438-05)
U-238	.9730-08(.199-03)	1.0000	.99.4292(.0398)	.9681-00(.449-03)	-.4908-02(.403-03)
TOTALS	.9800-00(.200-03)			.9736-00(.199-03)	-.6450-02(.402-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.1636-02(.330-04)	.1166(.0023)	.2025-04(.529-06)	.5244-05(.137-06)	.1501-04(.546-06)
PU239	90.5182(.0375)	1.0000	71.1640(.0846)	.1241-01(.206-03)	.1810-01(.181-03)	-.5681-02(.274-03)
PU240	8.2281(.0374)	.3105-00(.160-02)	22.0964(.0890)	.3871-02(.673-04)	.1652-02(.181-04)	.2219-02(.697-04)
PU241	1.1478(.0070)	.7764-01(.390-03)	5.8212(.0292)	.1024-02(.178-04)	.2314-03(.271-05)	.7926-03(.180-04)
PU242	.0796(.0018)	.1127-01(.656-04)	.8618(.0061)	.1416-03(.259-05)	.1611-04(.396-06)	.1255-03(.262-05)
TOTALS				.1747-01(.291-03)	.2000-01(.200-03)	-.2529-02(.353-03)

ISOTOPE	FISSIONS (GM)	FISSIONS BY BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1521-02(.2565-04)	1456.2	.0169(.0001)	.0491(.0049)	201.7
U-238	.4700-03(.4562-04)	459.8	.0193(.0010)		208.5
PU239	.3664-02(.1916-03)	6533.2	.0170(.0003)	.0563(.0056)	210.7
PU241	.3425-03(.1106-04)	337.9	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.6997-02(.1929-03)	8789.1			

U235/U238BOL=.733(.004) ALPHA235=.2239(.0051) U238 INTO PU239=.4457-02(.40-03)GM U236 INTO NP237=.108-04GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-11

ELEMENT 6067 ROD FS23(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 6.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.036YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .25916GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3746+02(.37-00)--SAMPLE--ND50/48 .5502-00(.20-02) MIXTURE--ND42/50 .7900-02(.40-04)

ATOMS/ML IN SPIKE ISOTOPIC DILUTION ANALYSIS
 PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) SPIKE VOL(ML) .2500-00(.12-02) SAMPLE VOL(ML) .9905-03(.50-05) PU9/2 .6879-00(.34-02) PU239 .8677+19(.11+18)
 ND150 .7640+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .6923-02(.35-04) ND8/0 .7258-01(.20-03) ND148 .4518+17(.58+15)

BOL U+PU=.2284(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .31% SAMPLE---ND CONTAMINATION---MIXTURE .04%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5200-04(.250-05)	.0052(.0002)	.4962-04(.243-05)	-.5311-05(.248-05)
U-235	.6971-02(.691-05)	.6308-02(.300-04)	.6267(.0029)	.6045-02(.291-04)	-.9261-03(.299-04)
U-236	.0000 (.000)	.1790-03(.300-05)	.0178(.0003)	.1723-03(.292-05)	.1723-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	99.3503(.0396)	.9705-00(.432-03)	-.2471-02(.383-03)
TOTALS	.9800-00(.200-03)			.9768-00(.199-03)	-.3228-02(.382-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU239	.0263(.0006)	.0010-03(.166-04)	.0647(.0013)	.1203-04(.312-06)	.5244-05(.137-06)	.6785-05(.341-06)
PU240	90.5182(.0375)	1.0000	80.8244(.0668)	.1508-01(.250-03)	.1810-01(.181-03)	-.3015-02(.309-03)
PU241	8.2281(.0374)	.1938-00(.100-02)	15.6638(.0682)	.2935-02(.510-04)	.1652-02(.181-04)	.1283-02(.541-04)
PU242	1.1476(.0076)	.3723-01(.190-03)	3.1622(.0164)	.5950-03(.104-04)	.2314-03(.271-05)	.3636-03(.107-04)
PU242	.0796(.0018)	.3525-02(.350-04)	.2849(.0028)	.5383-04(.104-05)	.1611-04(.396-06)	.3772-04(.111-05)
TOTALS				.1868-01(.310-03)	.2000-01(.200-03)	-.1324-02(.369-03)

FISSIONS BY ND 148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.7521-03(.3006-04)	720.9	.0169(.0001)	.0491(.0049)	201.7
U-238	.2384-03(.2329-04)	233.2	.0193(.0010)		208.5
PU239	.3473-02(.1006-03)	3405.0	.0170(.0003)	.0563(.0056)	210.7
PU241	.1029-03(.3961-05)	101.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.4566-02(.9754-04)	4460.6			

U235/U238BOL=.867(.004) ALPHA235=.2314(.0104) U238 INTO PU239=.2242-02(.36-03)GM U236 INTO NP237=.251-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6067 ROD FS23(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 9.7 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.036YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .24886GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4279+02(.26-00)--SAMPLE--ND50/48 .5475-00(.20-02) MIXTURE--ND42/50 .7990-02(.40-04)

ATOMS/ML IN SPIKE ISOTOPIC DILUTION ANALYSIS
 PU242 .4967+17(.50+15) PU9/2 .1031-03(.66-05) SPIKE VOL(ML) .2500-00(.12-02) SAMPLE VOL(ML) .9905-03(.50-05) PU9/2 .6293-00(.31-02) PU239 .7941+19(.11+18)
 ND150 .7640+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .6923-02(.35-04) ND8/0 .8089-01(.25-03) ND148 .5127+17(.66+15)

BOL U+PU=.2193(.0022)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .27% SAMPLE---ND CONTAMINATION---MIXTURE .07%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.250-05)	.0053(.0002)	.5056-04(.243-05)	-.4366-05(.248-05)
U-235	.6971-02(.691-05)	.6063-02(.300-04)	.6025(.0029)	.5809-02(.291-04)	-.1162-02(.299-04)
U-236	.0000 (.000)	.2140-03(.300-05)	.0213(.0003)	.2059-03(.292-05)	.2059-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	99.3710(.0398)	.9703-00(.430-03)	-.2646-02(.382-03)
TOTALS	.9600-00(.200-03)			.9764-00(.199-03)	-.3606-02(.381-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU239	.0263(.0006)	.3640-03(.200-04)	.0777(.0016)	.1408-04(.370-06)	.5244-05(.137-06)	.8840-05(.394-06)
PU240	90.5182(.0375)	1.0000	78.9441(.0702)	.1437-01(.239-03)	.1810-01(.181-03)	-.3723-02(.299-03)
PU241	8.2281(.0374)	.2151-00(.110-02)	16.9609(.0722)	.3105-02(.539-04)	.1652-02(.181-04)	.1453-02(.569-04)
PU242	1.1476(.0076)	.4387-01(.220-03)	3.6595(.0185)	.6682-03(.116-04)	.2314-03(.271-05)	.4368-03(.119-04)
PU242	.0796(.0018)	.4534-02(.450-04)	.3579(.0036)	.6599-04(.128-05)	.1611-04(.396-06)	.4988-04(.134-05)
TOTALS				.1823-01(.303-03)	.2000-01(.200-03)	-.1774-02(.363-03)

FISSIONS BY ND 148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.9531-03(.3007-04)	913.5	.0169(.0001)	.0491(.0049)	201.7
U-238	.2613-03(.2745-04)	275.2	.0193(.0010)		208.5
PU239	.4024-02(.1167-03)	3945.3	.0170(.0003)	.0563(.0056)	210.7
PU241	.1361-03(.4956-05)	134.3	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.3393-02(.1146-03)	5268.3			

U235/U238BOL=.863(.004) ALPHA235=.2192(.0078) U238 INTO PU239=.2374-02(.36-03)GM U236 INTO NP237=.387-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-12

ELEMENT 6067 ROD FS23(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 29.1 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.038YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2713GM/ML
SPIKE--ND42/50 .8050-02(.24-03) ND50/42 .2735+02(.20-00)--SAMPLE--ND50/48 .5508-00(.30-02) MIXTURE--ND42/50 .8280-02(.40-04)

ISOTOPIC DILUTION ANALYSIS
ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15) PU5/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .6097-00(.30-02) PU239 .7716+19(.10+18)
ND150 .7840+16(.78+14) ND6/0 .8679-02(.16-03) .5997-00(.30-02) .6923-02(.35-04) ND8/0 .1244+00(.40-03) ND148 .8424+17(.11+16)

BOL U+PU=.2392(.0024)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .43% SAMPLE--ND CONTAMINATION--MIXTURE .13%

ISOTOPIC INVENTORY
ISOTOPE BOL (GM) EOL MASS RATIO EOL (A/O) EOL (GM) NET PRODUCTION (GM)
U-234 .5493-04(.487-06) .4900-04(.250-05) .0049(.0002) .4667-04(.244-05) -.8262-05(.248-05)
U-235 .6971-02(.691-05) .5494-02(.275-04) .5462(.0027) .5255-02(.267-04) -.1716-02(.276-04)
U-236 .0000 (.000) .3150-03(.450-05) .0313(.0004) .3026-03(.438-05) .3026-03(.438-05)
U-238 .9730-00(.199-03) 1.0000 99.4176(.0398) .9687-00(.442-03) -.4306-02(.395-03)
TOTALS .9800-00(.200-03) .9743-00(.199-03) .9743-00(.199-03) -.5728-02(.394-03)

ISOTOPE BOL (A/O) EOL MASS RATIO EOL (A/O) EOL (GM) BOL (GM) NET PRODUCTION (GM)
PU238 .0263(.0006) .1413-02(.280-04) .1028(.0020) .1802-04(.466-06) .5244-05(.137-06) .1278-04(.486-06)
PU239 .05182(.0375) 1.0000 72.7629(.0820) .1281-01(.213-03) .1810-01(.181-03) -.5289-02(.279-03)
PU240 .6.2281(.0374) .2903-00(.150-02) 21.1231(.0863) .3733-02(.649-04) .1652-02(.181-04) .2082-02(.674-04)
PU241 1.1478(.0070) .6971-01(.350-03) 5.3303(.0269) .9460-03(.165-04) .2314-03(.271-05) .7147-03(.167-04)
PU242 .0796(.0018) .9358-02(.700-04) .6809(.0051) .1214-03(.221-05) .1611-04(.396-06) .1052-03(.225-05)
TOTALS .0796(.0018) .9358-02(.700-04) .6809(.0051) .1763-01(.293-03) .2000-01(.200-03) -.2374-02(.355-03)

F I S S I O N S B Y N D 1 4 8
ISOTOPE FISSIONS (GM) BURNUP (MWD/MTM) FISSION YIELD DEL MEV/FISSION
U-235 .1406-02(.2795-04) 1347.6 .0169(.0001) .0491(.0049) 201.7
U-235 .4239-03(.4131-04) 414.7 .0193(.0010) .0604(.0060) 208.5
PU239 .6004-02(.1714-03) 5886.0 .0170(.0003) .0563(.0056) 210.7
PU241 .2872-03(.9365-05) 283.3 .0189(.0005) .0604(.0060) 213.8
TOTALS .8121-02(.1716-03) 7931.6

U235/U235BOL=.754(.004) ALPHA235=.2206(.0058) U238 INTO PU239=.3898-02(.39-03)GM U236 INTO NP237=.895-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6067 ROD FS23(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 43.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.200YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2833GM/ML
SPIKE--ND42/50 .6050-02(.24-03) ND50/42 .3920+02(.22-00)--SAMPLE--ND50/48 .5491-00(.26-02) MIXTURE--ND42/50 .8440-02(.80-04)

ISOTOPIC DILUTION ANALYSIS
ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15) PU5/2 .1031-03(.66-05) .2500-00(.12-02) .9904-03(.50-05) PU9/2 .6536-00(.33-02) PU239 .8266+19(.11+18)
ND150 .7840+16(.78+14) ND6/0 .8679-02(.16-03) .5997-00(.30-02) .6923-02(.35-04) ND8/0 .1180+00(.60-03) ND148 .7925+17(.11+16)

BOL U+PU=.2497(.0025)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .30% SAMPLE--ND CONTAMINATION--MIXTURE .17%

ISOTOPIC INVENTORY
ISOTOPE BOL (GM) EOL MASS RATIO EOL (A/O) EOL (GM) NET PRODUCTION (GM)
U-234 .5493-04(.487-06) .5100-04(.150-05) .0051(.0001) .4860-04(.146-05) -.6324-05(.154-05)
U-235 .6971-02(.691-05) .5671-02(.265-04) .5637(.0026) .5428-02(.257-04) -.1543-02(.267-04)
U-236 .0000 (.000) .2680-03(.450-05) .0286(.0004) .2768-03(.438-05) .2768-03(.438-05)
U-238 .9730-00(.199-03) 1.0000 99.4026(.0398) .9693-00(.438-03) -.3633-02(.390-03)
TOTALS .9800-00(.200-03) .9751-00(.199-03) .9751-00(.199-03) -.4907-02(.389-03)

ISOTOPE BOL (A/O) EOL MASS RATIO EOL (A/O) EOL (GM) BOL (GM) NET PRODUCTION (GM)
PU238 .0263(.0006) .1434-02(.240-04) .1072(.0018) .1876-04(.443-06) .5244-05(.137-06) .1352-04(.463-06)
PU239 .05182(.0375) 1.0000 74.7260(.0751) .1314-01(.219-03) .1810-01(.181-03) -.4958-02(.284-03)
PU240 .6.2281(.0374) .2639-00(.130-02) 19.7202(.0782) .3482-02(.604-04) .1652-02(.181-04) .1830-02(.631-04)
PU241 1.1478(.0070) .6179-01(.300-03) 4.8399(.0242) .6669-03(.151-04) .2314-03(.271-05) .6356-03(.153-04)
PU242 .0796(.0018) .7451-02(.750-04) .5568(.0056) .9912-04(.193-05) .1611-04(.396-06) .3302-04(.197-05)
TOTALS .0796(.0018) .7451-02(.750-04) .5568(.0056) .1760-01(.293-03) .2000-01(.200-03) -.2396-02(.355-03)

F I S S I O N S B Y N D 1 4 8
ISOTOPE FISSIONS (GM) BURNUP (MWD/MTM) FISSION YIELD DEL MEV/FISSION
U-235 .1200-02(.2702-04) 1206.0 .0169(.0001) .0491(.0049) 201.7
U-235 .3620-03(.3726-04) 373.7 .0193(.0010) .0604(.0060) 208.5
PU239 .5430-02(.1582-03) 5343.4 .0170(.0003) .0563(.0056) 210.7
PU241 .2265-03(.7751-05) 223.5 .0189(.0005) .0604(.0060) 213.8
TOTALS .7319-02(.1586-03) 7148.5

U235/U235BOL=.779(.004) ALPHA235=.2244(.0064) U238 INTO PU239=.3265-02(.39-03)GM U236 INTO NP237=.721-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-13

ELEMENT 6067 ROD FS23(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 48.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.038YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .28536M/L
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4183+02(.40-00)--SAMPLE--ND50/48 .5498-00(.20-02) MIXTURE--ND42/50 .8390-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4967+17(.50+15)	PU9/2	.1031-03(.66-05)	.2500-00(.12-02)	.9905-03(.50-05)	PU9/2	.6832-00(.34-02)	PU239	.8634+19(.11+18)		
ND150	.7640+16(.78+14)	ND6/0	.8679-02(.16-03)	.5997-00(.30-02)	.6923-02(.35-04)	ND8/0	.1092+00(.30-03)	ND148	.7250+17(.92+15)		

BOL U+PU=.2515(.0025)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .28% SAMPLE---ND CONTAMINATION---MIXTURE .16%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.4900-04(.250-05)	.0049(.0002)	.4671-04(.243-05)	-.8217-05(.248-05)
U-235	.6971-02(.691-05)	.5839-02(.300-04)	.5803(.0029)	.5590-02(.291-04)	-.1381-02(.299-04)
U-236	.0000(.000)	.2590-03(.400-05)	.0257(.0004)	.2490-03(.390-05)	.2490-03(.390-05)
U-238	.9730-00(.199-03)	1.0000	.993691(.0399)	.9696-00(.434-03)	-.3367-02(.386-03)
TOTALS	.9800-00(.200-03)			.9755-00(.199-03)	-.4504-02(.385-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU239	.0263(.0006)	.1122-02(.220-04)	.0857(.0017)	.1523-04(.391-06)	.5244-05(.137-06)	.9982-05(.415-06)
PU239	.90.5182(.0375)	1.0000	.76.3489(.0721)	.1363-01(.226-03)	.1810-01(.181-03)	-.4468-02(.290-03)
PU240	.8.2281(.0374)	.2455-00(.120-02)	.18.7436(.0746)	.3360-02(.582-04)	.1652-02(.181-04)	.1708-02(.609-04)
PU241	1.1478(.0070)	.5412-01(.270-03)	4.3422(.0219)	.7815-03(.136-04)	.2314-03(.271-05)	.5502-03(.139-04)
PU242	.0796(.0018)	.6282-02(.470-04)	.4796(.0036)	.8668-04(.158-05)	.1611-04(.396-06)	.7058-04(.163-05)
TOTALS				.1787-01(.297-03)	.2000-01(.200-03)	-.2130-02(.358-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1127-02(.3019-04)	1080.3	.0169(.0001)	.0491(.0049)	201.7
U-236	.3472-03(.3365-04)	339.6	.0193(.0010)		208.5
PU239	.4904-02(.1418-03)	4886.2	.0170(.0003)	.0563(.0056)	210.7
PU241	.1926-03(.6505-05)	190.0	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.6651-02(.1406-03)	6496.1			

U235/U238BOL=.802(.004) ALPHA235=.2250(.0073) U238 INTO PU239=.3033-02(.39-03)GM U236 INTO NP237=.570-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6056 ROD FS00(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 29.9 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.038YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2620GM/L
 SPIKE--ND42/50 .6056-02(.24-03) ND50/42 .4393+02(.43-00)--SAMPLE--ND50/48 .5520-00(.20-02) MIXTURE--ND42/50 .8160-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4967+17(.50+15)	PU9/2	.1031-03(.66-05)	.2500-00(.12-02)	.9905-03(.50-05)	PU9/2	.6129-00(.31-02)	PU239	.7747+19(.10+18)		
ND150	.7640+16(.78+14)	ND6/0	.8679-02(.16-03)	.5997-00(.30-02)	.6923-02(.35-04)	ND8/0	.1086+00(.30-03)	ND148	.7210+17(.92+15)		

BOL U+PU=.2319(.0025)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .27% SAMPLE---ND CONTAMINATION---MIXTURE .12%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5000-04(.250-05)	.0050(.0002)	.4765-04(.244-05)	-.7281-05(.248-05)
U-235	.6971-02(.691-05)	.5701-02(.300-04)	.5667(.0029)	.5456-02(.291-04)	-.1515-02(.299-04)
U-236	.0000(.000)	.2800-03(.450-05)	.0278(.0004)	.2691-03(.438-05)	.2691-03(.438-05)
U-238	.9730-00(.199-03)	1.0000	.994005(.0399)	.9692-00(.438-03)	-.3730-02(.390-03)
TOTALS	.9800-00(.200-03)			.9750-00(.199-03)	-.4983-02(.389-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0263(.0006)	.1223-02(.240-04)	.0916(.0018)	.1622-04(.417-06)	.5244-05(.137-06)	.1097-04(.439-06)
PU239	.90.5182(.0375)	1.0000	.74.8975(.0753)	.1332-01(.222-03)	.1810-01(.181-03)	-.4780-02(.266-03)
PU240	.8.2281(.0374)	.2637-00(.136-02)	19.7505(.0783)	.3526-02(.612-04)	.1652-02(.181-04)	.1874-02(.638-04)
PU241	1.1478(.0073)	.5933-01(.300-03)	4.7891(.0238)	.8442-03(.147-04)	.2314-03(.271-05)	.6128-03(.150-04)
PU242	.0796(.0018)	.7261-02(.550-04)	.5513(.0041)	.9924-04(.181-05)	.1611-04(.396-06)	.8314-04(.185-05)
TOTALS				.1780-01(.297-03)	.2000-01(.200-03)	-.2199-02(.358-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1240-02(.3026-04)	1186.7	.0169(.0001)	.0491(.0049)	201.7
U-236	.3757-03(.3663-04)	367.6	.0193(.0010)		208.5
PU239	.3537-02(.1527-03)	5251.8	.0170(.0003)	.0563(.0056)	210.7
PU241	.2260-03(.7342-05)	223.8	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.7199-02(.1919-03)	7031.8			

U235/U238BOL=.733(.004) ALPHA235=.2216(.0069) U238 INTO PU239=.3368-02(.39-03)GM U236 INTO NP237=.686-056M

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-14

ELEMENT 6516 ROD FR64(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.5 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.200YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL=.29876M/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4526+02(.80-00)--SAMPLE--ND50/48 .5521-00(.20-02) MIXTURE--ND42/50 .8120-02(.40-04)

ISOTOPIC DILUTION ANALYSIS
ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15) PU9/2 .1031-03(.66-05) .2500-00(.12-02) .9905-03(.50-05) PU9/2 .7532-00(.38-02) PU239 .9510+19(.13+18)
ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .5997-00(.30-02) .7428-02(.37-04) ND8/0 .1082+00(.30-03) ND148 .6692+17(.85+15)
BOL U+PU=.2633(.0026)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .26% SAMPLE---ND CONTAMINATION---MIXTURE .11%

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5000-04(.250-05)	.0050(.0002)	.4767-04(.243-05)	-.7252-05(.248-05)
U-235	.6971-02(.691-05)	.5950-02(.300-04)	.5913(.0029)	.5698-02(.291-04)	-.1273-02(.299-04)
U-236	.0000 (.000)	.2300-03(.400-05)	.0229(.0004)	.2212-03(.390-05)	-.2212-03(.390-05)
U-238	.9730-00(.199-03)	1.0000	.99.3809(.0398)	.9698-00(.435-03)	-.3141-02(.387-03)
TOTALS	.9800-00(.200-03)			.9758-00(.199-03)	-.4197-02(.386-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
U-236	.0000(.0000)	.7330-03(.150-04)	.0573(.0012)	.1046-04(.276-06)	.0000 (.000)	.1046-04(.276-06)
PU239	.91.0504(.0381)	1.0000	.78.2116(.0691)	.1434-01(.238-03)	.1820-01(.182-03)	-.3867-02(.300-03)
PU240	.8.0865(.0377)	.2252-00(.110-02)	.17.6133(.0710)	.3242-02(.562-04)	.1623-02(.179-04)	.1618-02(.590-04)
PU241	.8111(.0084)	.4558-01(.230-03)	.3.7754(.0195)	.6978-03(.122-04)	.1635-03(.234-05)	.5343-03(.124-04)
PU242	.0520(.0013)	.4378-02(.440-04)	.3424(.0034)	.6355-04(.124-05)	.1054-04(.276-06)	.5301-04(.127-05)
TOTALS				.1835-01(.306-03)	.2000-01(.200-03)	-.1651-02(.365-03)

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1048-02(.3019-04)	1004.8	.0169(.0001)	.0491(.0049)	201.7
U-238	.3057-03(.2982-04)	299.1	.0193(.0010)		208.5
PU239	.4366-02(.1254-03)	4280.6	.0170(.0003)	.0563(.0056)	210.7
PU241	.1446-03(.4966-05)	142.7	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.5865-02(.1236-03)	5727.3			

U235/U235BOL=.817(.004) ALPHA235=.2145(.0076) U238 INTO PU239=.2847-02(.39-03)GM U236 INTO NP237=.461-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6520 ROD FR78(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.700YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL=.22526M/ML
SPIKE--ND42/50 .6050-02(.24-03) ND50/42 .4298+01(.20-01)--SAMPLE--ND50/48 .5588-00(.20-02) MIXTURE--ND42/50 .1180-01(.20-03)

ISOTOPIC DILUTION ANALYSIS
ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .2500-00(.12-02) .9900-03(.50-05) PU9/2 .4619-00(.14-02) PU239 .5840+19(.74+17)
ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .4997-00(.25-02) .4944-02(.25-04) ND8/0 .1088+00(.40-03) ND148 .8366+17(.11+16)
BOL U+PU=.1985(.0020)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME 2.83% SAMPLE---ND CONTAMINATION---MIXTURE .89%

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.150-05)	.0051(.0001)	.4855-04(.146-05)	-.6380-05(.154-05)
U-235	.6971-02(.691-05)	.5119-02(.300-04)	.5091(.0029)	.4894-02(.291-04)	-.2077-02(.300-04)
U-236	.0000 (.000)	.5710-03(.100-04)	.0369(.0010)	.3562-03(.974-05)	-.3562-03(.974-05)
U-238	.9730-00(.199-03)	1.0000	.99.4490(.0399)	.9682-00(.443-03)	-.4763-02(.396-03)
TOTALS	.9800-00(.200-03)			.9735-00(.199-03)	-.6497-02(.395-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0000(.0000)	.1480-02(.600-04)	.1030(.0042)	.1721-04(.751-06)	.0000 (.000)	.1721-04(.751-06)
PU239	.91.0504(.0381)	1.0000	.69.6262(.0540)	.1168-01(.189-03)	.1820-01(.182-03)	-.6524-02(.262-03)
PU240	.8.0865(.0377)	.3365-00(.100-02)	.23.4292(.0539)	.3946-02(.648-04)	.1623-02(.179-04)	.2323-02(.672-04)
PU241	.8111(.0084)	.7927-01(.400-03)	.5.9865(.0314)	.1013-02(.173-04)	.1635-03(.234-05)	.8490-03(.174-04)
PU242	.0520(.0013)	.1228-01(.100-03)	.8550(.0069)	.1452-03(.263-05)	.1054-04(.276-06)	.1347-03(.264-05)
TOTALS				.1680-01(.272-03)	.2000-01(.200-03)	-.3201-02(.337-03)

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1709-02(.3151-04)	1638.3	.0169(.0001)	.0491(.0049)	201.7
U-238	.5069-03(.4940-04)	495.9	.0193(.0010)		208.5
PU239	.7128-02(.2054-03)	6988.9	.0170(.0003)	.0563(.0056)	210.7
PU241	.3674-03(.1158-04)	362.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.9712-02(.2060-03)	9485.5			

U235/U235BOL=.702(.004) ALPHA235=.2153(.0079) U238 INTO PU239=.4274-02(.39-03)GM U236 INTO NP237=.133-04GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-15

ELEMENT 6065 ROD FS07(12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.700YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2729GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3109+01(.15-01)--SAMPLE--ND50/48 .5647-00(.20-02) MIXTURE--ND42/50 .1350-01(.20-03)

ISOTOPIC DILUTION ANALYSIS
 ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .2500-00(.12-02) .9900-03(.50-05) PU9/2 .5665-00(.17-02) PU239 .7172+19(.91+17)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .4997-00(.25-02) .4944-02(.25-04) ND8/0 .1235+00(.40-03) ND148 .9659+17(.12+16)

BOL U+PU=.2406(.0024)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME 3.99% SAMPLE---ND CONTAMINATION---MIXTURE 1.10%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5000-04(.150-05)	.0050(.0001)	.4761-04(.146-05)	-.7318-05(.154-05)
U-235	.6971-02(.691-05)	.5259-02(.300-04)	.5229(.0029)	.5029-02(.291-04)	-.1942-02(.300-04)
U-236	.0000 (.000)	.3530-03(.100-04)	.0351(.0010)	.3390-03(.974-05)	.3390-03(.974-05)
U-238	.9730-00(.199-03)	1.0000	.99.4370(.0399)	.9685-00(.439-03)	-.4482-02(.392-03)
TOTALS	.9800-00(.200-03)			.9739-00(.199-03)	-.6097-02(.390-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.1840-02(.700-04)	.1294(.0049)	.2168-04(.896-06)	.5244-05(.137-06)	.1644-04(.907-06)
PU239	.90.5182(.0375)	1.0000	.70.3093(.0550)	.1183-01(.191-03)	.1810-01(.181-03)	-.6261-02(.263-03)
PU240	.8.2281(.0374)	.3235-00(.100-02)	.22.7451(.0549)	.3844-02(.632-04)	.1652-02(.181-04)	.2193-02(.657-04)
PU241	1.1478(.0070)	.7815-01(.400-03)	5.9598(.0316)	.1012-02(.173-04)	.2314-03(.271-05)	.7802-03(.175-04)
PU242	.0796(.0018)	.1218-01(.100-03)	.8564(.0070)	.1460-03(.265-05)	.1611-04(.396-06)	.1298-03(.268-05)
TOTALS				.1686-01(.272-03)	.2000-01(.200-03)	-.3142-02(.338-03)

FISSIONS BY ND 148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1593-02(.3150-04)	1526.6	.0169(.0001)	.0491(.0049)	201.7
U-236	.4832-03(.4709-04)	472.7	.0193(.0010)		208.5
PU239	.6824-02(.1953-03)	6690.0	.0170(.0003)	.0563(.0056)	210.7
PU241	.3543-03(.1138-04)	349.5	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.9254-02(.1955-03)	9038.8			

U235/U235BOL=.721(.004) ALPHA235=.2192(.0085) U238 INTO PU239=.4016-02(.39-03)GM U236 INTO NP237=.117-04GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6065 ROD F017(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 10.0 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .2532GM/ML
 SPIKE--ND42/50 .6056-02(.24-03) ND50/42 .4344+02(.30-00)--SAMPLE--ND50/48 .5513-00(.20-02) MIXTURE--ND42/50 .8020-02(.40-04)

ISOTOPIC DILUTION ANALYSIS
 ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .1001+00(.50-03) .4933-03(.25-05) PU9/2 .8862-00(.40-03) PU239 .8971+19(.11+18)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .4997-00(.25-02) .9864-02(.50-04) ND8/0 .1003+00(.30-03) ND148 .3849+17(.49+15)

BOL U+PU=.2232(.0022)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .27% SAMPLE---ND CONTAMINATION---MIXTURE .09%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.150-05)	.0053(.0001)	.5057-04(.146-05)	-.4358-05(.154-05)
U-235	.6971-02(.691-05)	.6416-02(.300-04)	.6374(.0029)	.6148-02(.290-04)	-.8228-03(.299-04)
U-236	.0000 (.000)	.1690-03(.250-05)	.0168(.0002)	.1626-03(.243-05)	.1626-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3406(.0398)	.9705-00(.425-03)	-.2500-02(.375-03)
TOTALS	.9800-00(.200-03)			.9768-00(.199-03)	-.3162-02(.374-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.5310-03(.270-04)	.0442(.0022)	.8436-05(.449-06)	.0000 (.000)	.8436-05(.449-06)
PU239	.91.1282(.0370)	1.0000	.83.1547(.0511)	.1595-01(.253-03)	.1822-01(.182-03)	-.2264-02(.312-03)
PU240	.8.0556(.0369)	.1708-00(.700-03)	.14.2028(.0500)	.2736-02(.448-04)	.1623-02(.178-04)	.1113-02(.482-04)
PU241	.7450(.0065)	.2700-01(.200-03)	2.4313(.0184)	.4704-03(.830-05)	.1502-03(.199-05)	.3202-03(.854-05)
PU242	.0410(.0009)	.2006-02(.600-04)	.1670(.0050)	.3244-04(.110-05)	.8301-05(.200-06)	.2414-04(.112-05)
TOTALS				.1920-01(.305-03)	.2000-01(.200-03)	-.7980-03(.365-03)

FISSIONS BY ND 148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.6508-03(.3002-04)	631.5	.0169(.0001)	.0609(.0061)	201.7
U-236	.2727-03(.2626-04)	266.8	.0193(.0010)		208.5
PU239	.2976-02(.6906-04)	2918.1	.0170(.0003)	.0766(.0077)	210.7
PU241	.6566-04(.3453-05)	65.0	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.3974-02(.6457-04)	3881.4			

U235/U235BOL=.882(.004) ALPHA235=.2490(.0122) U238 INTO PU239=.2236-02(.38-03)GM U236 INTO NP237=.209-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-16

ELEMENT 6065 ROD F017(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .26226GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .4652+02(.75-00)--SAMPLE--ND50/48 .5544-00(.20-02) MIXTURE--ND42/50 .8290-02(.30-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4987+17(.50+15)	PU9/2 .1031-03(.66-05)	.1001+00(.50-03)	.4933-03(.25-05)	PU9/2 .8483-00(.40-03)	PU239 .8610+19(.11+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.4997-00(.25-02)	.9864-02(.50-04)	ND8/0 .1462-00(.40-03)	ND148 .5936+17(.75+15)

BOL U+PU=.2311(.0023)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .25% SAMPLE---ND CONTAMINATION---MIXTURE .13%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5000-04(.150-05)	.0050(.0001)	.4765-04(.146-05)	-.7273-05(.154-05)
U-235	.6971-02(.691-05)	.5980-02(.300-04)	.5943(.0029)	.5724-02(.291-04)	-.1247-02(.299-04)
U-236	.0000 (.000)	.2450-03(.300-05)	.0243(.0003)	.2355-03(.292-05)	.2355-03(.292-05)
U-238	.9730-00(.199-03)	1.0000	.99.3764(.0398)	.9694-00(.429-03)	-.3571-02(.380-03)
TOTALS	.9800-00(.200-03)			.9754-00(.199-03)	-.4587-02(.379-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.7680-03(.380-04)	.0608(.0030)	.1131-04(.588-06)	.0000 (.000)	.1131-04(.588-06)
PU239	.91.1282(.0370)	1.0000	.79.2013(.0543)	.1479-01(.234-03)	.1822-01(.182-03)	-.3432-02(.297-03)
PU240	.8.0858(.0369)	.2156-00(.600-03)	.17.0758(.0527)	.3201-02(.521-04)	.1623-02(.178-04)	.1578-02(.551-04)
PU241	.7450(.0065)	.3936-01(.280-03)	.3.3758(.0244)	.6355-03(.111-04)	.1502-03(.199-05)	.4853-03(.113-04)
PU242	.0410(.0009)	.3615-02(.900-04)	.2863(.0071)	.5412-04(.160-05)	.8301-05(.200-06)	.4582-04(.161-05)
TOTALS				.1869-01(.297-03)	.2000-01(.200-03)	-.1312-02(.358-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.1008-02(.3007-04)	.965.8	.0169(.0001)	.0609(.0061)	201.7
U-238	.4057-03(.3896-04)	.396.9	.0193(.0010)		208.5
PU239	.4377-02(.1275-03)	.4291.6	.0170(.0003)	.0766(.0077)	210.7
PU241	.1250-03(.5374-05)	.123.3	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.5916-02(.1249-03)	.5777.7			

U235/U235BOL=.821(.004) ALPHA235=.2375(.0079) U238 INTO PU239=.3178-02(.38-03)GM U236 INTO NP237=.479-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6065 ROD FE74(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 10.0 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .21606GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3278+02(.90-00)--SAMPLE--ND50/48 .5537-00(.20-02) MIXTURE--ND42/50 .8050-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4981+17(.50+15)	PU9/2 .1030-03(.66-05)	.1001+00(.50-03)	.4933-03(.25-05)	PU9/2 .7745-00(.40-03)	PU239 .7840+19(.97+17)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.4997-00(.25-02)	.1481-01(.75-04)	ND8/0 .1068+00(.30-03)	ND148 .2756+17(.35+15)

BOL U+PU=.1904(.0019)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .36% SAMPLE---ND CONTAMINATION---MIXTURE .09%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.150-05)	.0051(.0001)	.4868-04(.146-05)	-.6249-05(.154-05)
U-235	.6971-02(.691-05)	.6519-02(.300-04)	.6476(.0029)	.6249-02(.290-04)	-.7218-03(.299-04)
U-236	.0000 (.000)	.1450-03(.200-05)	.0144(.0002)	.1396-03(.195-05)	.1396-03(.195-05)
U-238	.9730-00(.199-03)	1.0000	.99.3330(.0398)	.9708-00(.424-03)	-.2144-02(.375-03)
TOTALS	.9600-00(.200-03)			.9773-00(.199-03)	-.2727-02(.374-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.6880-03(.340-04)	.0580(.0029)	.1120-04(.581-06)	.5244-05(.137-06)	.5953-05(.597-06)
PU239	.90.5182(.0375)	1.0000	.84.2833(.0368)	.1634-01(.259-03)	.1810-01(.181-03)	-.1752-02(.316-03)
PU240	.8.2281(.0374)	.1545-00(.500-03)	.13.0218(.0367)	.2536-02(.411-04)	.1652-02(.181-04)	.8839-03(.449-04)
PU241	.1.1478(.0070)	.2685-01(.900-04)	.2.4506(.0096)	.4792-03(.784-05)	.2314-03(.271-05)	.2478-03(.829-05)
PU242	.0796(.0018)	.2211-02(.660-04)	.1864(.0056)	.3659-04(.124-05)	.1611-04(.396-06)	.2048-04(.130-05)
TOTALS				.1941-01(.308-03)	.2000-01(.200-03)	-.5940-03(.367-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5813-03(.2998-04)	.557.2	.0169(.0001)	.0636(.0064)	201.7
U-238	.2439-03(.2341-04)	.238.6	.0193(.0010)		208.5
PU239	.2452-02(.7627-04)	.2404.2	.0170(.0003)	.0826(.0083)	210.7
PU241	.5589-04(.3806-05)	.55.1	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.3333-02(.7043-04)	.3255.1			

U235/U235BOL=.896(.004) ALPHA235=.2418(.0131) U238 INTO PU239=.1908-02(.38-03)GM U236 INTO NP237=.155-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-17

ELEMENT 6065 ROD FE74(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME= 2.330YRS OXIDE FUEL= .31826M/MIL
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .5745+02(.25-00)--SAMPLE--ND50/48 .5531-00(.20-02) MIXTURE--ND42/50 .8210-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4981+17(.50+15)	PU9/2	.1030-03(.66-05)	.1499-00(.75-03)	.4933-03(.25-05)	PU9/2	.7215-00(.40-03)	PU239	.1095+20(.13+18)	ND150	.7840+16(.78+14)
ND150	.7840+16(.78+14)	ND8/0	.8679-02(.16-03)	.4997-00(.25-02)	.9864-02(.50-04)	ND8/0	.1478-00(.40-03)	ND148	.6010+17(.76+15)		

BOL U+PU=.2805(.0028)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .20% SAMPLE---ND CONTAMINATION---MIXTURE .12%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.4900-04(.150-05)	.0049(.0001)	.4672-04(.146-05)	-.8206-05(.154-05)
U-235	.6971-02(.691-05)	.6170-02(.300-04)	.6131(.0029)	.5908-02(.291-04)	-.1063-02(.299-04)
U-236	.0000 (.000)	.2110-03(.250-05)	.0210(.0002)	.2029-03(.243-05)	.2029-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3611(.0398)	.9698-00(.428-03)	-.3157-02(.379-03)
TOTALS	.9600-00(.200-03)			.9760-00(.199-03)	-.4020-02(.378-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0263(.0006)	.9490-03(.470-04)	.0770(.0038)	.1464-04(.761-06)	.5244-05(.137-06)	.9398-05(.774-06)
PU239	.90.5182(.0375)	1.0000	.81.1833(.0576)	.1549-01(.246-03)	.1810-01(.181-03)	-.2602-02(.305-03)
PU240	.8.2281(.0374)	.1882-00(.800-03)	.15.2787(.0552)	.2928-02(.481-04)	.1652-02(.181-04)	.1276-02(.514-04)
PU241	1.1478(.0070)	.3619-01(.300-03)	.3.1816(.0265)	.6123-03(.110-04)	.2314-03(.271-05)	.3809-03(.114-04)
PU242	.0796(.0018)	.3441-02(.900-04)	.2794(.0073)	.5398-04(.165-05)	.1611-04(.396-06)	.3788-04(.170-05)
TOTALS				.1910-01(.303-03)	.2000-01(.200-03)	-.8973-03(.363-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.8570-03(.3002-04)	821.5	.0169(.0001)	.0636(.0064)	201.7
U-236	.3610-03(.3454-04)	353.2	.0193(.0010)		208.5
PU239	.3611-02(.1077-03)	3540.4	.0170(.0003)	.0826(.0083)	210.7
PU241	.1033-03(.5295-05)	102.0	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.4933-02(.1038-03)	4817.0			

U235/U235BOL=.848(.004) ALPHA235=.2398(.0091) U238 INTO PU239=.2807-02(.38-03)GM U236 INTO NP237=.345-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6519 ROD FN86(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 7.8 INCHES FROM THE TOP OF THE FUEL

INPUT DATA----- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL= .24036M/MIL
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3978+02(.70-00)--SAMPLE--ND50/48 .5584-00(.20-02) MIXTURE--ND42/50 .8000-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE		SPIKE		SPIKE VOL(ML)		SAMPLE VOL(ML)		MIXTURE		ATOMS/ML IN SAMPLE	
PU242	.4981+17(.50+15)	PU9/2	.1030-03(.66-05)	.1001+00(.50-03)	.4933-03(.25-05)	PU9/2	.9004-00(.50-03)	PU239	.9109+19(.11+18)	ND150	.7840+16(.78+14)
ND150	.7840+16(.78+14)	ND8/0	.8679-02(.16-03)	.4997-00(.25-02)	.9864-02(.50-04)	ND8/0	.5290-01(.20-03)	ND148	.1809+17(.25+15)		

BOL U+PU=.2118(.0021)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .30% SAMPLE---ND CONTAMINATION---MIXTURE .07%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.150-05)	.0051(.0001)	.4873-04(.146-05)	-.6202-05(.154-05)
U-235	.6971-02(.691-05)	.6818-02(.300-04)	.6771(.0029)	.6542-02(.290-04)	-.4289-03(.299-04)
U-236	.0000 (.000)	.6400-04(.150-05)	.0063(.0001)	.8094-04(.146-05)	.8094-04(.146-05)
U-238	.9730-00(.199-03)	1.0000	.99.3095(.0398)	.9718-00(.423-03)	-.1208-02(.373-03)
TOTALS	.9800-00(.200-03)			.9784-00(.200-03)	-.1556-02(.372-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU236	.0000(.0000)	.5370-03(.270-04)	.0468(.0024)	.9128-05(.481-06)	.0000 (.000)	.9128-05(.481-06)
PU239	.91.0504(.0361)	1.0000	.87.1578(.0463)	.1707-01(.271-03)	.1820-01(.182-03)	-.1133-02(.326-03)
PU240	.8.0865(.0377)	.1278-00(.600-03)	.11.1388(.0465)	.2191-02(.362-04)	.1623-02(.179-04)	.5672-03(.404-04)
PU241	.8111(.0064)	.1639-01(.800-04)	1.5469(.0082)	.3055-03(.512-05)	.1635-03(.234-05)	.1420-03(.563-05)
PU242	.0520(.0013)	.1258-02(.380-04)	.1096(.0033)	.2174-04(.743-06)	.1054-04(.276-06)	.1121-04(.792-06)
TOTALS				.1960-01(.311-03)	.2000-01(.200-03)	-.4039-03(.370-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.3478-03(.2994-04)	333.3	.0169(.0001)	.0609(.0061)	201.7
U-236	.1348-03(.1314-04)	131.6	.0193(.0010)		208.5
PU239	.1455-02(.5173-04)	1426.1	.0170(.0003)	.0766(.0077)	210.7
PU241	.3058-04(.2239-05)	30.2	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.1968-02(.4261-04)	1921.5			

U235/U235BOL=.936(.004) ALPHA235=.2333(.0207) U238 INTO PU239=.1077-02(.37-03)GM U236 INTO NP237=.519-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-18

ELEMENT 6519 ROD FN86(6-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL= .3082GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .5430+02(.30-00)--SAMPLE--ND50/48 .5524-00(.20-02) MIXTURE--ND42/50 .8140-02(.40-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4981+17(.50+15)	PU9/2 .1030-03(.66-05)	.1499-00(.75-03)	.4933-03(.25-05)	PU9/2 .7308-00(.50-03)	PU239 .1108+20(.14+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.5997-00(.40-02)	.9864-02(.50-04)	ND8/0 .8749-01(.24-03)	ND148 .3943+17(.53+15)

BOL U+PU=.2717(.0027)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .22% SAMPLE---ND CONTAMINATION---MIXTURE .12%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5200-04(.150-05)	.0052(.0001)	.4964-04(.146-05)	-.5283-05(.154-05)
U-235	.6971-02(.691-05)	.6521-02(.300-04)	.6477(.0029)	.6252-02(.290-04)	-.7185-03(.299-04)
U-236	.0000(.000)	.1440-03(.200-05)	.0143(.0002)	.1387-03(.195-05)	.1387-03(.195-05)
U-238	.9730-00(.199-03)	1.0000	.99.3328(.0398)	.9711-00(.422-03)	-.1923-02(.373-03)
TOTALS	.9600-00(.200-03)			.9775-00(.199-03)	-.2505-02(.371-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.4460-03(.220-04)	.0377(.0019)	.7187-05(.372-06)	.0000(.000)	.7187-05(.372-06)
PU239	.91.0504(.0381)	1.0000	.84.4775(.0439)	.1618-01(.257-03)	.1820-01(.182-03)	-.2019-02(.315-03)
PU240	.8.0865(.0377)	.1562-00(.600-03)	.13.1954(.0440)	.2538-02(.415-04)	.1623-02(.179-04)	.9150-03(.452-04)
PU241	.8111(.0084)	.2341-01(.100-03)	.2.1416(.0101)	.4137-03(.686-05)	.1635-03(.234-05)	.2502-03(.725-05)
PU242	.0520(.0013)	.1751-02(.530-04)	.1479(.0045)	.2869-04(.982-06)	.1054-04(.276-06)	.1816-04(.102-05)
TOTALS				.1917-01(.304-03)	.2000-01(.200-03)	-.8290-03(.364-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5789-03(.2998-04)	554.9	.0169(.0001)	.0609(.0061)	201.7
U-238	.2292-03(.2212-04)	224.2	.0193(.0010)		208.5
PU239	.2487-02(.7770-04)	2438.4	.0170(.0003)	.0766(.0077)	210.7
PU241	.4954-04(.3038-05)	48.9	.0189(.0005)	.0799(.0080)	213.8
TOTALS	.3345-02(.7245-04)	3266.4			

U235/U238BOL=.897(.004) ALPHA235=.2412(.0131) U238 INTO PU239=.1701-02(.37-03)GM U236 INTO NP237=.154-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6519 ROD FE69(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 7.8 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL= .2496GM/ML
SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .3102+02(.12+00)--SAMPLE--ND50/48 .5573-00(.20-02) MIXTURE--ND42/50 .7930-02(.30-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE	SPIKE	SPIKE VOL(ML)	SAMPLE VOL(ML)	MIXTURE	ATOMS/ML IN SAMPLE
PU242 .4981+17(.50+15)	PU9/2 .1030-03(.66-05)	.1001+00(.50-03)	.4933-03(.25-05)	PU9/2 .9430-00(.50-03)	PU239 .9539+19(.12+18)
ND150 .7840+16(.78+14)	ND8/0 .8679-02(.16-03)	.3997-00(.16-03)	.9864-02(.50-04)	ND8/0 .5904-01(.20-03)	ND148 .1653+17(.22+15)

BOL U+PU=.2200(.0022)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .38% SAMPLE---ND CONTAMINATION---MIXTURE .04%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5100-04(.150-05)	.0051(.0001)	.4873-04(.146-05)	-.6195-05(.154-05)
U-235	.6971-02(.691-05)	.6892-02(.300-04)	.6844(.0029)	.6614-02(.290-04)	-.3570-03(.299-04)
U-236	.0000(.000)	.7700-04(.150-05)	.0076(.0001)	.7421-04(.146-05)	.7421-04(.146-05)
U-238	.9730-00(.199-03)	1.0000	.99.3029(.0398)	.9719-00(.423-03)	-.1078-02(.373-03)
TOTALS	.9600-00(.200-03)			.9786-00(.200-03)	-.1362-02(.372-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.3650-03(.300-04)	.0320(.0026)	.6255-05(.524-06)	.0000(.000)	.6255-05(.524-06)
PU239	.91.0504(.0381)	1.0000	.87.6831(.0318)	.1721-01(.273-03)	.1820-01(.182-03)	-.9943-03(.328-03)
PU240	.8.0865(.0377)	.1221+00(.400-03)	.10.7061(.0313)	.2110-02(.342-04)	.1623-02(.179-04)	.4865-03(.386-04)
PU241	.8111(.0084)	.1566-01(.800-04)	.1.4869(.0082)	.2943-03(.495-05)	.1635-03(.234-05)	.1308-03(.547-05)
PU242	.0520(.0013)	.1048-02(.310-04)	.0919(.0027)	.1826-04(.613-06)	.1054-04(.276-06)	.7726-05(.673-06)
TOTALS				.1964-01(.312-03)	.2000-01(.200-03)	-.3630-03(.370-03)

F I S S I O N S B Y N D 1 4 8

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.2827-03(.2994-04)	271.0	.0169(.0001)	.0636(.0064)	201.7
U-238	.1270-03(.1239-04)	124.3	.0193(.0010)		208.5
PU239	.1301-02(.4773-04)	1275.3	.0170(.0003)	.0826(.0083)	210.7
PU241	.2108-04(.1907-05)	20.8	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.1732-02(.3744-04)	1690.3			

U235/U238BOL=.949(.004) ALPHA235=.2628(.0285) U238 INTO PU239=.9554-03(.37-03)GM U236 INTO NP237=.394-06GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

A-19

ELEMENT 6519 ROD FE69(CENTRAL ROD) BATCH CORE THE SAMPLE WAS CUT 30.4 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.666YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS OXIDE FUEL=.2158GM/ML
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .6133+02(.36-00)--SAMPLE--ND50/48 .5498-00(.20-02) MIXTURE--ND42/50 .7810-02(.50-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .1001+00(.50-03) .4933-03(.25-05) PU9/2 .7818-00(.40-03) PU239 .7910+19(.97+17)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .4997-00(.25-02) .1481-01(.75-04) ND8/0 .9534-01(.40-03) ND148 .2418+17(.32+15)

BOL U+PU=.1902(.0019)GM/ML AS CALCULATED BY FUEL WEIGHT AND SOLUTION VOLUME .19% SAMPLE---ND CONTAMINATION---MIXTURE .03%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.150-05)	.0053(.0001)	.5061-04(.146-05)	-.4319-05(.154-05)
U-235	.6971-02(.691-05)	.6604-02(.300-04)	.6560(.0029)	.6333-02(.290-04)	-.6378-03(.299-04)
U-236	.0000(.000)	.1270-03(.250-05)	.0126(.0002)	.1223-03(.243-05)	.1223-03(.243-05)
U-238	.9730-00(.199-03)	1.0000	.99.3262(.0398)	.9712-00(.423-03)	-.1754-02(.373-03)
TOTALS	.9800-00(.200-03)			.9777-00(.200-03)	-.2270-02(.372-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.4270-03(.300-04)	.0364(.0026)	.7018-05(.505-06)	.0000(.000)	.7018-05(.505-06)
PU239	.91.0504(.0381)	1.0000	.85.3450(.0374)	.1650-01(.262-03)	.1820-01(.182-03)	-.1698-02(.319-03)
PU240	.8.0865(.0377)	.1461-00(.500-03)	.12.4689(.0374)	.2421-02(.393-04)	.1623-02(.179-04)	.7980-03(.432-04)
PU241	.8111(.0084)	.2182-01(.800-04)	2.0166(.0085)	.3933-03(.646-05)	.1635-03(.234-05)	.2298-03(.687-05)
PU242	.0520(.0013)	.1559-02(.470-04)	.1331(.0040)	.2605-04(.888-06)	.1054-04(.276-06)	.1552-04(.930-06)
TOTALS				.1935-01(.307-03)	.2000-01(.200-03)	-.6477-03(.367-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.5148-03(.3001-04)	493.5	.0169(.0001)	.0636(.0064)	201.7
U-236	.2142-03(.2061-04)	209.6	.0193(.0010)		208.5
PU239	.2157-02(.6925-04)	2114.8	.0170(.0003)	.0826(.0083)	210.7
PU241	.4234-04(.2744-05)	41.8	.0189(.0005)	.0855(.0085)	213.8
TOTALS	.2928-02(.6284-04)	2859.6			

U235/U235BOL=.909(.004) ALPHA235=.2389(.0151) U238 INTO PU239=.1546-02(.37-03)GM U236 INTO NP237=.119-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

ELEMENT 6519 ROD 4 (12-ROD RING) BATCH CORE THE SAMPLE WAS CUT 30.0 INCHES FROM THE TOP OF THE FUEL

INPUT DATA---- TIME OUT OF REACTOR=1.879YRS BOL PU241 DECAY CORRECTION TIME=-2.100YRS
 SPIKE--ND42/50 .8056-02(.24-03) ND50/42 .7599+02(.20-00)--SAMPLE--ND50/48 .5496-00(.10-02) MIXTURE--ND42/50 .9950-02(.50-04)

ISOTOPIC DILUTION ANALYSIS

ATOMS/ML IN SPIKE SPIKE SPIKE VOL(ML) SAMPLE VOL(ML) MIXTURE ATOMS/ML IN SAMPLE
 PU242 .4981+17(.50+15) PU9/2 .1030-03(.66-05) .1001+00(.50-03) .6916-02(.35-04) PU9/2 .8191+01(.10-01) PU239 .6076+19(.75+17)
 U-233 .5146+19(.50+17) U 8/3 .2404-02(.12-04) .4992-01(.25-03) .6916-02(.35-04) U 8/3 .1106+02(.70-01) U-238 .4107+21(.50+19)
 ND150 .7840+16(.78+14) ND8/0 .8679-02(.16-03) .4997-00(.25-02) .1499-00(.75-03) ND8/0 .7945-00(.15-02) ND148 .3640+17(.46+15)

BOL U+PU=.1672(.0020)GM/ML AS CALCULATED BY ISOTOPIC DILUTION .15% SAMPLE---ND CONTAMINATION---MIXTURE .14%

ISOTOPIC INVENTORY

ISOTOPE	BOL (GM)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	NET PRODUCTION (GM)
U-234	.5493-04(.487-06)	.5300-04(.150-05)	.0053(.0003)	.5058-04(.292-05)	-.4344-05(.296-05)
U-235	.6971-02(.691-05)	.6200-02(.100-03)	.6160(.0097)	.5943-02(.968-04)	-.1028-02(.970-04)
U-236	.0000(.000)	.2060-03(.400-04)	.0205(.0039)	.1983-03(.389-04)	.1983-03(.389-04)
U-238	.9730-00(.199-03)	1.0000	.99.3582(.0411)	.9707-00(.428-03)	-.2226-02(.380-03)
TOTALS	.9800-00(.200-03)			.9769-00(.199-03)	-.3059-02(.365-03)

ISOTOPE	BOL (A/O)	EOL MASS RATIO	EOL (A/O)	EOL (GM)	BOL (GM)	NET PRODUCTION (GM)
PU238	.0000(.0000)	.6200-03(.100-04)	.0496(.0008)	.8904-05(.201-06)	.0000(.000)	.8904-05(.201-06)
PU239	.91.0504(.0381)	1.0000	.79.9925(.0334)	.1442-01(.227-03)	.1820-01(.182-03)	-.1378-02(.291-03)
PU240	.8.0865(.0377)	.2071-00(.500-03)	.16.5665(.0334)	.2999-02(.477-04)	.1623-02(.179-04)	.1376-02(.510-04)
PU241	.8111(.0084)	.3560-01(.100-03)	3.1154(.0114)	.5664-03(.916-05)	.1635-03(.234-05)	.4029-03(.945-05)
PU242	.0520(.0013)	.3450-02(.200-04)	.2760(.0016)	.5038-04(.847-06)	.1054-04(.276-06)	.3985-04(.891-06)
TOTALS				.1805-01(.284-03)	.2000-01(.200-03)	-.1953-02(.347-03)

FISSIONS BY ND148

ISOTOPE	FISSIONS (GM)	BURNUP (MWD/MTM)	FISSION YIELD	DEL	MEV/FISSION
U-235	.6274-03(.1046-03)	793.1	.0169(.0001)	.0491(.0049)	201.7
U-236	.2623-03(.2629-04)	256.6	.0193(.0010)		208.5
PU239	.3826-02(.1518-03)	3751.4	.0170(.0003)	.0563(.0056)	210.7
PU241	.1087-03(.3619-05)	107.3	.0189(.0005)	.0604(.0060)	213.8
TOTALS	.5025-02(.1121-03)	4908.4			

U235/U235BOL=.853(.014) ALPHA235=.2425(.0650) U238 INTO PU239=.1972-02(.38-03)GM U236 INTO NP237=.325-05GM

-----QUANTITIES ENCLOSED BY PARENTHESES ARE ONE STANDARD DEVIATION ERRORS-----

APPENDIX B

APPENDIX BANALYSIS OF FERTF FUEL ASSEMBLY 9035 BY GAMMA SCANNINGINTRODUCTION

Test fuels have been irradiated in the Fuel Element Rupture Test Facility (FERTF) of the PRTR. To assist in researching the behavior of these fuels*, gamma activities have been measured to obtain the relative power generation profile around the circumference of the FERTF fuel assembly as part of the post-irradiation analysis. The rods from FERTF assembly 9035 have been scanned on three different occasions using different procedures to determine the power profile and to establish the reliability of the measured relative power generation values. A brief summary of the results was included in a previous quarterly report.⁽¹⁾ The detailed results are presented here along with a description of assembly 9035 and the procedures used to measure the circumferential power profile.

IRRADIATION HISTORY

Fuel assembly 9035 was an 8-rod test assembly containing vibrationally compacted UO_2 -2 wt% PuO_2 fuel and the configuration of the assembly is illustrated in Figure B-1. The assembly was irradiated in the FERTF location (process channel 1550) between June 29 and July 14, 1968, accumulating a total exposure of 4.08 MWd (324.1 MWd/MTM). After its removal from the reactor, the assembly was disassembled so that each rod could be analyzed separately. A punch mark was put on the top end cap of each rod so that the orientation of the rod in the assembly would be known.

* Conducted by the Fuels Research Section of the Materials Department

FIGURE B-1. FUEL ASSEMBLY 9035

The rods were then scanned after cooling times of 29 days, 232 days, and 240 days. The scans were made using the PNL Underwater Gamma Scan Facility.

SCANNING PROCEDURES

The first measurements were made after 29 days cooling time, using an automated continuous scan drive over a 6 in. length on each rod in the region of maximum power generation (26 7/16 in. to 32 7/16 in. from the bottom tip of the rod). The $^{95}\text{Zr}/^{95}\text{Nb}$ gamma rays were monitored by setting a single channel analyzer (SCA) to accept the pulses from a NaI(Tl) detector in the energy range from 660 KeV to 880 KeV. The activity profile over the 6 in. span was recorded using a linear rate-meter and a strip-chart recorder. Also, the area beneath the activity profile was integrated by means of a scaler in parallel with the rate-meter. The activity plots could then be compared as well as the integrated counts. Two scans were made in opposite directions over the 6 in. length to check the reproducibility of the data. A timer was used with the scaler to indicate the total elapsed time of each scan. The integrated counts were recorded as counts per second. The scan rate was 1 in. per 3 minutes (i.e., 18 min to scan the 6 in. length). A ^{137}Cs source was used after each scan for calibration. No corrections were made for background since it was constant and less than 1% of the total counts. All the data for this set of measurements were taken on the same day over a 9 hour period and no corrections for decay were made. Although an 815 KeV gamma ray from 12.8 day half-life

$^{140}\text{Ba}/^{140}\text{La}$ was present in the energy range counted, it was not the major contributor to the measured activity and decayed only 2% during the measurement interval.

After 232 days cooling time, 6 of the 8 rods were rescanned using a Ge(Li) detector (2 rods had been destructively analyzed). Continuous scans were made over the total length of the $\text{UO}_2\text{-PuO}_2$ fuel in each rod. Due to the long cooling time and the low efficiency of the detector, the single channel analyzer was set to accept all gamma rays of energies greater than 30 KeV in order to operate the ratemeter in a range that would give statistical significance to variations in the power generation profile of a rod. The area beneath the profile was again integrated by use of a scaler and timer so that, in this case, the total relative power generated by each rod could be compared. The scan rate was approximately 1.5 in. per minute. Five of the six rods were scanned on the same day and the sixth, rod FS-43, was scanned on the following day. The values measured for FS-43 appeared low and may have resulted from an electronic gain shift caused by a temperature change of 60°F which occurred.

The third set of measurements scanned the same 6 in. of fuel as the first measurements and were done after 240 days cooling. The Ge(Li) detector was used to take this set of data, on the same day, including two repeat measurements. Again, the single channel analyzer was set to accept all gamma rays of energy greater than 30 KeV and a scaler was used to integrate the area beneath the activity profiles. The scan rate was approximately 1 in. per 5 minutes.

RESULTS

The activity profiles for rod FS-43 by each method are shown in Figures B-2. These results are typical of the results obtained from all the rods. The profiles for the 6 in. (from 26 7/16 to 32 3/16 inches) show very nearly the same details. Three points of low activity are discernible in each trace. The integrated activities in counts per second are presented in Table B-I for all measurements. In addition, each set of data has been averaged and the average value used to normalize each count rate of the set. The normalized values as a function of rod position in element 9035 are shown in Figure B-3.

It is concluded from Table B-I and Figure B-3 that the relative power generation profile around the circumference of element 9035 in the region of peak power was constant to within $\pm 1.0\%$. Each of the three measurement procedures gave this result, independent of the other two sets of data. Measurement method number two where the entire fuel length was scanned appeared the most favorable since the total power generation profile of each rod was determined.

REFERENCE

1. D. G. Carter, T. B. Burley and M. D. Freshley, "PRTR Fuel Evaluations," Plutonium Utilization Program Technical Activities Quarterly Report - September, October, November 1969, BNWL-1289, p. 3.1 (January 1970).

FIGURE B-2. GAMMA-RAY ACTIVITY PROFILES FOR ROD FS43 A) OVER 6-INCH LENGTH AFTER 29 DAYS COOLING, B) OVER TOTAL LENGTH AFTER 233 DAYS COOLING AND C) OVER 6 INCH LENGTH AFTER 240 DAYS COOLING. THE 6 INCH LENGTH IS IDENTIFIED WITH REFERENCE TO THE BOTTOM TIP OF THE ROD

TABLE B-I
 INTEGRATED ACTIVITY EXPRESSED AS COUNTS PER SECOND
 FROM CONTINUOUS SCANS OF FERTF RODS
 MEASURED AFTER 29, 232, AND 240 DAYS COOLING TIME

	<u>Set I: Over 6 in. Length</u>		<u>Set II: Over Entire Fuel Length</u>	<u>Set III: Over 6 in. Length</u>	
	<u>Toward Top of Rod</u>	<u>Toward Bottom of Rod</u>		<u>Toward Bottom of Rod</u>	<u>Repeat</u>
FS 41	678.5 (1.0012)	680.9 (1.0048)	309.0 (1.0006)	359.2 (1.0093)	356.9 (1.0028)
FS 42	676.6 (0.9984)	682.8 (1.0075)	308.8 (1.0001)	356.5 (1.0045)	
FS 43	680.7 (1.0045)	680.9 (1.0048)	305.1 (0.9880)	354.4 (0.9958)	356.1 (1.0006)
FS 44	684.7 (1.0104)	684.1 (1.0094)			
FS 45	675.8 (0.9972)	675.9 (0.9973)	309.2 (1.0012)	354.9 (0.9972)	
FS 46	674.3 (0.9951)	674.0 (0.9946)	310.6 (1.0059)	352.3 (0.9899)	
FS 47	673.6 (0.9941)	673.3 (0.9936)			
FS 48	673.3 (0.9936)	673.0 (0.9932)	310.1 (1.0041)	355.6 (0.9992)	
Averages	677.7	677.7	308.8	355.9	355.9

Note: Numbers in parentheses () are the integrated activity of the *i*th rod in the assembly divided by the integrated activity averaged over all rods in the assembly.

FIGURE B-3. NORMALIZED ACTIVITY OF EIGHT RODS FROM FUEL ASSEMBLY 9035 AS A FUNCTION OF ROD POSITION. THE VALUES SHOWN ARE LISTED IN TABLE B-1.

APPENDIX CGAMMA-RAY SCANNING OF INTACT FUEL ASSEMBLIESPROCEDURE

During the scanning of intact 19-rod fuel assemblies using a NaI(Tl) detector, gamma-ray spectra were accumulated on a 512 multi-channel analyzer (MCA). Simultaneously, single channel analyzer (SCA) data were also taken. The ^{140}Ba - ^{140}La and ^{95}Zr - ^{95}Nb gammas were monitored with the SCA using energy ranges from 1480 to 1700 KeV and from 662 to 878 KeV, respectively. The procedure was to accumulate a 10 minute live time count on the MCA at the same time taking two four minute counts with the SCA and a scaler, one in each energy range mentioned above. After a spectrum was accumulated, the spectrum was stored in the first 256 channels of the MCA and the procedure was repeated with the aperture closed to collect a background spectrum in the second 256 channels and to determine SCA background counts. The background spectrum was then subtracted from the first spectrum while both spectra were stored in the MCA. The resulting background corrected spectrum was then typed out. Using this procedure, a total of 23 spectra were obtained and recorded along with SCA data from eight assemblies.

The eight assemblies represented one assembly each from core ring positions 1, 2, 4, 5, 6 and 7 and two assemblies from core ring position 3 of the Batch Core. Measurements were made at the axial peak power position of each assembly. A 1/16 inch diameter aperture positioned at

27-9/16 inches from the top of the fuel was used while scanning. Since the orientation of each assembly in its process tube was fixed (see Figure 5 in the body of the report), measurements were made on the inside (major gusset up) and outside (major gusset down) edge rods of the assemblies relative to the center of the core. The assemblies were positioned horizontally during scanning.

The purpose of the measurements was to infer the shape of the core radial power profile. The MCA and SCA data were taken concurrently to give more credence to the results from either set of measurements and to expand upon the results obtained solely from SCA measurements.

RESULTS

The assemblies scanned are identified in Table C-I. As indicated, the data were collected February 21 to 23, 1968, which was three weeks after reactor shutdown, January 28, 1968. Spectra obtained using the NaI(Tl) detector and the MCA are shown in Figure C-1 where a spectrum plus background, a background spectrum and a spectrum minus background are illustrated. Also illustrated are the SCA window settings used to monitor the ^{140}Ba - ^{140}La gamma ray at 1600 KeV and the ^{95}Zr - ^{95}Nb gamma rays.

Due to the short cooling time of the fuel and the half-life of ^{140}Ba - ^{140}La (12.8 days), the peak at 1600 KeV was contributed to primarily by ^{140}Ba - ^{140}La and would thus indicate the power profile during the last month of reactor operation. Although other fission products contributed gamma-ray activity within the energy setting of the SCA, the relative contributions were small compared to ^{140}Ba - ^{140}La and no corrections were made to account for them.

TABLE C-1

GAMMA-RAY ACTIVITY MEASUREMENTS FROM INTACT FUEL ASSEMBLIES

ASSEMBLY AND MEASUREMENT DATA						GAMMA-RAY ACTIVITY RESULTS					
Assembly No.	Core Ring Position	Orientation*	Date	Time	Distance** From Core Center	¹⁴⁰ La- ¹⁴⁰ Ba @ 1600 KeV			⁹⁵ Zr- ⁹⁵ Nb @ ~750 KeV		
						SCA C/M	MCA C/M	MCA SCA	SCA C/M	MCA C/M	MCA SCA
6055	1	Up	2-22-68	11:15	17.16	7739	6591	0.852	36214	22801	0.630
		Down		11:55	23.48	7586	6540	0.862	36550	23265	0.636
6051	2	Up		9:35	32.03	9836	8617	0.876	40999	26410	0.644
		Down		10:23	38.36	7051	6067	0.860	34260	21648	0.632
		Up		13:32	32.03	8424	7245	0.860	40025	24070	0.638
		Up		8:15	32.03	9257	8127	0.878	39142	24932	0.637
		Up	2-23-68	11:05	32.03	9260	7970	0.861	38410	24256	0.631
		Up		11:27	32.03	8584	7424	0.865	37377	23877	0.639
		Up		11:50	32.03	8940	7740	0.866	37748	24239	0.642
		Up		14:30	37.48	7358	6327	0.860	33900	21059	0.621
6066	3	Down	2-22-68	15:10	43.80	6975	5951	0.853	33111	20663	0.624
		Up		16:00	37.48	7043	5935	0.843	34279	21003	0.613
6067	3	Down	2-21-68	15:10	43.80	6638	5637	0.849	31374	19041	0.607
		Up		8:20	37.48	6994	6003	0.858	33573	20739	0.618
		Up		8:17	53.14	6335	5397	0.852	32186	20217	0.628
6047	4	Down	2-21-68	8:50	59.46	5870	5094	0.868	26950	16665	0.618
		Up		13:37	57.80	5962	5115	0.858	29271	18142	0.620
6035	5	Down		14:19	64.12	5528	4711	0.852	24342	14391	0.591
		Up		11:37	67.23	5879	5152	0.876	20741	17247	0.638
6031	6	Down		12:20	73.55	4753	5057	0.854	21120	12526	0.593
		Up		12:43	67.23	5258	4480	0.852	25973	16300	0.628
6019	7	Up		10:00	70.10	4965	4308	0.867	22286	136171	0.611
		Down		10:45	76.43	4397	3821	0.869	19494	11588	0.594

* Major gusset up or down.

** Distance in cm.

FIGURE C-1. TYPICAL GAMMA RAY SPECTRA OBTAINED WITH NaI(TL) DETECTOR AND MCA

The ^{140}Ba - ^{140}La SCA results are given in Table C-I where the numbers in counts per minute, corrected for background and decay, are listed. The zero time reference point was chosen as 8:17 A.M. on February 21, 1968, and the largest decay correction was 12%. The ^{140}Ba - ^{140}La MCA results are also shown in Table C-I and were obtained by integrating the peak plus Compton and then subtracting the Compton values. The MCA values were also decay corrected. The SCA data correspond directly to the MCA integrated peak plus Compton values and the ratio of peak plus Compton integrated values to SCA values (both decay corrected) was 1.087 ± 0.008 or $\pm 0.7\%$.^{*} The MCA integrated values and the SCA values thus provided the same information to within one percent. The ratio of the peak minus Compton values from the MCA spectra which are given in Table C-I to the SCA values was 0.860 ± 0.009 or $\pm 1.1\%$ indicating that peak minus Compton values and the SCA data also provided the same information. The latter ratio values for each set of measurements are listed in Table C-I.

The ^{140}Ba - ^{140}La results (at 1600 KeV) for both the SCA and MCA measurements are shown in Figure C-2 as a function of assembly core position. Except for two measurements, from assemblies 6051, ring position 2, and 6031, ring position 6, the results indicated a cosine power distribution consistent with measured tube power data. The results also provided quantitative information about the power tilt across an assembly at various radial positions in the core. The high

* The value represents the average ratio from all measurements and the plus and minus value is the one standard deviation of the average. All comparison values used in this appendix are given in this same format.

C-6

FIGURE C-2. RADIAL POWER DISTRIBUTION FOR BATCH CORE PRIOR TO SHUTDOWN ON JANUARY 28, 1968

values from assembly 6051 (up) as seen in Figure C-2 and Table C-I was determined to be due to a localized accumulation of fission products similar to those indicated by the gamma-ray activity profiles of several rods given in the body of the report. The high values did not represent a peak in the power distribution. Additional axial measurements over a 17-inch span using SCA readings only indicated an activity of 7350 counts per minute on either side of the point of localized accumulation of fission products which was consistent with other measurements given. In the case of assembly 6031, a re-measurement gave results consistent with the rest of the data.

Due to the low resolution of a NaI(Tl) detector, the ^{95}Zr - ^{95}Nb data collected were not as readily interpreted as the ^{140}Ba - ^{140}La data (1600 KeV) were. In addition to the ^{95}Zr - ^{95}Nb gamma rays at 724, 756 and 764 KeV, ^{137}Cs (662 KeV), ^{144}Ce - ^{144}Pr (696 KeV), ^{134}Cs (796 and 801 KeV), ^{140}Ba - ^{140}La (815 KeV) and ^{106}Ru - ^{106}Rh (874 KeV) contributed gamma rays in the energy range indicated by the single gross gamma activity peak at approximately 750 KeV discernable in Figure C-1. Furthermore, the peak was superimposed upon the Compton contributions from the 1600 KeV ^{140}Ba - ^{140}La gammas. The largest single contributor to SCA readings other than ^{95}Zr - ^{95}Nb was the Compton contribution.

The 65 day half-life of ^{95}Zr indicates that ^{95}Zr - ^{95}Nb data would provide an indication of the average radial power distribution over a period of reactor operation of approximately 180 days or since the start of the Batch Core. However, the SCA data given in Table C-I

included major contributions from ^{140}Ba - ^{140}La which affects the interpretation of what the true average distribution should be. Using the MCA data, it is possible to approximate the true distribution more closely.

To illustrate, first, the ratio of SCA values and the integrated peak plus Compton values was 1.090 ± 0.010 or $\pm 0.9\%$, indicating both the SCA and MCA systems were providing the same gross information. In this case, the Compton contributions from ^{140}Ba - ^{140}La amounted to approximately 43% of the total SCA counts as indicated by the MCA results. The ratio of Compton to integrated peak plus Compton was 0.429 ± 0.016 or $\pm 3.8\%$. The 3.8% variation was due in part to the fact that the Compton decreased with a 12.8 day half-life while the peak was decaying with essentially a 65 day half-life. Subtracting away the Compton, as was done for the MCA values given in Table C-I, values more representative of the average radial power distribution for the first 180 days were determined. Also, because the Compton contributions were subtracted for the MCA data, the variation of the ratio of MCA to SCA values was larger. The ratio for each set of measurements are also listed in Table C-I and the average value was 0.623 ± 0.016 or $\pm 2.5\%$.

The ^{140}Ba - ^{140}La contributions from the 815 KeV gamma ray are still present in the MCA ^{95}Zr - ^{95}Nb data listed in Table C-I. The contribution was not as large as the Compton contribution, however, and no attempt was made to subtract the activity from the ^{95}Zr - ^{95}Nb activity. All other contributions from other gamma-ray sources were

also small compared to the ^{95}Zr - ^{95}Nb activity and no corrections were made. Decay corrections were not made either since these corrections were less than 2% using 8:17 A.M. on February 21 as the zero time reference.

It is seen from the ^{95}Zr - ^{95}Nb values for assembly 6051 (up) in Table C-I that they were also high as were the ^{140}Ba - ^{140}La values. A possible explanation for the high values may be that ^{95}Nb may have concentrated as did the ^{140}Ba - ^{140}La as part of the localized concentration of fission products. Additional data are needed, high resolution gamma-ray spectra for example, to determine the exact composition of fission products present at the point. The additional SCA data taken on each side of the localized concentration indicated that a ^{95}Zr - ^{95}Nb value of 35800 counts/min was more representative of the activity for assembly 6051 (up).

Since the power distribution changes with increasing exposure, it was expected that the distribution from ^{140}Ba - ^{140}La activity data would be different from the distribution derived from the ^{95}Zr - ^{95}Nb activity data. This was the case as the ratio of the activity of assembly 6055 (up) to the activity of assembly 6019 (down) was 1.74 (average of SCA and MCA values) for ^{140}Ba - ^{140}La (see Table C-I for the activity values) while the same ratio for ^{95}Zr - ^{95}Nb was 1.97 (from MCA data only). The power distribution thus flattened as the exposure increased, as was expected.

APPENDIX D

APPENDIX D

TABULATION OF GAMMA-RAY SPECTRA

The spectra obtained from gamma-ray measurements are tabulated in Table D-I on the pages that follow. The order of the spectra is the same as that given in Table XII of the body of the report.

TABLE D-I

GAMMA-RAY SPECTRA COLLECTED FROM BATCH CORE FUEL RODS

pp. D-2 to D-34

[illegible]

[illegible]

801	252	272	255	244	245	248	301	288	253	310	290	265	256	248	278	281	245	291	298	276
821	249	237	294	254	256	290	272	244	253	282	279	269	263	242	279	257	256	284	271	273
841	257	249	218	232	245	283	247	267	289	260	277	298	245	284	284	290	296	262	265	265
861	255	208	257	277	267	249	259	292	219	245	229	219	245	252	238	281	221	211	222	206
881	199	188	191	176	201	176	204	188	200	182	188	213	201	188	158	184	184	184	176	197
901	200	185	183	170	182	184	201	169	177	167	167	190	153	167	185	154	188	163	176	156
921	191	172	184	162	164	145	159	157	188	197	157	172	177	178	171	180	177	162	175	156
941	186	166	151	179	180	170	190	190	213	259	266	310	334	292	204	147	180	182	139	156
961	145	169	173	148	171	164	189	142	187	181	157	137	131	182	137	159	148	147	144	152
981	156	144	155	145	177	163	140	157	146	160	146	159	152	149	172	131	160	145	154	175
1001	153	170	151	140	145	157	136	166	168	188	156	199	136	108	126	110	108	121	129	117
1021	125	143	121	132	100	93	82	93	99	88	86	91	87	84	92	97	89	97	78	81
1041	92	87	96	98	80	78	89	75	85	108	108	133	139	157	146	163	157	146	228	248
1061	368	520	613	516	299	148	73	71	64	69	63	69	63	71	67	59	62	68	72	49
1081	63	67	74	72	63	57	56	56	58	63	55	52	49	43	68	50	47	55	58	43
1101	55	63	51	44	53	54	50	53	42	47	41	53	54	39	51	47	37	41	42	35
1121	48	50	52	49	49	40	40	39	53	41	41	37	45	31	55	44	60	42	31	43
1141	42	50	51	36	41	61	35	37	48	41	42	48	39	33	29	46	47	28	44	35
1161	42	33	47	32	35	38	48	46	39	27	30	37	36	37	33	44	35	40	39	37
1181	25	28	41	39	27	41	38	27	44	45	34	32	37	33	43	58	63	58	69	84
1201	92	143	216	310	413	476	402	218	95	55	27	32	25	16	17	21	32	26	30	
1221	28	19	38	32	28	25	23	18	22	30	20	24	20	29	43	47	29	23	29	16
1241	22	29	28	27	27	18	27	16	26	26	21	28	16	27	20	21	36	19	19	21
1261	21	20	21	27	20	29	17	21	15	24	22	26	24	17	14	22	20	11	17	19
1281	23	19	28	27	14	17	22	11	20	22	23	31	22	22	14	23	21	24	27	27
1301	25	19	20																	

[illegible]

GAMMA RAY SPECTRUM DATA

[illegible]

801	1378	1321	1327	1380	1326	1292	1250	1297	1307	1411	1350	1301	1292	1277	1244	1256	1273	1256	1245	1230
821	1219	1266	1239	1259	1312	1181	1223	1174	1223	1184	1170	1237	1265	1168	1126	1178	1177	1181	1108	1155
841	1086	1136	1057	1119	1063	1092	1096	1092	1037	1078	1100	1008	1066	1005	1015	990	1009	1009	1047	1073
861	1046	976	993	1049	961	1021	961	950	958	928	928	914	977	938	933	966	921	865	920	830
881	897	873	885	926	869	837	944	881	896	886	850	847	853	810	812	859	830	866	857	817
901	890	777	844	863	812	793	818	801	819	788	806	843	773	865	839	782	789	771	781	781
921	776	749	751	743	733	757	804	763	734	774	782	786	786	725	762	748	752	700	829	784
941	760	778	757	742	762	841	998	1269	1656	2322	2994	3664	3863	2888	1750	995	745	714	691	678
961	687	777	719	708	694	639	664	679	675	644	665	643	687	645	680	617	583	653	612	650
981	627	611	659	588	595	621	631	650	700	655	596	593	651	648	615	588	653	624	662	639
1001	623	636	608	613	628	633	604	592	656	637	615	645	584	577	552	605	626	755	815	948
1021	1135	1257	1195	1003	735	586	546	518	532	491	525	512	494	495	461	537	501	530	521	522
1041	528	479	474	489	486	493	457	496	591	637	716	828	866	937	927	906	750	691	654	672
1061	837	948	1088	995	800	553	541	468	465	466	437	458	450	471	447	406	499	453	494	485
1081	508	562	539	494	464	406	453	447	444	442	484	446	427	431	429	398	428	385	417	419
1101	407	411	379	420	411	447	406	393	418	453	419	417	399	418	421	411	415	395	407	394
1121	400	376	401	395	415	395	385	417	408	401	431	422	404	392	443	407	391	407	413	367
1141	388	397	381	363	375	377	358	385	368	416	391	415	379	386	405	370	371	327	317	353
1161	326	334	350	327	299	347	305	348	328	330	323	297	319	301	334	327	338	312	327	330
1181	321	349	318	328	313	283	297	297	300	279	324	356	300	331	329	325	318	315	332	372
1201	376	420	461	546	707	788	700	565	415	322	283	282	294	238	282	302	288	285	281	279
1221	280	275	247	246	235	272	217	278	237	244	316	265	254	303	295	262	251	257	271	230
1241	216	221	252	214	230	218	217	238	231	219	233	226	238	251	236	223	213	212	229	213
1261	226	202	220	217	192															

[illegible]

D-5

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-16 SPECTRUM NO. 9 DATA TAKEN 2/27/69 LIVE TIME 900.MIN. POSITION 6.IN. ENERGY(KEV)= 1.110*CHAN -7.5

[illegible][illegible]

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-16 SPECTRUM NO. 10 DATA TAKEN 2/28/69 LIVE TIME 330. MIN. POSITION 28. IN. ENERGY(KEV)= 1.110*CHAN -7.3

[illegible]

801	1467	1502	1467	1548	1507	1371	1364	1318	1397	1374	1406	1348	1355	1339	1299	1387	1303	1273	1364	1333
821	1287	1299	1225	1277	1269	1302	1253	1263	1210	1258	1246	1213	1250	1189	1205	1149	1121	1211	1099	1136
841	1122	1093	1144	1122	1133	1116	1084	1054	1103	1103	1059	1154	1133	1028	1002	1053	1033	1041	1077	954
861	1088	995	993	992	1049	1021	969	1023	1015	999	968	980	987	948	946	958	912	943	933	941
881	944	963	905	884	923	879	948	959	902	860	934	955	924	848	811	839	877	826	801	794
901	901	879	920	893	903	914	842	898	896	938	934	955	924	848	811	839	877	826	801	794
921	828	842	760	748	781	839	808	730	790	758	818	810	740	764	773	766	776	774	718	744
941	872	827	841	836	805	927	1033	1302	1699	2360	3153	3823	4121	3480	2177	1257	846	774	718	744
961	721	736	782	766	733	647	643	687	657	685	662	677	678	605	686	603	678	633	637	669
981	658	670	641	632	625	647	639	658	679	667	631	610	663	631	626	634	623	638	666	565
1001	624	619	612	648	634	616	678	638	654	676	641	631	635	610	614	674	679	719	844	994
1021	1100	1284	1330	1191	825	654	590	581	569	494	565	506	558	565	534	677	615	493	527	557
1041	522	566	556	522	518	498	549	541	629	628	719	859	900	993	1097	938	855	737	601	676
1061	647	743	789	788	688	627	580	517	514	522	489	493	496	497	499	518	483	500	508	531
1081	598	575	573	519	548	489	493	456	508	508	476	509	532	461	506	449	443	448	450	470
1101	472	436	454	454	469	464	437	471	459	457	476	444	491	456	454	463	455	487	438	432
1121	431	460	466	460	475	445	477	422	422	470	446	452	468	434	477	430	405	445	440	462
1141	414	443	454	438	429	419	426	448	452	484	469	480	499	576	529	490	411	385	407	387
1161	378	347	357	375	359	353	359	351	326	353	376	320	384	340	389	316	354	351	349	344
1181	360	362	322	361	331	376	345	341	345	301	372	334	358	324	331	297	348	354	366	375
1201	390	384	386	478	490	542	577	499	397	330	335	340	313	318	304	307	306	296	270	302
1221	257	305	290	296	297	271	281	282	281	290	293	283	377	338	346	379	315	322	261	256
1241	267	288	275	214	255	267	257	249	301	281	298	288	277	290	258	258	266	250	226	266
1261	239	250	246	240	231	257	269	235	234	228	228	222	254	259	243	225	263	239	230	231
1281	242	241	219	238	224	210	209	218	217	235	224	237	223	250	231	242	229	230	267	259
1301	229	196	225	213	229	231	232	199	221	218	210	189	235	215	196	228	211	220	221	230
1321	193	222	223	204	214	228	200	217	216	212	224	216	202	243	227	212	213	234	236	269
1341	271	313	360	401	540	526	620	634	456	377	258	228	232	228	244	230	227	187	206	185
1361	207	217	219	204	187	201	182	188	177	160	176	198	192	188	227	198	197	172	181	192
1381	195	202	200	178	199	181	189	197	183	171	179	216	194	176	199	176	186	173	185	206
1401	164	185	184	190	230	231	271	261	307	275	275	357	395	322	275	205	177	179	176	184
1421	149	172	167	162	199	192	199	195	190	163	182	140	148	166	166	172	170	168	163	168
1441	180	195	175	152	187	174	191	165	190	158	170	172	165	154	158	183	178	179	171	182
1461	165	154	162	162	174	158	179	163	171	155	153	180	166	137	154	157	166	167	166	166
1481	168	165	156	177	169	168	179	171	162	184	228	204	212	217	197	198	170	169	159	167
1501	151	167	165	150	182	171	173	171	190	193	228	204	212	217	197	198	170	169	159	167
1521	172	185	163	157	166	172	160	149	158	153	158	145	177	163	166	156	150	174	167	163
1541	170	172	171	168	159	174	182	172	168	167	172	135	168	144	176	160	182	149	171	160
1561	172	151	161	166	187	181	154	164	183	148	161	152	183	156	174	161	166	191	157	160
1581	168	172	159	155	151	160	180	180	174	169	168	181	159	181	203	187	197	176	169	174
1601	162	166	145	177	141	180	160	154	158	158	154	171	153	168	190	181	142	176	173	184
1621	203	165	214	196	204	183	181	156	150	146	166	151	172	181	183	168	164	169	169	176
1641	155	166	167	174	175	159	148	137	179	171	176	157	185	187	160	166	159	189	175	171
1661	164	174	180	161	178	185	165	185	187	147	194	178	166	156	152	163	174	176	154	158
1681	192	153	207	163	177	172	175	186	174	163	177	183	183	194	160	192	165	180	170	192
1701	195	197	189	201	195	168	187	202	185	189	172	181	172	177	209	172	161	180	201	193
1721	183	191	177	190	174	166	184	173	229	177	196	184	204	168	192	187	208	187	185	186
1741	204	203	212	195	189	188	172	179	184	183	175	188	173	178	187	181	187	180	158	168
1761	153	160	161	173	139	135	141	120	134	118	102	111	105	108	96	102	116	104	108	96

1781	115	101	90	88	97	79	105	110	88	98	109	85	104	91	99	104	97	85	82	86
1801	68	74	74	74	90	58	78	72	63	101	86	60	74	71	85	90	89	87	85	74
1821	89	78	76	72	73	80	81	54	75	65	61	67	75	54	53	64	86	53	84	72
1841	55	58	65	54	73	54	61	69	43	65	44	46	43	52	57	51	53	55	47	50
1861	45	40	48	33	36	50	41	38	32	21	36	47	33	33	39	34	35	31	39	25
1881	35	31	27	32	24	34	32	22	23	30	21	31	30	22	27	27	39	33	36	36
1901	28	31	44	32	51	51	53	57	51	48	33	33	20	22	29	25	29	22	21	29
1921	31	23	34	28	19	21	24	20	30	33	30	13	20	19	25	24	27	20	30	25
1941	14	16	21	28	25	22	26	30	34	17	32	24	23	24	24	30	31	30	40	48
1961	47	76	91	123	172	204	244	296	312	423	455	487	545	418	232	137	47	31	16	16
1981	14	9	16	10	8	16	11	12	5	8	12	5	10	7	14	8	7	9	9	13
2001	6	10	13	11	11	9	10	8	11	9	10	7	10	10	7	10	8	9	8	8
2021	11	7	9	11	6	8	10	12	10	9	8	7	13	7	5	6	6	6	4	1

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801	3003	3118	3175	3210	3076	3033	2964	2886	2876	2854	2797	2882	2843	2860	2726	2855	2773	2802	2741	2695
821	2813	2874	2764	2784	2644	2616	2562	2753	2668	2620	2682	2632	2653	2669	2639	2461	2459	2414	2395	2329
841	2401	2373	2446	2303	2309	2304	2269	2302	2354	2325	2336	2388	2355	2276	2151	2218	2216	2261	2280	2222
861	2142	2233	2095	2141	2171	2122	2074	2085	2081	2091	2079	1984	2062	1988	2045	1953	1982	1929	1986	1979
881	1909	1859	1913	1933	1907	1814	1838	1940	1973	1937	1833	1809	1790	1717	1875	1835	1827	1737	1724	1780
901	1838	1980	1851	1911	1818	1857	1841	1726	1828	1825	1917	1847	1869	1739	1768	1702	1707	1668	1668	1688
921	1698	1662	1683	1647	1674	1651	1586	1657	1607	1616	1664	1743	1648	1643	1680	1656	1660	1612	1714	1751
941	1751	1713	1666	1729	1782	1806	2160	2795	3778	4862	6754	8094	8424	6623	4079	2320	1614	1545	1442	1482
961	1498	1474	1548	1557	1568	1388	1378	1356	1413	1394	1385	1438	1363	1377	1319	1303	1346	1329	1403	1335
981	1305	1380	1355	1302	1378	1391	1331	1420	1337	1369	1366	1290	1333	1292	1364	1331	1325	1323	1316	1275
1001	1321	1331	1361	1282	1398	1314	1308	1318	1427	1340	1333	1323	1285	1264	1261	1339	1364	1556	1806	2137
1021	2594	2781	2764	2342	1627	1344	1224	1191	1101	1085	1156	1080	1123	1105	1104	1033	1116	1054	1115	1131
1041	1132	1035	1122	1089	1138	1126	1158	1151	1282	1494	1568	1740	1965	2175	2175	2039	1732	1469	1335	1437
1061	1505	1676	1897	1802	1419	1221	1083	1072	1056	1059	1054	1078	1016	989	1008	1054	1049	1086	1095	1160
1081	1220	1198	1177	1160	1081	1010	986	945	985	959	1060	985	1004	1029	958	911	923	929	979	963
1101	945	985	986	959	917	947	930	991	941	969	903	947	947	882	937	974	935	900	936	935
1121	938	907	950	944	928	992	932	979	917	918	981	938	905	936	939	897	876	939	919	818
1141	922	886	863	890	857	905	892	913	872	969	914	998	1033	1050	1048	913	884	784	775	745
1161	756	757	751	758	769	783	713	732	735	706	725	748	677	714	716	711	701	672	687	742
1181	730	719	667	738	677	719	692	706	740	724	717	679	721	716	717	666	732	715	726	757
1201	823	811	881	1018	1151	1353	1281	1091	818	732	662	642	636	620	667	679	628	603	662	584
1221	549	566	576	572	555	559	592	602	613	590	605	644	690	741	757	755	719	594	564	536

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801	1676	1632	1744	1685	1501	1605	1633	1674	1612	1602	1607	1545	1573	1567	1587	1614	1533	1605	1593	1545
812	1539	1517	1540	1554	1567	1475	1498	1434	1427	1453	1456	1473	1471	1423	1446	1402	1370	1364	1401	1400
841	1323	1361	1301	1250	1319	1340	1302	1315	1266	1286	1309	1291	1225	1267	1272	1213	1240	1117	1147	1151
861	1215	1185	1199	1184	1239	1170	1143	1146	1140	1156	1174	1164	1165	1141	1167	1049	1090	1106	1047	1053
881	1056	1113	1045	1110	1019	1043	1044	1124	1050	1057	1022	956	1054	1038	983	967	1013	1011	967	993
901	977	1040	1013	1013	995	979	998	945	986	1003	980	1020	1020	1013	961	960	949	955	980	970
921	940	919	1008	949	897	972	926	889	980	914	939	967	907	869	947	880	902	942	859	993
941	941	920	970	876	989	1049	1328	1641	2320	3058	4050	4750	4469	3098	1783	1102	899	790	866	860
961	794	875	872	877	851	805	772	789	797	773	782	769	815	784	793	792	722	763	780	755
981	817	764	796	781	727	747	811	767	735	825	742	737	772	740	755	708	742	769	761	716
1001	751	708	799	799	762	746	784	737	798	799	779	727	742	702	731	773	801	925	1083	1224
1021	1444	1601	1405	1141	813	676	653	573	641	652	661	621	576	625	607	647	628	618	647	637
1041	626	626	620	627	597	641	650	665	739	848	869	973	1072	1191	1170	1001	844	728	782	852
1061	967	1113	1131	1024	744	694	582	557	609	603	581	575	512	560	595	544	573	572	603	619
1081	627	675	637	590	519	561	537	596	602	551	546	587	500	500	523	500	514	549	490	530
1101	537	491	480	540	506	486	522	487	510	536	536	476	500	515	517	484	484	550	503	520
1121	527	473	566	540	510	479	531	476	503	491	484	461	517	518	500	474	472	483	539	518
1141	500	462	468	494	467	469	479	462	455	455	471	560	507	537	489	477	423	445	375	435
1161	433	432	428	454	421	378	429	413	409	424	431	428	409	408	414	390	430	383	430	375
1181	391	419	386	418	411	392	385	415	400	365	362	421	366	392	391	417	409	371	412	397
1201	443	511	576	702	857	796	715	570	416	384	344	355	368	336	375	370	365	359	307	304
1221	342	303	333	335	377	301	305	345	325	349	343	343	353	381	375	392	329	309	296	317
1241	310	313	295	273	320	281	272	298	307	311	314	314	311	271	280	314	309	274	293	257

[illegible]

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801	965	971	931	930	953	932	885	923	893	870	873	831	911	877	880	836	828	871	843	844
821	805	858	885	806	805	821	825	880	796	776	800	813	818	778	778	746	741	778	794	769
841	730	735	724	674	713	715	670	690	720	731	760	659	679	718	653	649	644	662	674	646
861	648	695	604	644	686	689	582	673	655	647	638	658	582	596	669	634	627	636	600	590
881	586	561	638	566	585	571	584	572	576	583	603	613	561	561	549	579	529	562	543	551
901	557	566	600	602	578	525	522	546	579	592	632	574	550	555	497	504	502	525	546	534
921	488	498	523	514	508	508	494	500	524	496	492	492	503	495	477	529	501	517	526	480
941	544	553	522	534	541	557	718	941	1214	1674	2255	2517	2419	1633	964	619	496	465	440	447
961	497	464	471	452	476	448	410	450	425	399	434	421	457	403	401	435	441	377	411	429
981	383	415	430	425	445	431	431	408	447	442	423	398	386	423	352	413	414	443	380	416
1001	423	351	414	394	393	431	408	393	448	396	404	372	387	418	378	414	426	473	576	662
1021	766	805	747	641	449	363	315	347	352	345	357	342	350	344	343	346	352	372	347	343
1041	334	318	342	305	321	312	379	399	444	439	501	581	607	680	617	609	482	454	431	460
1061	494	556	619	580	427	383	354	297	333	325	287	353	319	315	296	296	292	333	339	341
1081	329	328	341	329	299	314	296	277	282	320	289	300	292	334	308	292	287	280	27A	276
1101	272	287	278	289	303	300	293	283	275	281	313	279	310	305	272	258	272	254	305	289
1121	269	312	269	272	285	259	290	256	296	281	264	274	279	258	283	283	315	273	246	300
1141	264	271	249	279	269	260	264	245	282	257	295	333	289	295	296	274	248	218	22A	231
1161	220	256	215	230	207	250	228	209	244	228	220	203	217	216	215	186	217	223	231	212
1181	212	221	196	229	188	196	205	228	222	227	198	198	209	214	213	221	206	221	24A	233
1201	242	256	292	363	390	437	364	325	252	220	190	188	206	180	181	200	224	174	193	169
1221	177	182	167	173	174	190	164	195	178	183	203	163	214	209	215	227	222	177	194	161
1241	177	169	162	165	160	130	163	159	177	176	173	155	175	175	168	186	152	163	163	131
1261	160	149	121	168	160	150	140	131	163	160	177	133	129	16						

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GAMMA RAY SPECTRUM DATA

[illegible]

801	2365	2455	2416	2445	2450	2299	2281	2330	2313	2212	2243	2283	2238	2275	2241	2154	2229	2230	2240	2217
802	2277	2199	2154	2199	2209	2162	2269	2053	2133	2227	2024	2170	2047	1960	2094	2048	1965	1881	1985	1887
84	1890	1862	1855	1863	1919	1835	1810	1864	1879	1894	1878	1857	1839	1778	1778	1775	1709	1772	1756	1740
861	1824	1720	1713	1699	1747	1799	1795	1682	1646	1654	1610	1684	1659	1667	1563	1650	1612	1566	1641	1573
881	1549	1452	1518	1561	1535	1554	1513	1502	1543	1478	1571	1393	1450	1451	1458	1377	1384	1344	1425	1447
901	1465	1449	1503	1485	1508	1498	1446	1479	1453	1474	1470	1492	1457	1458	1393	1362	1364	1345	1335	1307
921	1330	1359	1316	1331	1292	1247	1306	1300	1352	1280	1334	1285	1336	1255	1307	1350	1265	1404	1366	1316
941	1407	1410	1320	1349	1365	1485	1696	1952	2793	3693	5019	6235	6588	5313	3317	1855	1363	1253	1157	1171
961	1168	1209	1254	1171	1158	1162	1145	1115	1161	1157	1120	1121	1078	1064	1159	1050	1139	1180	1093	1105
981	1046	1129	1090	1159	1097	1088	1099	1153	1089	1159	1086	1145	1122	1089	1109	1058	1070	1119	1118	1077
1001	1023	1067	1065	1073	1090	1092	1043	1090	1151	1144	1134	1104	1035	1049	971	1096	1133	1183	1362	1620
1021	1864	2087	2192	1832	1411	1047	977	911	942	895	873	932	904	905	910	887	905	877	904	889
1041	857	936	830	867	860	872	850	859	972	1143	1216	1298	1514	1709	1751	1745	1428	1250	1130	1155
1061	1300	1479	1637	1624	1326	1011	884	864	846	853	846	817	825	819	835	803	791	791	810	890
1081	955	927	948	863	866	800	795	791	765	757	740	796	736	770	780	732	716	759	803	767
1101	778	738	744	739	711	783	758	700	723	699	730	689	730	765	694	743	737	753	701	740
1121	735	730	719	743	757	695	737	702	659	706	708	703	716	712	710	737	697	693	714	695
1141	680	706	735	659	683	643	682	669	658	690	726	719	785	835	807	715	698	591	609	590
1161	595	565	542	582	575	633	597	597	601	597	574	557	580	580	520	560	592	535	566	604
1181	571	544	516	576	599	544	566	582	541	566	564	572	547	557	554	533	530	591	611	546
1201	659	629	743	900	1011	1203	1203	1055	761	582	510	499	476	488	461	526	516	468	448	464
1221	447	413	488	484	430	449	421	444	436	441	480	543	492	547	571	582	564	502	457	447
1241	435	404	431	394	390															

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GAMMA RAY SPECTRUM DATA

PRTR ROD FS-01 SPECTRUM NO. 25 DATA TAKEN 3/07/69 LIVE TIME 1127.MIN. POSITION 27.IN. ENERGY(KEV)= 1.112*CHAN -7.7

[illegible]

1791	539	514	503	511	479	507	497	477	490	504	494	501	475	505	535	565	518	554	538	501
1791	501	427	410	408	437	472	417	396	447	385	433	417	410	426	396	422	391	393	392	431
1821	416	361	399	391	361	350	364	358	358	402	385	322	326	371	368	367	366	345	331	376
1831	332	361	322	289	350	302	277	306	303	297	296	249	268	257	255	245	246	236	270	218
1861	244	265	236	241	220	214	211	206	208	194	205	220	184	188	178	212	192	188	182	174
1881	176	161	173	172	166	174	165	126	155	167	141	155	163	148	139	140	152	146	156	134
1901	167	144	206	184	196	171	228	224	263	252	238	200	184	173	136	136	117	131	130	131
1921	156	134	152	137	129	131	179	140	143	114	108	124	118	137	110	121	137	153	119	139
1941	128	115	128	119	125	131	127	131	127	126	126	126	126	126	126	126	126	126	126	126
1961	164	207	232	272	357	475	627	613	1105	1292	1530	1824	2107	2551	2766	2647	2256	1527	850	387
1981	187	122	91	65	66	51	51	56	55	65	47	71	53	84	51	61	56	46	64	42
2001	51	71	43	51	47	41	54	50	47	52	47	47	52	40	41	48	42	45	48	58
2021	46	54	52	35	43	50	39	43	46	48	50	42	41	45	40	36	41	43	35	42

[illegible]

801	3065	3129	3156	3129	3068	2985	2951	2914	2871	2815	2947	2932	2869	2868	2954	2902	2851	2815	2571	2766
821	2742	2681	2807	2817	2703	2679	2724	2570	2651	2566	2622	2941	2508	2458	2353	2392	2341	2337	2327	2202
841	2316	2246	2166	2203	2207	2142	2163	2176	2158	2214	2143	2097	2027	2018	1985	2059	1956	2010	1947	2071
861	1921	1920	1925	1893	1939	1556	1890	1826	1896	1849	1933	1859	1846	1922	1820	1867	1791	1823	1760	1775
881	1709	1718	1684	1738	1782	1754	1689	1741	1747	1723	1666	1658	1686	1657	1634	1671	1661	1677	1697	1621
901	1689	1727	1642	1666	1666	1553	1641	1608	1677	1716	1601	1686	1644	1535	1526	1601	1544	1505	1466	1531
921	1568	1471	1482	1460	1467	1445	1385	1574	1480	1481	1420	1454	1565	1524	1444	1456	1453	1479	1512	1457
941	1555	1538	1557	1717	1929	2496	3605	5227	7560	9816	11408	10939	8382	1747	2713	1697	1417	1275	1390	1363
961	1306	1372	1360	1314	1216	1211	1216	1114	1124	1122	1183	1171	1123	1134	1234	1156	1215	1140	1112	1107
981	1119	1175	1178	1181	1159	1224	1159	1163	1198	1133	1074	1094	1067	1131	1156	1097	1004	1137	1034	1112
1001	1160	1068	1165	1129	1148	1117	1222	1169	1169	1147	1155	1100	1127	1101	1247	1453	1738	2200	2658	3211
1021	3451	3195	2409	1681	1261	1090	1018	996	914	941	987	895	983	980	1048	927	1020	985	946	939
1041	1000	950	963	977	945	972	1047	1096	1153	1266	1305	1452	1534	1507	1320	1151	1124	1081	1106	1011
1061	1118	1064	1052	1022	999	989	980	947	958	885	889	906	830	908	931	956	1010	989	1105	1151
1081	1244	1133	1000	881	916	827	842	823	929	890	863	878	863	881	870	837	863	885	849	849
1101	848	838	817	854	809	845	882	821	801	795	896	837	821	792	848	805	851	820	828	795
1121	770	812	856	774	810	812	832	819	816	724	763	804	826	850	800	830	800	837	824	769
1141	795	765	824	758	751	785	816	827	884	877	909	930	911	888	821	773	722	743	763	693
1161	723	703	749	731	695	712	670	718	715	742	722	696	647	611	684	705	675	675	670	642
1181	722	656	669	705	728	630	706	626	635	685	660	685	654	624	655	649	589	690	713	659
1201	730	714	759	784	766	765	707	691	581	542	621	600	640	617	622	648	645	562	570	563
1221	542	524	526	539	534	515	572	489	546	565	613	602	637	571	571	570	524	500	533	506
1241	506	513	501	482																

[illegible]

GAMMA RAY SPECTRUM DATA

[illegible]

821	2599	2675	2708	2496	2387	2392	2277	2332	2364	2383	2309	2268	2377	2320	2330	2358	2296	2281	2256	2290
822	2214	2154	2160	2325	2175	2235	2191	2137	2165	2205	2167	2138	2070	2061	2084	1994	1954	1923	1985	1944
841	2017	1914	1910	1894	1879	1926	1922	1934	1948	1941	1909	1901	1769	1684	1786	1738	1812	1693	1724	1776
861	1815	1676	1766	1686	1735	1606	1656	1713	1708	1683	1661	1652	1628	1619	1700	1604	1648	1631	1541	1584
881	1609	1570	1560	15c7	1613	1539	1550	1545	1505	1508	1631	1540	1526	1527	1547	1506	1469	1441	1593	1587
901	1555	1578	1630	1527	1545	1485	1539	1603	1721	1772	1677	1566	1491	1407	1448	1419	1511	1342	1354	1382
921	1409	1391	1455	1366	1313	1300	1324	1368	1307	1391	1380	1338	1349	1364	1365	1384	1387	1358	1436	1475
941	1498	1373	1433	1424	1770	2111	2849	3860	5216	6389	6813	5749	3853	2272	1518	1235	1250	1194	1264	1237
91	1292	1270	1203	1176	1128	1161	1154	1117	1111	1119	1065	1155	1055	1061	1123	1076	1156	1103	1097	1162
91	1099	1133	1134	10c4	1110	1112	1172	1116	1116	1114	1058	1073	1084	1044	1017	1076	1092	1073	1052	1090
1001	1124	1c97	1086	1015	1127	1931	1115	1c38	1060	1077	1033	1065	1084	1066	1155	1275	1494	1724	2054	2223
1021	2249	1844	1475	1146	1032	943	1019	894	942	924	930	964	1028	1048	893	979	943	979	943	985
1041	975	968	952	916	956	947	1026	1217	1333	1456	1672	1789	1843	1624	1407	1225	1174	1122	1098	1140
1061	1204	1116	1c76	9c4	887	930	906	926	881	866	820	874	865	859	869	897	993	970	982	953
1081	1019	939	822	871	881	c51	932	846	897	877	870	842	867	789	773	850	784	830	783	846
1111	615	614	836	810	820	824	783	866	734	786	761	813	810	824	839	834	763	775	781	775
1121	778	783	829	792	788	791	773	787	719	802	765	736	767	742	783	765	775	735	725	763
1141	753	752	749	758	752	761	623	892	903	996	984	1009	1016	843	735	619	661	642	633	590
1161	671	663	637	641	587	596	594	658	600	595	581	628	599	628	575	604	668	586	600	598
1181	651	580	c01	551	615	591	609	541	593	605	637	603	581	587	540	593	574	591	617	621
1201	705	750	777	790	745	669	633	562	590	552	545	533	534	519	549	487	513	526	483	539
1221	526	463	481	4c9	495	481	535	561	591	548	1c0	637	652	614	534	515	524	432	454	417
1241	452	461	453	4c1	480	5														

1761	147	147	150	174	162	169	159	166	177	172	158	181	148	151	157	176	132	156	166	137
1861	131	126	131	177	136	152	135	137	137	153	119	113	129	149	128	135	113	123	126	131
1621	91	134	136	149	122	107	131	163	94	113	109	112	115	111	124	92	107	88	119	96
1611	91	77	102	105	109	95	84	89	78	83	87	79	83	68	85	76	85	79	73	57
1861	55	62	70	64	63	60	54	52	48	60	58	62	57	50	61	60	52	68	45	47
1881	44	52	45	42	58	55	57	58	48	53	41	71	44	59	51	68	77	77	58	69
1911	69	84	84	69	59	38	35	41	27	38	41	56	42	40	43	50	44	41	34	37
1921	56	35	29	43	55	40	50	40	37	33	38	40	34	37	47	32	51	40	42	34
1941	42	33	42	44	55	35	52	43	34	51	52	26	50	55	65	90	120	171	205	295
1961	316	467	511	617	734	849	941	937	757	486	245	99	53	30	24	28	21	12	19	15
1961	16	13	13	17	12	19	13	14	16	20	13	20	11	24	10	13	21	13	17	16
2001	14	9	12	15	21	10	14	18	21	17	16	20	15	12	18	18	15	10	13	18
2021	14	10	26	13	14	7	13	13	18	20	14	11	8	13	15	14	8	19	17	10

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-01 SPECTRUM NO. 28 DATA TAKEN 3/10/69 LIVE TIME 90. MIN. POSITION 55. IN. ENERGY (KEV) $\pm$ 1.112*CHAN -8.2

[illegible]

801	91	105	81	100	85	85	100	67	92	85	89	77	83	94	78	74	78	87	86	93
821	76	83	95	95	90	82	61	78	96	100	76	77	77	72	63	67	60	70	72	81
841	60	80	75	86	78	72	73	77	83	70	77	88	65	70	84	68	68	70	48	87
861	81	78	64	73	72	80	78	70	61	79	59	70	82	47	66	52	73	70	67	
881	69	68	59	65	70	44	51	58	63	53	69	53	69	60	46	60	50	63	45	61
901	59	62	50	70	72	50	54	46	58	45	46	63	54	53	51	48	58	54	54	58
921	37	45	53	46	60	48	57	51	44	59	59	43	43	51	57	58	47	59	55	51
941	65	55	52	51	38	46	70	65	81	121	148	185	160	139	91	64	47	53	42	43
961	48	31	53	54	49	48	49	51	45	46	46	37	48	52	47	33	39	44	37	35
981	35	39	46	47	49	46	56	44	52	48	49	45	46	43	40	45	47	40	44	37
1001	41	39	48	36	49	47	53	44	26	48	37	39	29	44	46	33	39	38	45	53
1021	63	67	63	44	44	36	35	31	31	31	35	29	34	35	32	37	30	34	44	28
1041	34	28	32	36	33	39	43	43	43	35	41	33	74	68	66	70	65	54	45	61
1061	69	80	119	88	62	50	30	30	24	28	28	25	25	18	33	19	23	26	36	38
1081	33	34	39	27	27	32	31	30	19	31	35	30	27	26	17	20	27	22	27	26
1101	27	20	27	26	20	16	30	14	16	30	30	24	18	28	25	31	27	29	29	19
1121	30	13	17	20	30	21	25	17	20	18	34	16	22	19	25	22	26	22	17	20
1141	20	18	18	21	16	17	17	21	20	24	22	23	26	18	24	21	18	27	23	16
1161	15	20	16	18	18	19	21	24	13	22	12	17	23	11	19	17	23	12	17	18
1181	18	19	21	13	18	16	20	13	25	20	16	21	15	10	16	23	13	19	27	21
1201	32	41	40	57	62	79	58	42	37	24	19	14	17	10	13	14	16	12	16	6
1221	13	11	11	11	7	16	17	15	13	12	11	23	19	20	22	26	11	23	20	6
1241	7	9	5	6	8	16	12	9	13	13	11	10	13	14	16	10	10	11	3	11
1261	9	14	9	12	7	14	6	12	9	7	11	8	8	12	8	7	8	7	10	12
1281	14	8	9	5	8	7	8	13	14	10	10	6	10	8	8	16	8	3	12	12
1301	11	11	10	10	13	11	15	13	5	8	8	6	19	9	9	9	22	9	12	17
1321	11	15	16	11	10	7	8	14	7	14	10	10	7	11	8	15	11	17	12	12
1341	15	11	31	28	24	33	31	28	15	18	10	14	9	10	17	11	12	16	11	9
1361	11	10	8	16	8	11	11	12	7	17	8	10	9	12	8	9	7	8	12	6
1381	11	12	7	12	13	13	16	7	8	7	9	8	6	13	8	11	7	3	7	11
1401	9	7	6	7	10	8	7	15	15	12	10	17	16	9	13	10	6	9	7	15
1421	7	12	7	4	0	10	7	13	5	8	4	9	9	7	8	8	8	5	8	
1441	12	7	11	9	7	10	10	6	7	13	10	8	12	6	8	7	9	8	7	5
1461	8	7	13	9	4	6	8	5	7	4	7	6	7	14	6	8	11	5	9	5
1481	2	9	8	10	5	8	7	13	9	8	8	10	8	6	13	12	5	8	6	5
1501	9	5	9	7	8	8	9	11	12	7	15	5	8	12	15	7	7	11	12	9
1521	5	14	9	9	9	10	8	8	4	7	4	10	9	11	9	7	6	6	11	8
1541	7	8	12	8	9	14	5	3	8	6	13	20	11	6	11	7	10	7	11	-0
1561	9	13	12	7	15	12	8	7	4	8	5	10	11	8	6	10	3	7	10	8
1581	9	10	9	13	8	10	9	12	6	9	7	11	13	13	11	10	10	14	6	
1601	10	9	9	9	6	5	9	12	4	9	4	11	11	7	13	9	10	11	3	7
1621	13	11	10	12	10	12	3	10	12	11	9	7	9	7	13	7	8	11	10	7
1641	8	5	9	14	9	10	10	6	7	7	12	8	6	8	10	5	6	10	5	8
1661	5	11	5	9	7	9	9	8	7	9	6	11	14	8	9	11	11	7	6	9
1681	8	14	7	8	7	4	10	7	8	12	10	15	6	12	9	12	12	4	13	8
1701	8	10	13	6	5	15	12	13	11	12	8	9	8	7	10	7	11	14	13	6
1721	10	11	10	5	10	8	9	5	11	8	16	11	8	11	8	7	10	10	7	6
1741	15	6	13	12	10	14	4	5	7	9	13	12	16	7	11	5	11	10	11	9
1761	6	11	6	7	8	7	6	7	5	5	5	9	4	4	6	7	5	5	8	3

1781	8	6	4	3	5	11	7	1	4	6	5	7	6	4	6	4	5	9	8	4
1801	1	4	3	7	6	2	1	8	3	2	5	5	1	1	4	4	4	2	5	10
1821	3	2	4	5	6	3	2	5	1	2	3	5	6	7	4	4	6	2	6	6
1841	0	1	2	3	5	1	1	5	2	2	2	2	1	3	4	0	1	5	4	4
1861	0	1	2	5	1	1	1	5	2	0	3	2	0	1	2	0	1	1	3	3
1881	2	1	1	0	3	0	2	1	0	0	1	2	1	0	3	2	0	1	1	1
1901	2	1	3	3	2	4	1	2	2	0	4	1	2	2	1	0	1	0	2	0
1921	1	3	3	1	3	0	0	0	3	0	1	0	2	2	0	2	1	2	3	3
1941	2	0	3	1	0	0	1	0	1	0	2	0	1	2	4	2	1	3	3	2
1961	3	3	3	7	11	16	10	18	20	23	27	44	21	7	2	1	2	2	0	0
1981	1	2	0	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	1
2001	1	0	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	3	0
2021	0	0	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
2041	2	0	2	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0

PLOT CALLED FOR

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-01 SPECTRUM NO. 27 DATA TAKEN 3/10/69 LIVE TIME 60. MIN. POSITION 59. IN. ENERGY (KEV) = 1.111 * CHAN - 7.7

[illegible]

801	186	183	192	203	172	199	154	179	166	158	160	152	151	145	171	157	146	130	155	143
821	143	151	149	158	150	163	156	148	114	168	144	138	152	142	134	126	149	132	160	133
841	133	157	121	135	143	130	156	135	132	150	120	124	141	144	124	116	132	116	134	134
861	126	108	111	142	109	128	116	115	107	120	113	104	111	102	132	120	135	112	131	112
881	98	110	106	107	115	101	110	119	106	98	97	108	97	103	96	118	108	92	94	106
901	90	100	111	99	111	109	106	104	96	124	89	101	97	104	108	103	90	94	94	91
921	78	98	111	82	99	78	94	93	79	97	111	82	102	97	102	81	74	81	103	111
941	98	93	91	108	88	112	128	166	221	284	363	470	456	357	235	110	89	86	57	90
961	81	100	85	94	96	96	84	75	86	89	80	74	81	101	72	55	85	86	76	60
981	79	76	90	84	74	68	70	90	80	69	85	89	77	75	66	76	85	69	72	73
1001	73	78	85	82	78	81	70	96	76	72	80	90	71	70	78	64	84	77	82	133
1021	125	156	186	114	96	74	73	68	81	78	62	69	75	57	70	43	69	86	68	72
1041	59	70	53	60	62	70	68	70	74	88	77	103	112	141	132	104	120	99	80	104
1061	78	98	94	113	82	86	71	56	63	63	59	70	56	49	68	46	58	59	51	67
1081	68	89	68	62	60	64	60	53	63	61	60	52	64	62	53	53	54	54	48	65
1101	48	57	50	70	58	61	56	55	43	49	60	64	57	55	56	52	65	50	58	52
1121	47	55	43	50	50	41	55	60	53	52	51	49	48	51	54	43	54	49	51	43
1141	44	43	53	41	52	48	53	55	57	51	65	48	61	55	62	38	57	38	36	46
1161	46	38	42	37	37	48	36	44	30	51	42	40	33	40	47	35	30	32	38	38
1181	35	45	40	53	32	32	44	43	40	41	46	35	34	47	39	39	50	38	36	39
1201	41	42	60	41	69	69	78	69	56	49	44	27	36	35	43	37	33	33	35	35
1221	30	28	36	29	31	24	44	34	48	27	40	41	40	45	63	42	40	43	32	26
1241	31	34	34	31	24	24	29	35	31	33	30	32	28	26	38	31	32	32	27	31
1261	26	29	23	24	26	24	26	28	26	26	23	32	27	35	28	26	23	28	24	31
1281	16	27	37	28	25	20	25	33	31	22	24	33	22	35	26	29	35	32	26	16
1301	21	24	33	25	17	14	19	16	26	23	21	28	30	17	27	22	15	25	32	22
1321	23	24	25	24	33	17	27	22	22	22	20	32	15	25	26	25	16	20	38	20
1341	26	41	40	57	78	63	75	78	49	35	27	19	26	26	19	28	27	21	22	20
1361	21	31	25	25	21	21	18	25	18	21	27	35	31	17	27	18	15	23	28	31
1381	20	20	20	23	15	16	16	25	18	21	27	25	14	23	16	26	23	9	25	18
1401	15	22	24	23	19	19	32	40	32	27	37	43	38	48	23	25	21	20	26	18
1421	22	23	19	24	20	28	21	17	22	24	20	17	25	22	15	18	23	19	17	16
1441	32	26	19	12	24	22	22	21	18	13	18	22	17	17	24	18	20	25	19	13
1461	19	16	19	19	22	20	15	20	19	25	24	21	19	19	12	20	15	21	15	15
1481	27	17	19	28	17	23	22	21	21	15	11	18	26	19	14	18	22	15	27	27
1501	20	20	17	19	17	25	27	21	27	18	27	30	26	28	18	20	24	23	22	14
1521	16	22	14	16	22	14	27	17	24	8	14	21	15	24	22	19	17	20	11	8
1541	17	16	27	13	26	15	25	26	19	19	18	15	20	20	17	13	15	16	17	20
1561	20	16	21	16	19	16	15	25	15	20	16	21	27	13	21	24	17	29	20	19
1581	14	18	18	21	20	19	16	16	15	24	18	21	24	25	22	27	20	25	16	25
1601	17	19	17	20	17	19	25	18	12	22	19	26	15	19	15	20	20	29	21	13
1621	8	28	25	20	18	22	15	23	23	15	17	21	10	25	20	19	17	13	18	15
1641	22	21	20	26	22	20	24	28	15	24	27	17	21	23	21	22	13	16	24	15
1661	17	27	22	28	19	26	24	29	22	18	15	19	14	18	31	21	30	25	21	26
1681	12	28	28	23	21	16	14	19	18	25	15	28	18	19	17	18	23	19	20	25
1701	22	17	26	17	39	24	27	27	18	29	19	29	17	30	25	27	20	21	31	25
1721	22	17	23	26	23	24	20	19	23	23	23	19	20	21	30	22	21	19	24	25
1741	26	30	18	26	25	22	23	25	9	22	22	30	23	25	23	19	16	21	18	17
1761	20	12	17	19	12	13	12	11	20	9	8	14	14	8	10	14	12	13	4	12

[illegible]

[illegible]

801	3392	3579	3624	3497	3369	3278	3193	3201	3232	3085	3152	3120	3124	3157	3050	3050	3218	3015	3084	3023
821	3066	3067	3027	2995	2952	3045	2935	2931	2934	2932	2993	2945	2812	2744	2804	2752	2695	2768	2669	2669
841	2663	2617	2671	2544	2612	2589	2547	2644	2598	2639	2542	2628	2503	2521	2436	2452	2510	2529	2463	2310
861	2339	2466	2391	2510	2342	2276	2314	2304	2304	2310	2359	2205	2200	2252	2196	2148	2213	2233	2217	2150
881	2172	2079	2172	2112	2137	2154	2102	2208	2055	2107	2048	2183	2040	1942	1936	2042	2055	2031	2034	2049
901	2074	2061	2147	2010	2008	1918	1981	1987	2012	2041	2081	2018	1996	1947	1932	1931	1963	1880	1973	1832
921	1855	1889	1932	1812	1869	1836	1884	1817	1842	1847	1822	1799	1822	1831	1862	1876	1886	1889	1893	1919
941	1925	1945	1905	1959	1979	2159	2779	3681	4980	6626	8415	9310	8467	5620	3233	2044	1705	1726	1611	1678
961	1729	1710	1794	1676	1616	1611	1548	1558	1512	1521	1537	1536	1519	1552	1524	1454	1443	1508	1533	1520
981	1466	1544	1450	1533	1502	1511	1485	1559	1515	1516	1510	1460	1468	1447	1499	1476	1410	1516	1445	1432
1001	1462	1514	1440	1484	1466	1509	1527	1520	1481	1487	1502	1356	1442	1396	1395	1524	1655	1909	2193	2638
1021	2949	3069	2763	2144	1575	1378	1362	1305	1291	1281	1319	1341	1231	1307	1210	1293	1212	1266	1283	1240
1041	1271	1247	1267	1201	1348	1286	1249	1397	1570	1701	1894	2060	2339	2489	2410	2052	1733	1506	1555	1624
1061	1717	1983	1857	1691	1491	1272	1164	1268	1237	1198	1242	1106	1071	1095	1165	1210	1216	1249	1248	1327
1081	1322	1325	1266	1233	1149	1130	1103	1162	1202	1195	1243	1150	1148	1125	1093	1053	1009	1084	1108	1094
1101	1084	1040	1050	1108	1139	1104	1026	1091	1082	1071	1077	1064	1057	1003	1059	1052	1085	1034	1071	1036
1121	1065	1036	1021	976	1033	1015	1044	1039	1027	955	1043	1001	997	975	994	1059	1055	1013	963	1034
1141	1011	1017	1029	994	1075	986	1063	984	1068	1114	1057	1096	1161	1076	1034	923	939	890	866	917
1161	874	822	815	847	873	805	802	867	813	828	841	807	836	811	814	835	824	768	810	777
1181	839	822	804	828	800	782	769	803	768	818	790	831	842	753	815	793	751	811	906	876
1201	874	971	1153	1257	1409	1307	1149	977	857	687	689	767	725	781	773	698	675	693	689	729
1221	669	629	667	664	667	654	663	715	661	686	749	787	845	832						

[illegible]

D-18

GAMMA RAY SPECTRUM DATA

PRTR MOD FS-23 SPECTRUM NO. 21 DATA TAKEN 3/06/69 LIVE TIME 330.MIN. POSITION 9.IN. ENERGY(KEV)= 1.111*CHAN -8.1

CHAN	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
21	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11	265	3360	31134
41	52447	58343	65800	73243	80032	84108	85991	83086	74509	65039	59953	58585	58862	59026	59459	60102	60036	60303	61333	61664
61	61812	63118	63113	63887	64719	64498	65718	65405	66437	66535	67285	67442	68221	69843	70907	71682	72083	71996	72073	73499
81	75251	75295	74853	75245	76865	77881	79549	80289	82860	85346	90325	105681	378001	633441	630691	7786321	778320	84381	93381	102886
101	85848	82816	82367	81844	82661	88721	110100	406011	151652	33913	114086	4564	90814	76792	69024	67059	65659	65834	65561	65231
121	65605	66106	65654	65687	65981	67578	75411	92011	101735	90525	74996	67213	64869	64165	64206	63787	64471	64808	66122	66323
141	65628	64383	63809	63649	63593	63135	63594	63207	63222	63026	62798	63336	62942	63004	62828	62673	62887	62795	62627	62514
161	62588	62748	63019	62719	62785	62463	63470	62894	62363	62369	62499	62001	62763	62286	62296	62033	62493	62568	62396	62315
181	62546	62538	62209	62139	61949	61497	61500	61196	61095	61075	60649	60578	60343	60734	60645	59953	60310	60057	59882	59839
201	59853	59669	59634	60028	59843	59517	59071	59633	59793	58939	59697	59299	59318	59335	59087	58740	59135	58965	58976	59198
221	59165	59081	58798	58640	59137	58791	58931	58605	58498	58846	58498	58288	58100	58672	58750	58580	58475	58243	58337	58530
241	58812	58114	58265	58014	58597	58746	58448	58094	58740	58002	58023	57898	58290	57721	57578	57999	57614	58052	58404	57871
261	58050	58005	57860	57772	58234	57918	58405	57967	58516	58116	58267	57741	58370	58754	58812	58040	58183	58043	57972	58403
281	58356	57990	57959	58006	58397	58486	58454	58740	58609	58504	58825	58076	58175	58634	58351	58182	58270	57666	58132	57563
301	57666	57504	57457	57183	57336	56947	56501	56463	56239	56149	55900	55256	55045	53896	53207	52554	52087	51079	50709	50599
321	56402	50124	49736	49711	49674	49254	49092	48694	49039	49006	48598	48594	48852	48531	48570	48236	48048	48348	48443	47907
341	47783	47859	47996	47888	47946	47378	47727	47362	47313	47643	48081	47699	47646	47329	47113	47058	46998	47236	47192	46843
361	47084	47047	47149	46583	46569	46543	46659	46549	46862	46695	46637	46274	46576	46556	46302	46738	46437	46467	46504	46250
381	46099	46347	46680	46290	46427	46311	46343	46656	46827	46512	47291	48105	49099	48961	47602	46087	45980	45979	45618	45217
401	45201	45406	45502	44642	44558	44163	44021	44030	43416	43716	43667	42718	43258	43194	43265	43021	43078	43361	43358	43331
421	43372	43278	43441	44013	44393	44117	43634	43400	43440	43112	43318	43685	43167	43464	42848	43194	43343	42752	42106	41984
441	42295	41743	41674	41684	41790	41684	42013	41472	41863	42493	42795	44644	49447	58076	65237	63646	64070	43617	42814	
461	42676	42942	43451	45396	51585	69117	105635	144594	52196	14446	71819	49453	42751	40926	40815	40389	41118	40964	40658	
481	40463	40035	41185	40594	40717	40766	40346	40366	40695	39934	39637	39293	39337	39614	38936	39485	38709	38746	39238	38946
501	38609	38681	38880	38814	38865	38955	38435	38570	38162	37869	37986	37422	37703	37671	36911	36517	35265	34828	34757	
521	33119	31527	29483	27839	26190	24903	23966	22824	21956	21320	20645	20751	19979	19539	19272	18777	18671	18572	18129	17983
541	17682	17621	17435	17143	16937	17439	17756	18407	19368	21325	24288	26056	24207	20225	17477	16312	16149	15874	15696	15644
561	16842	18060	18540	20558	27718	41038	54771	56572	42591	25378	16139	12437	11727	11623	11405	11350	11112	11092	11263	11102
581	16893	10507	10143	9751	9658	9622	9348	9139	9168	8765	8674	8737	8417	8388	8304	8135	8298	8736	10683	10640
601	25151	38526	48255	43449	28179	14534	8392	6715	6196	6133	6109	6085	5931	5778	5777	5606	5638	5513	5508	5286
621	5531	5313	5339	5258	5318	5364	5271	5129	5336	5496	6118	7321	9280	10778	10967	9051	6865	5526	5165	5131
641	5040	5004	5201	5207	5212	5135	5164	5246	5244	5283	5465	5511	5727	6338	7860	12367	20833	32983	43360	42284
661	29595	15367	7690	5577	5025	4775	4930	4719	4988	4976	4942	4869	5073	5057	5219	5241	5314	5399	5597	5605
681	5774	6158	6848	6544	13384	21936	35676	48294	52551	40466	25120	19791	30793	60530	107045	59098	78703	39613	72792	26715
701	8464	3502	2566	2402	2370	2260	2310	2268	2263	2190	2278	2314	2342	2248	2311	2341	2372	2428	2686	3115
721	4219	5899	7742	8306	7260	4953	3326	2775	2737	2750	2549	2312	2141	2098	2156	2115	2079	2119	2094	2101
741	2095	2071	2033	1945	2172	2133	2021	2057	2086	2027	2026	2040	2073	2007	2040	1969	2097	1952	1996	1951
761	1919	1951	1938	1946	1926	1867	1854	1840	1771	1726	1662	1781	1771	1680	1658	1600	1633	1609	1675	1598
781	1586	1633	1570	1624	1595	1622	1635	1591	1716	1857	2178	2409	2774	2922	2586	2046	1666	1529	1530	1485

801	1543	1526	1612	1652	1573	1489	1468	1445	1460	1418	1418	1387	1451	1430	1440	1308	1407	1410	1376	1378
821	1401	1428	1382	1328	1378	1379	1307	1320	1343	1329	1349	1296	1293	1211	1286	1265	1263	1193	1146	1156
841	1196	1198	1207	1195	1129	1152	1170	1190	1122	1161	1245	1154	1178	1106	1137	1077	1073	1065	1079	1085
861	1077	1011	1110	1084	1088	1053	1017	1039	1015	1024	1041	1051	991	1021	1005	986	1060	994	999	940
881	956	947	948	1001	945	931	938	934	989	909	960	838	953	876	866	907	907	897	890	899
901	901	928	968	960	939	924	884	887	965	956	928	1048	974	912	889	859	829	859	822	859
921	806	830	812	835	820	827	841	872	797	828	847	808	800	797	851	842	824	853	848	846
941	841	872	894	832	882	926	1016	1326	1811	2475	3265	3998	4150	3333	2213	1365	882	769	755	722
961	753	765	806	769	687	686	743	713	645	738	679	686	658	672	670	664	661	691	644	713
981	654	691	721	700	705	702	686	709	664	714	685	652	627	659	643	635	639	627	667	725
1001	645	658	645	711	679	707	706	655	666	677	656	647	645	673	634	675	738	814	935	1026
1021	1157	1394	1395	1181	889	708	598	570	568	578	554	605	589	586	589	596	574	566	552	550
1041	582	541	569	526	546	611	566	627	629	724	798	852	921	1141	1103	1035	857	715	698	693
1061	681	780	803	751	713	590	534	511	547	522	521	509	541	464	539	489	508	526	619	608
1081	628	600	651	554	542	521	533	507	510	575	535	549	527	535	526	484	488	497	483	511
1101	465	495	485	465	506	480	526	442	508	460	440	513	486	465	472	493	434	446	489	449
1121	556	475	500	500	475	490	462	516	439	475	484	501	468	438	428	454	470	465	454	450
1141	463	454	459	420	456	432	473	475	470	510	479	509	537	575	514	513	445	383	375	416
1161	375	386	402	416	377	363	363	386	386	366	412	373	360	362	406	395	351	409	367	356
1181	393	366	367	367	382	369	336	357	371	339	355	394	386	349	377	326	388	367	334	369
1201	359	356	419	477	509	556	537	482	417	379	324	320	321	339	326	318	348	322	345	329
1221	310	318	309	294	280	289	311	338	318	329	338	356	361	382	408	383	358	345	306	280
1241	294	291	288	270	267	266	293	283	293	302	272	322	279	309	282	313	284	259	236	227
1261	255	259	268	244	221	272	248	256	272	270	242	273	294	259	233	257	245	246	245	240
1281	270	250	239	255	252	260	257	241	253	230	256	259	220	255	233	235	251	222	248	212
1301	225	254	209	253	232	233	231	209	251	222	209	203	252	232	228	251	211	222	223	234
1321	244	229	190	225	210	232	240	236	236	228	273	215	237	229	241	210	267	229	255	281
1341	316	321	376	468	606	664	701	589	491	336	276	245	259	254	277	239	236	234	234	231
1361	229	229	224	229	211	200	241	200	221	222	208	223	195	192	180	208	222	196	213	201
1381	163	209	193	268	230	207	196	184	195	181	187	198	199	193	197	201	194	173	213	201
1401	227	269	243	229	218	207	262	226	219	226	233	259	415	235	235	224	239	166	182	211
1421	194	170	181	174	180	174	187	204	174	182	181	172	173	200	193	163	172	181	144	176
1441	191	192	179	179	177	201	194	192	150	182	196	182	186	188	194	169	193	158	155	189
1461	183	171	158	160	163	175	193	208	181	174	197	175	198	187	199	166	178	154	196	172
1481	193	167	164	176	181	198	186	168	179	204	203	199	193	160	171	190	199	167	173	172
1501	165	201	202	163	196	172	163	188	227	202	204	202	236	224	234	193	208	191	178	181
1521	171	171	186	161	180	187	175	179	201	166	148	130	181	182	208	151	156	160	164	161
1541	168	193	168	176	147	153	161	157	179	173	159	182	181	201	186	161	175	156	179	172
1561	165	159	191	176	187	180	178	200	164	179	160	169	164	162	192	181	177	171	204	177
1581	175	155	157	181	178	170	171	164	164	166	195	178	189	159	209	201	176	178	195	174
1601	171	171	182	197	162	166	171	153	173	172	185	150	181	197	170	162	191	177	191	186
1621	202	200	203	194	167	191	184	177	180	175	174	169	198	159	179	167	185	180	159	172
1641	176	170	176	192	177	170	169	170	193	171	183	163	206	184	182	156	175	194	177	189
1661	177	180	189	167	172	182	187	197	187	205	175	201	179	175	185	182	147	191	162	190
1681	174	183	206	215	197	226	165	168	190	158	160	136	183	206	177	184	178	202	209	193
1701	206	188	195	164	178	191	177	195	205	170	190	195	203	199	201	189	199	160	194	212
1721	189	193	183	197	175	212	174	197	192	191	184	201	191	200	178	215	217	213	192	181
1741	203	190	192	212	199	205	201	211	211	198	199	176	176	181	201	208	172	184	176	174
1761	196	171	173	159	150	139	126	126	160	111	164	105	126	105	93	96	118	114	103	105

[illegible]

801	2114	2299	2221	2057	2130	1956	1980	1875	1863	1936	1861	1927	1835	1919	1853	1896	1802	1914	1891	1822
821	1865	1770	1765	1857	1799	1915	1711	1789	1836	1791	1812	1831	1680	1699	1703	1677	1688	1626	1674	1601
841	1581	1556	1524	1602	1616	1528	1551	1636	1568	1616	1646	1575	1545	1510	1499	1423	1487	1423	1487	1505
861	1421	1431	1393	1400	1476	1455	1395	1384	1441	1388	1366	1320	1336	1339	1366	1384	1324	1318	1374	1298
881	1324	1288	1323	1212	1257	1307	1281	1318	1330	1329	1214	1231	1237	1207	1181	1261	1205	1257	1226	1274
901	1290	1349	1333	1270	1203	1295	1250	1221	1320	1314	1297	1285	1223	1176	1150	1167	1127	1172	1244	1212
921	1182	1120	1105	1140	1143	1097	1126	1148	1124	1043	1123	1102	1163	1153	1102	1111	1088	1122	1153	1224
941	1257	1182	1150	1204	1343	1576	2049	2640	3728	4075	5526	5161	3967	2547	1607	1204	1036	1032	1022	1007
961	1051	1093	1044	966	919	925	973	934	937	872	883	952	939	914	917	928	886	954	1014	903
981	919	908	912	969	859	900	920	954	900	864	871	915	912	883	878	872	924	848	891	883
1001	855	875	909	902	839	898	897	900	914	899	850	835	901	866	918	1032	1123	1368	1512	1752
1021	1853	1649	1311	1106	840	856	794	751	780	774	767	781	823	797	745	784	801	772	780	825
1041	790	758	825	842	780	829	876	975	1061	1115	1324	1322	1536	1449	1214	1141	992	907	898	960
1061	989	935	956	841	780	770	690	741	763	738	684	746	695	745	722	714	706	740	801	803
1081	794	854	746	764	677	687	710	714	726	730	715	666	670	668	684	684	680	630	675	662
1101	668	661	637	681	655	666	665	645	685	672	673	718	602	695	668	665	654	678	670	639
1121	636	625	594	648	669	660	688	650	640	615	645	617	610	625	647	597	608	648	652	649
1141	654	624	667	606	617	625	626	678	662	741	829	806	751	749	595	561	565	588	507	560
1161	540	536	519	530	496	556	467	495	525	477	526	476	543	533	509	507	485	520	514	455
1181	508	497	502	497	511	494	468	487	473	479	530	490	506	485	481	501	481	493	474	537
1201	590	576	624	694	653	627	511	480	461	470	419	470	427	426	476	447	429	446	412	392
1221	405	428	417	400	409	403	414	438	435	481	447	511	527	515	564	479	403	391	395	408
1241	380	368	384	357	355	385	376	420	417	426	464	405	424							

[illegible]

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GAMMA RAY SPECTRUM DATA

PRTR ROD FS-23 SPECTRUM NO. 19 DATA TAKEN 3/05/69 LIVE TIME 310. MIN. POSITION 43. IN. ENERGY(KEV)= 1.112*CHAN -8.8

[illegible]

801	1881	2003	1975	2065	1975	1948	1815	1861	1753	1797	1772	1854	1824	1726	1835	1665	1681	1767	1837	1735
821	1746	1736	1733	1760	1682	1620	1644	1766	1696	1699	1700	1617	1647	1591	1533	1579	1536	1533	1557	1505
841	1606	1476	1514	1475	1465	1466	1436	1466	1436	1526	1562	1473	1527	1373	1351	1366	1336	1398	1351	1383
861	1333	325	1390	1327	1684	1321	1293	1263	1297	1315	1237	1294	1329	1263	1260	1249	1206	1287	1254	1217
881	1241	1161	1262	1136	1220	1222	1201	1203	1203	1202	1127	1191	1172	1161	1134	1111	1150	1163	1190	1163
901	1204	1157	1186	1290	1217	1186	1157	1177	1198	1209	1216	1243	1267	1074	1074	1074	1114	1116	1101	1120
921	1061	1103	1022	1026	1116	1068	1031	1080	1064	1017	1034	1020	1058	999	1037	999	1065	1006	1010	1016
941	1069	1046	1164	1131	1131	1281	1500	1987	2639	3502	4517	5323	5129	3739	2248	1326	1049	901	872	
961	894	996	971	967	945	918	828	885	846	867	840	823	875	839	862	900	873	868	890	893
981	860	629	873	817	847	841	866	655	895	859	843	846	795	847	810	825	846	835	792	783
1001	772	763	806	826	785	845	890	642	869	867	816	857	791	825	785	846	863	1049	1193	1434
1021	1610	1746	1626	1348	949	637	793	728	744	728	721	702	721	697	749	670	736	715	701	698
1041	751	739	650	668	726	706	706	761	873	906	1014	1203	1279	1415	1293	1166	975	922	824	860
1061	864	886	894	857	779	767	727	711	670	686	634	682	636	639	650	677	686	681	677	766
1081	763	748	733	716	687	680	653	654	718	695	714	695	638	573	647	609	614	609	611	579
1101	636	637	607	630	638	603	592	670	582	618	609	637	576	560	623	575	597	668	583	593
1121	585	594	565	541	593	565	623	560	585	611	586	594	502	609	573	593	606	608	572	607
1141	617	617	589	586	572	535	598	583	566	610	695	655	714	739	630	578	527	523	506	462
1161	502	491	469	506	527	459	494	481	448	442	484	479	474	486	492	464	458	472	449	437
1181	471	429	436	451	483	433	479	432	469	441	440	460	439	442	454	474	482	466	500	477
1201	494	509	532	606	628	652	617	494	455	461	445	421	424	414	433	415	405	388	407	411
1221	386	385	358	368	396	382	379	373	389	413	384	449	455	503	473	464	420	389	381	371
1241	337	350	310	336	350	345	351	359	352	369	374	401	388	365	371	344	352	360	338	347
1261	347	340	326	318	310	349	339	361	331	319	301	313	311	331	319	311	298	304	317	329
1281	313	324	312	296	330	320	321	305	304	328	306	287	324	300	277	315	274	296	283	260
1301	308	290	316	273	282	288	314	285	260	289	283	279	294	272	286	297	277	284	286	302
1321	254	297	287	273	289	309	278	278	280	279	253	290	323	290	297	328	287	278	350	385
1341	365	521	557	664	743	831	782	605	463	358	326	316	290	312	279	304	299	263	294	284
1361	271	256	265	259	261	271	265	272	252	270	276	255	275	242	253	238	244	258	254	233
1381	236	242	237	248	259	251	254	252	231	251	266	226	244	287	258	214	261	274	255	200
1401	253	243	262	263	253	300	336	349	385	469	440	500	397	355	297	280	229	246	260	231
1421	237	233	216	220	252	223	229	269	246	214	245	203	211	211	237	229	230	223	230	
1441	243	228	221	237	236	215	234	219	222	211	237	226	197	202	199	224	220	214	227	211
1461	222	205	207	200	194	215	278	234	210	230	233	220	236	214	212	222	232	211	222	202
1481	211	229	228	228	236	193	214	228	236	246	260	207	218	222	216	219	202	212	211	201
1501	225	235	223	223	216	224	219	233	249	263	259	278	266	253	235	224	238	236	216	214
1521	235	229	224	224	225	409	196	197	200	232	223	201	223	211	209	206	211	208	244	195
1541	233	206	197	223	207	220	209	213	192	209	223	226	215	214	200	222	209	221	235	185
1561	205	205	271	215	221	233	196	224	207	222	225	204	191	210	215	211	191	204	211	266
1581	245	216	206	233	220	223	230	230	225	236	243	238	234	251	270	221	217	206	195	254
1601	222	198	202	208	202	217	226	201	230	220	219	240	213	221	226	223	217	250	250	259
1621	244	260	226	254	229	166	229	230	223	245	232	199	206	239	223	248	196	231	237	206
1641	233	209	255	245	226	222	240	225	212	234	232	228	209	196	245	216	243	243	213	206
1661	247	224	243	265	264	232	224	225	236	244	241	213	228	240	258	224	216	222	250	242
1681	245	225	259	211	235	244	259	219	212	202	242	238	211	232	253	238	241	251	250	259
1701	243	286	236	227	239	239	260	228	219	267	252	248	242	242	277	232	271	251	243	238
1721	249	234	242	219	246	234	219	268	256	240	252	263	265	231	281	241	225	284	269	240
1741	267	244	274	253	243	236	241	245	246	260	256	243	263	242	224	217	209	205	238	208
1761	262	188	163	140	164	165	148	180	141	137	133	149	129	127	145	119	119	125	130	111

[illegible]

[illegible]

801	2604	2955	2913	2994	2831	2786	2637	2607	2599	2590	2687	2593	2595	2604	2622	2650	2656	2575	2500	2578
821	2524	2581	2579	2519	2455	2400	2486	2444	2395	2477	2415	2420	2377	2421	2320	2232	2236	2182	2225	2135
841	2123	2111	2176	2142	2039	2052	2137	2090	2149	2153	2141	2152	2111	2063	2080	1976	1965	2075	2025	1980
861	2074	1958	1929	1869	1934	2010	1873	1952	1881	1843	1967	1917	1897	1875	1910	1821	1855	1748	1791	1802
881	1832	1732	1792	1766	1739	1793	1751	1781	1725	1747	1634	1687	1697	1699	1635	1638	1679	1597	1622	1632
901	1642	1725	1790	1704	1713	1671	1662	1696	1748	1685	1837	1775	1748	1665	1596	1628	1615	1632	1565	1688
921	1542	1582	1502	1560	1506	1511	1584	1585	1528	1566	1485	1491	1484	1553	1544	1518	1508	1596	1515	1547
941	1605	1636	1657	1596	1613	1724	2031	2615	3436	4711	6146	7456	7714	5993	3779	2166	1534	1327	1713	1382
961	1375	1432	1500	1384	1301	1295	1274	1295	1292	1264	1300	1269	1353	1196	1322	1233	1200	1247	1300	1230
981	1213	1278	1205	1253	1221	1219	1217	1273	1263	1212	1232	1291	1237	1220	1247	1233	1178	1205	1252	1175
1001	1216	1185	1259	1246	1212	1190	1234	1194	1212	1295	1183	1252	1166	1133	1176	1211	1285	1425	1593	1994
1021	2279	2634	2552	2127	1494	1246	1153	1092	1081	1072	1074	1077	1023	969	1030	1078	1064	1073	1055	1015
1041	1029	1038	1015	1043	966	1014	1067	1106	1169	1306	1544	1625	1869	2043	2075	1857	1504	1363	1302	1231
1061	1216	1446	1443	1403	1271	1092	1061	1045	972	965	964	943	928	977	964	948	973	979	1060	1100
1081	1109	1147	1107	1013	1036	909	933	941	960	1027	1020	1029	940	916	983	857	947	937	917	874
1101	866	873	921	917	907	891	826	882	873	829	848	891	936	926	818	873	886	862	895	866
1121	883	851	882	884	877	855	883	837	849	851	856	825	869	872	896	837	844	865	842	820
1141	836	849	875	816	797	871	806	639	872	869	899	955	978	1016	977	845	746	693	729	789
1161	678	699	742	720	736	715	729	722	731	676	690	682	726	684	700	684	654	692	695	685
1181	665	670	618	664	693	705	635	583	735	698	666	670	670	690	715	619	646	642	732	640
121	688	747	734	797	967	1033	1013	840	698	649	633	563	586	613	586	622	599	544	621	567
1221	523	598	575	527	533	563	574	489	569	579	607	655	607	714	658	755	654	587	528	830
1241	553																			

[illegible]

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[illegible]

801	1454	1466	1651	1529	1462	1388	1459	1263	1397	1396	1375	1316	1386	1311	1304	1331	1319	1368	1316	1301
821	1275	1256	1243	1254	1268	1290	1342	1228	1291	1287	1296	1228	1264	1153	1201	1174	1225	1204	1112	1120
841	1149	1138	1136	1043	1083	1165	1075	1141	1128	1128	1166	1099	1109	1049	1078	1057	1071	1042	1034	1015
861	989	948	945	1030	1026	999	1301	958	1006	1000	1004	1002	966	988	983	972	928	939	971	926
881	936	928	912	937	909	970	925	903	916	947	914	907	916	847	836	865	884	817	864	886
901	880	865	903	871	929	887	869	823	888	943	903	959	917	869	847	846	815	833	763	843
921	833	829	793	830	836	800	785	746	793	802	793	758	779	803	769	769	732	803	833	754
941	833	859	793	803	873	892	1035	1311	1847	2496	3265	3892	3922	2945	1806	1094	826	696	754	698
961	707	685	720	677	728	692	620	655	652	636	633	619	720	618	650	643	649	654	629	655
981	641	631	627	597	652	648	655	671	658	648	684	662	643	631	662	632	615	659	632	621
1001	631	626	610	621	617	623	582	628	639	631	597	628	609	611	592	640	699	771	938	1042
1021	1269	1306	1287	1040	833	612	557	526	548	570	581	540	524	542	533	567	538	569	565	573
1041	504	541	528	544	540	500	555	598	594	722	807	867	921	1037	1093	891	811	704	607	658
1061	639	734	724	680	630	551	502	524	517	521	505	554	517	482	477	513	513	500	537	525
1081	584	560	589	525	497	502	473	484	486	457	566	538	474	499	461	503	508	462	471	442
1101	457	476	452	439	473	436	451	432	463	418	450	456	446	448	437	454	438	469	430	471
1121	491	445	453	498	467	457	435	468	493	470	458	411	438	441	464	451	424	423	451	425
1141	434	434	451	429	406	458	404	446	484	480	514	542	590	605	486	446	354	372	365	370
1161	399	368	319	374	378	384	357	329	368	358	352	415	325	396	329	362	336	393	339	311
1181	357	348	343	380	327	346	341	369	332	352	302	390	365	332	330	333	350	367	357	347
1201	376	411	410	404	526	526	486	422	351	311	334	318	303	290	303	309	302	307	309	298
1221	313	280	294	262	272	308	269	293	291	307	287	344	345	340	346	362	372	345	327	287
1241	263	270	231	253	246	250	268	265	286	293	313	272	301	300	246	240	271	258	229	229
1261	245	244	242	251</																

[illegible]

GAMMA RAY SPECTRUM DATA

PRTR ROD FR-78 SPECTRUM NO. 15 DATA TAKEN 9/17/69 LIVE TIME 180. MIN. POSITION 30. IN. ENERGY (KEV) = 1.113 * CHAN -9.0

[illegible]

801	821	1071	1087	1092	1049	1006	952	921	931	919	942	972	952	951	940	922	933	887	882	954	894
802	821	965	945	890	862	917	910	840	860	780	881	843	840	781	859	800	785	817	840	764	756
841	816	771	773	806	762	746	804	786	754	786	764	724	715	749	663	691	747	683	660	688	
861	641	722	683	689	688	719	652	669	698	670	674	684	690	673	670	664	645	646	633	625	
881	593	625	612	593	588	611	639	609	640	634	610	651	650	590	614	584	646	590	582	631	
901	703	644	681	642	663	652	650	649	759	717	764	653	639	600	589	549	598	581	518	527	
921	575	564	533	545	520	550	561	526	550	581	534	540	547	520	549	569	599	568	602	569	
941	561	604	566	625	639	782	1024	1390	1902	2570	2817	2733	2205	1411	942	678	496	507	501	522	
961	498	524	498	505	473	438	488	467	452	469	453	446	444	492	457	426	449	479	449	417	
981	439	457	442	475	476	452	436	450	428	423	415	380	382	451	464	424	449	413	414	443	
1001	428	397	432	405	434	437	420	494	421	409	424	414	396	444	446	496	501	624	803	908	
1021	992	941	774	554	431	384	407	346	389	375	419	367	401	405	361	399	408	340	365	355	
1041	413	351	353	378	357	358	346	395	444	474	598	743	745	747	633	599	536	513	487	459	
1061	490	492	423	383	395	399	356	346	381	353	347	342	331	339	335	373	360	385	366	463	
1081	363	385	381	362	388	341	349	330	348	319	340	370	332	323	323	332	334	332	336	307	
1101	281	298	333	303	312	304	306	299	335	296	298	318	316	310	285	334	306	320	320	291	
1121	336	314	337	324	310	283	313	326	301	290	316	313	331	338	311	305	309	302	305	272	
1141	305	296	291	306	287	301	308	384	395	483	484	480	402	366	315	273	252	237	237		
1161	253	254	262	264	229	248	252	268	240	249	249	234	239	224	228	246	257	256	259	250	
1181	248	260	235	221	251	239	224	241	220	244	223	231	219	235	232	217	218	247	253	246	
1201	246	300	327	335	307	305	252	264	225	229	208	196	218	223	239	219	217	197	187	193	
1221	201	185	211	203	170	170	190	245	216	212	252	265	298	304	246	219	219	221	190	171	
1241	163	194	229	167	182	195	208	197	201	197	182	215	196	180	174	185	166	165	182	176	
1261	162	165	162	149	149	147	157	151	156	156	162	142	161	137	161	186	163	160	155	140	
1281	162	145	145	162	149	174	142	148	149	156	158	130	200	127	147	148	146	162	147	146	
1301	172	168	144	151	140	145	154	149	146	144	142	136	161	128	153	158	122	144	171	134	
1321	150	156	136	137	165	151	145	148	130	145	146	133	166	161	128	148	146	154	165	174	
1341	229	273	321	385	463	433	368	300	255	213	164	150	162	150	173	144	143	150	156	139	
1361	120	146	122	117	127	141	129	134	143	121	149	134	149	118	144	119	123	148	138	135	
1381	129	132	135	132	134	113	137	124	140	121	137	133	109	98	139	139	135	109	125	135	
1401	120	115	149	133	133	116	156	159	201	224	230	279	235	229	207	150	139	126	145	122	139
1421	127	118	113	126	127	130	112	112	118	104	104	110	114	104	119	102	111	103	96	111	
1441	127	108	140	118	123	114	110	110	113	135	108	108	108	120	91	148	115	109	113	104	
1461	124	105	105	109	113	123	103	89	102	103	118	121	113	120	95	114	95	112	84	89	
1481	104	111	121	117	107	91	96	118	106	107	118	100	113	100	107	124	123	123	136	120	
1501	126	99	103	116	115	111	129	156	125	177	140	155	150	124	116	126	123	109		107	
1521	137	110	110	113	102	90	124	136	87	103	103	114	106	100	106	102	109	97		105	
1541	98	97	108	100	123	123	104	126	140	110	121	102	95	112	114	118	112	112		117	
1561	124	107	130	130	122	100	106	99	120	106	118	107	99	113	123	107	117	127	104	107	
1581	110	125	112	111	109	115	117	107	112	112	109	130	147	121	129	128	121	110	110	123	
1601	103	104	122	113	110	109	104	113	102	92	92	109	108	119	106	107	99	125	142	135	
1621	135	155	129	115	143	115	105	98	117	92	118	107	99	113	115	105	108	107	120	111	
1641	112	121	116	109	118	131	122	107	117	114	118	111	142	115	130	126	118	89	115	127	
1661	96	119	104	128	110	131	115	115	134	126	121	115	129	110	114	119	129	107	104	122	
1681	133	118	128	118	111	136	124	117	133	115	110	118	115	121	115	107	136	121	124	106	
1701	114	80	128	131	115	143	111	105	135	117	147	120	123	108	111	117	139	136	165	126	
1721	108	113	124	127	115	136	120	107	135	124	131	121	121	121	132	128	139	154	130	128	
1741	160	145	142	132	118	134	135	125	121	139	135	114	118	111	108	110	107	119	101	104	
1761	106	108	105	106	94	101	75	78	70	77	85	65	56	56	73	62	60	59	58	66	

[illegible]

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GAMMA RAY SPECTRUM DATA

[illegible]

801	4872	5186	4968	4891	4612	4593	4356	4279	4230	4141	4164	4172	4165	4229	4140	4049	4115	4231	4225	4983
821	4134	3988	4036	4040	4070	4134	3960	3904	4002	3872	3895	3957	3776	3628	3729	3629	3603	3647	3494	3563
841	3484	3351	3548	3513	3492	3618	3527	3612	3609	3561	3578	3326	3295	3355	3274	3131	3197	3149	3250	3181
861	3308	3145	3106	3142	3058	3155	3051	3117	3025	3102	3063	3036	3047	2966	3008	3019	2922	2974	2852	2914
881	2822	2796	2789	2805	2880	2804	2942	2837	2852	2723	2821	2721	2772	2765	2721	2673	2750	2725	2769	2956
901	3047	3051	3146	2969	2878	2805	2843	2990	3163	3243	3291	3060	2772	2594	2680	2584	2645	2594	2425	2518
921	2457	2585	2617	2556	2612	2462	2574	2468	2482	2437	2489	2547	2470	2483	2553	2487	2624	2571	2695	2604
941	2725	2822	2779	2763	3099	3464	4484	6232	8203	10971	12740	12666	9883	6737	4188	3008	2548	2271	2283	2307
961	2278	2305	2341	2173	2217	2133	2133	2045	2094	2061	2041	2076	2015	2034	1957	2017	2036	2048	2022	1956
981	1968	2052	2026	2047	2098	2035	2075	2045	2042	2034	2051	2028	1982	1945	1946	1988	1945	2038	1958	1941
1001	1961	1906	1982	1882	2054	1930	1978	2107	1953	2084	1964	1899	2018	1954	2054	2205	2548	2886	3433	3894
1021	4285	4094	3469	2670	2121	1838	1824	1758	1769	1723	1711	1693	1708	1711	1698	1753	1679	1668	1714	1693
1041	1703	1734	1628	1735	1632	1721	1751	1883	2075	2314	2615	2961	3357	3239	2961	2640	2393	2199	2141	2176
1061	2254	2226	2187	1946	1722	1725	1629	1603	1564	1585	1582	1625	1518	1531	1544	1661	1545	1635	1755	1857
1081	1862	1696	1666	1655	1517	1539	1504	1538	1562	1457	1489	1403	1433	1467	1474	1432	1413	1502	1451	1852
1101	1456	1485	1428	1428	1426	1444	1441	1396	1404	1435	1432	1444	1351	1387	1413	1453	1442	1371	1397	1423
1121	1451	1384	1406	1365	1459	1468	1350	1462	1332	1407	1396	1380	1342	1366	1359	1322	1371	1416	1394	1346
1141	1344	1301	1277	1303	1379	1310	1377	1526	1558	1767	1964	2107	2165	1945	1674	1371	1264	1183	1136	1115
1161	1159	1169	1166	1127	1172	1166	1172	1121	1120	1189	1147	1094	1123	1148	1118	1040	1089	1119	1092	1886
1181	1053	1023	1063	1074	1041	1062	1073	1076	1056	1064	1021	1047	1028	1037	1076	1039	1080	1097	1085	1085
1201	1141	1331	1418	1562	1568	1507	1374	1215	999	1614	1003	984	976	984	972	914	941	929	828	902
1221	943	835	878	898	942	915														

[illegible]

PLOT CALLED FOR)

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-07 SPECTRUM NO. 7 DATA TAKEN 9/10/69 LIVE TIME 120. MIN. POSITION 39. IN. ENERGY (KEV) = 1.107 * CHAN - 4.6

[illegible]

801	650	609	675	646	675	613	576	552	543	589	556	579	556	581	563	556	567	575	539	561
821	549	566	580	571	547	550	510	528	565	537	493	523	540	468	487	490	474	514	506	486
841	502	478	509	469	501	464	490	478	448	447	503	491	507	496	468	472	410	464	454	422
861	437	469	444	427	416	389	389	401	397	383	378	449	402	422	376	401	445	428	421	396
881	420	375	391	380	371	381	371	381	388	367	408	382	388	374	368	385	380	379	359	382
901	404	401	413	436	398	404	421	357	388	423	437	446	404	396	374	377	342	361	316	351
921	377	346	298	330	353	372	350	373	290	326	342	363	325	346	371	330	303	324	373	360
941	387	366	395	414	387	400	467	550	670	941	1244	1562	1698	1508	1127	711	465	371	328	281
961	324	329	338	306	293	300	292	275	296	274	272	281	276	284	289	263	284	310	269	280
981	288	286	255	268	264	286	266	284	282	269	277	275	286	280	275	241	276	272	282	256
1001	261	288	262	244	249	279	281	275	251	281	250	282	270	288	252	257	277	297	371	383
1021	461	545	570	535	438	349	257	255	260	282	268	227	226	229	246	226	233	208	222	240
1041	234	244	235	216	212	231	253	242	267	284	266	346	355	405	459	418	400	377	307	296
1061	294	314	302	329	276	259	241	233	209	222	236	193	215	206	196	212	189	195	207	208
1081	250	233	226	239	204	236	192	195	213	192	240	199	230	229	201	192	176	186	212	167
1101	187	219	220	172	218	191	220	175	189	213	192	201	203	182	192	189	204	200	200	189
1121	199	182	189	187	194	211	176	200	213	183	179	217	191	189	166	185	175	177	191	177
1141	177	190	183	188	193	185	182	200	183	189	247	270	269	303	274	227	217	169	161	160
1161	153	162	134	155	149	155	155	152	144	114	151	149	134	168	139	157	137	149	130	151
1181	126	152	143	146	136	148	169	147	154	137	153	143	124	164	141	140	160	164	141	153
1201	165	174	180	146	198	210	214	196	176	155	143	149	145	126	139	132	122	140	119	135
1221	102	112	110	128	136	122	129	134	137	121	123	134	156	161	180	168	192	159	150	118
1241	104	96	97	128	85	101	103	99	121	109	113	139	125	147	138	124	114	122	114	107
1261	101	111	105	104	93	103	118	114	101	93	90	88	113	72	128	100	92	129	99	98
1281	99	91	96	80	122	102	110	105	84	95	97	97	88	98	93	98	110	104	89	92
1301	92	76	90	88	96	84	81	82	64	78	100	94	86	90	87	92	90	76	105	94
1321	76	106	102	92	89	97	89	90	98	87	71	84	99	114	99	93	111	75	93	97
1341	112	125	150	174	211	246	266	266	248	188	139	102	90	85	92	104	73	78	89	89
1361	82	78	83	92	89	83	90	95	73	94	72	86	78	72	65	82	77	90	82	74
1381	81	74	69	83	86	71	73	85	83	68	75	69	77	79	78	79	79	83	74	71
1401	83	73	71	94	65	88	101	84	120	118	129	159	153	161	140	112	107	79	76	69
1421	75	74	76	79	80	70	76	75	62	73	71	75	68	73	68	75	86	71	68	60
1441	77	82	68	71	72	75	78	74	64	78	67	61	60	73	75	58	78	82	71	69
1461	70	70	61	82	66	72	60	84	70	68	76	77	77	78	68	66	56	76	67	57
1481	85	81	65	58	75	74	59	70	63	78	69	49	63	67	63	76	58	75	72	75
1501	59	70	76	68	68	72	75	62	72	76	86	98	91	90	88	94	65	74	76	71
1521	65	78	72	72	67	59	71	68	52	69	71	59	79	75	68	60	74	71	74	70
1541	77	63	80	57	67	57	70	79	84	66	65	65	58	58	89	83	67	73	59	55
1561	46	58	68	69	83	67	73	68	67	58	73	78	76	49	75	74	68	78	73	59
1581	59	69	54	61	69	73	81	64	58	74	87	73	73	78	78	79	76	82	92	80
1601	69	79	69	77	57	66	67	60	73	83	68	73	71	62	76	63	67	70	67	75
1621	80	76	69	80	93	75	65	69	87	70	55	79	59	71	68	70	64	79	68	66
1641	72	74	75	85	73	53	64	53	57	67	64	59	53	73	62	69	66	63	84	77
1661	74	76	74	69	66	75	60	88	71	79	73	70	79	95	67	57	76	68	86	71
1681	76	59	64	74	68	83	70	75	77	66	77	87	79	82	83	74	94	75	66	81
1701	83	82	83	98	77	78	79	69	81	69	63	61	75	85	67	53	82	70	73	72
1721	73	63	84	76	71	76	88	79	68	78	80	65	88	75	77	91	76	71	85	92
1741	75	88	75	77	84	72	86	84	89	83	111	80	64	72	79	72	58	67	66	64
1761	66	84	65	85	78	57	54	61	56	40	49	40	48	33	54	53	33	46	48	38

[illegible]

PLOT CALLED FOR

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-07 SPECTRUM NO. 3 DATA TAKEN 9/09/69 LIVE TIME 180. MIN. POSITION 39. IN. ENERGY (KEV) = 1.109*CHAN -6.5

CHAN	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3	27
41	11238	25084	28409	31393	35419	39278	41950	43771	43213	38233	33536	30060	29177	29516	29786	30201	30337	30412	30916
61	31599	31976	32105	32346	32792	32912	33593	33419	34120	34237	34727	34856	35445	35503	36463	36488	37514	37673	38065
81	39093	39509	39862	39178	40688	41175	41654	42470	43257	45668	48297	54690	66411	78205	85937	92657	102310	104685	89905
101	52492	46333	44304	43654	44915	47602	55702	66284	74166	73173	65919	58351	51599	45189	39738	36523	35616	35474	35197
121	35320	34928	35153	35022	35458	36720	40097	45951	50748	50058	44687	38790	35796	35032	33721	34188	34405	34442	34334
141	34329	33995	34178	33885	34169	34122	34163	34010	33862	33803	34028	33902	33928	34017	34001	33601	33684	33637	33719
161	33758	34454	34017	33909	34121	34191	33952	33888	33896	33655	33754	33376	33633	33583	33555	33372	33580	33434	33587
181	32937	33134	33321	33370	33173	33164	32856	33124	32490	33140	32528	32772	32911	32751	32835	32392	32607	32346	32686
201	32574	32524	32111	32544	32015	32338	32041	31859	32845	32093	31953	32326	32061	32367	32398	32051	32622	31959	32056
221	32485	32038	31881	31984	31963	32248	31843	32077	31847	32210	31990	31915	31774	32197	32024	32003	32043	31910	31993
241	32058	31856	32094	31989	32087	32133	31593	32225	31854	32096	32069	31901	32220	31926	31923	31887	31910	32169	32191
261	32046	32329	31927	32172	32248	32560	32316	32642	32368	32682	32531	32672	32716	32439	32780	32576	32747	32855	32675
281	32913	32925	32984	32506	32571	32962	33169	33262	33086	33437	33258	33084	33117	33218	33348	33020	33246	33035	33005
301	33310	33030	33130	32854	33089	32518	32612	32547	32233	32208	31455	30832	30857	30242	29554	28938	28339	27480	26905
321	26297	26335	26175	25478	25551	25535	25394	25280	24895	24917	25184	24394	24714	24640	24819	24638	24545	24602	24698
341	24195	24112	24306	23847	24308	24072	23837	23935	24213	23806	23871	23687	23743	23631	23822	23548	23747	23690	23391
361	23292	23214	23225	23236	23103	23220	22970	22993	22973	22735	23233	22866	23118	22943	22671	22928	22704	22773	22543
381	22639	22546	22533	22623	22402	22522	22303	22124	22534	22665	23044	23677	24178	23535	23115	21937	21842	21278	21821
401	20707	20445	20207	19785	19770	18975	19251	18644	18534	18227	18224	18187	18005	17738	17781	17841	17696	17772	17486
421	17920	17716	18003	17791	18152	18041	17355	17335	17070	17164	17142	16677	16904	16637	16653	16467	16191	15842	15436
441	15359	15388	14957	14725	14742	14650	14520	14491	14706	14453	14524	14737	14893	15491	16002	15715	15704	15041	14736
461	15063	15564	16536	20622	11181	55645	92312	22262	124006	91590	52477	27145	16024	12594	11695	11288	11404	11247	11432
481	11067	1124	1133	1112	11151	10904	10973	10893	10671	10892	10685	10521	10805	10646	10610	10378	10312	10247	10399
501	10373	10186	10238	10389	10124	10303	10773	9947	9812	9989	9983	10178	10476	10756	10439	10324	10326	10328	10643
521	10378	9716	8932	8523	8171	7978	7074	7560	7591	7389	7302	7137	7176	7217	7081	7006	6889	6902	6917
541	9582	9688	6885	6888	6209	913	7878	10411	13024	15566	16562	16131	10896	8116	6968	6369	6338	6676	8036
561	9463	10765	12933	17702	32633	42089	52603	56335	61800	62865	12122	14812	4855	35403	31540	33433	38805	4043	4885
581	9655	4506	4241	4199	4033	4119	4142	4078	4098	4086	4044	4032	4076	4027	4187	4198	4428	4453	6104
601	21471	30899	36234	31962	21580	11866	6210	4030	3349	3200	3074	3070	3004	3013	3073	2906	2827	2890	2837
621	2886	2809	2774	2837	2779	2718	2789	2824	2769	2937	3368	3909	4843	5723	5795	4782	3833	3112	2673
641	2622	2898	2652	2554	2580	2597	2520	2522	2469	2541	2560	2594	2707	2726	3001	3629	4811	6610	7683
661	6506	4822	3364	2803	2542	2451	2466	2471	2502	2400	2432	2417	2383	2475	2510	2457	2504	2543	2547
681	2509	2622	2690	2930	3460	4668	6368	8195	9273	8550	6865	5592	6541	9792	15690	23309	27297	25970	18295
701	5116	2882	2296	2085	2010	2007	1952	1998	1993	1993	2018	1952	2022	2043	1979	2057	2133	2128	2331
721	3581	1211	6667	8060	7955	6401	4366	3157	2812	2580	2399	2221	1911	1927	1882	1895	1877	1828	1872
741	1887	1638	1861	1864	1847	1803	1844	1853	1815	1852	1836	1835	1815	1764	1818	1859	1762	1825	1845
761	1771	1774	1781	1753	1694	1723	1696	1644	1595	1576	1449	1502	1480	1444	1400	1473	1421	1440	1371
781	1367	1428	1262	1345	1372	1366	1423	1402	1417	1531	1712	2124	2514	2726	2747	2457	1919	1611	1382

801	1302	1255	1364	1365	1324	1308	1263	1256	1172	1234	1226	1186	1181	1218	1190	1156	1173	1200	1187	1250
821	1203	1130	1170	1152	1186	1170	1111	1150	1123	1158	1118	1048	1045	1105	1026	1019	978	1085	994	1059
841	974	1008	991	973	930	949	908	923	918	975	1021	999	909	968	915	882	934	876	892	853
861	839	832	869	857	899	864	841	865	821	834	774	838	829	830	845	805	852	783	768	816
881	757	746	774	785	769	794	787	716	749	755	772	777	747	764	701	729	732	763	780	710
901	723	764	804	778	775	800	778	761	710	790	759	793	767	801	778	724	693	667	634	764
921	697	704	640	657	663	630	636	679	659	637	660	640	653	680	699	677	690	701	708	662
941	739	728	758	725	712	714	834	953	1285	1735	2372	3450	4142	4577	3871	2689	1619	972	730	617
961	632	614	620	628	639	634	547	566	481	546	537	529	543	515	472	513	547	554	568	486
981	551	522	500	487	538	498	506	570	589	535	520	494	514	526	486	513	490	493	510	498
1001	527	553	535	508	519	480	513	520	537	517	554	545	523	538	471	530	523	580	630	853
1021	1050	1200	1320	1354	1170	899	696	548	496	470	463	449	485	467	432	435	441	483	445	443
1041	429	476	446	442	446	453	441	448	474	498	486	569	580	672	753	744	735	709	603	552
1061	544	541	537	531	563	467	479	439	418	458	455	470	431	444	425	422	393	427	467	432
1081	454	462	505	477	471	421	390	372	356	390	409	402	384	394	384	398	390	410	386	387
1101	381	369	373	374	386	390	392	371	367	336	339	363	368	388	384	404	351	394	336	371
1121	362	370	358	350	362	385	375	353	386	390	380	361	362	383	335	383	348	345	373	362
1141	340	339	347	329	339	347	361	362	386	382	369	419	447	465	500	463	411	383	353	341
1161	331	286	304	302	309	317	293	297	313	313	291	346	292	307	317	275	304	311	316	308
1181	292	308	304	308	304	300	298	298	244	285	306	291	277	284	272	282	292	258	281	298
1201	291	315	317	334	324	352	357	399	329	347	301	229	296	259	257	260	250	277	261	271
1221	261	227	230	250	231	253	240	219	234	264	253	259	287	285	303	321	316	316	282	244
1241	222	215	248	219	197	230	214	217	185	244	221	227	227	219	247	228	212	210	202	206
1261	209	234	210	195	183	193	220	209	195	188	211	182	177	191	201	166	200	194	194	196
1281	190	212	215	183	205	221	182	170	207	198	205	181	153	175	186	176	162	224	179	201
1301	191	171	176	162	182	195	171	182	148	157	182	185	187	192	165	157	185	170	186	171
1321	167	174	177	192	149	166	175	183	166	171	178	164	167	169	183	167	166	182	182	201
1341	203	207	241	276	305	371	389	453	371	320	312	238	219	232	226	191	193	201	169	182
1361	159	159	186	137	154	179	171	169	157	152	136	134	166	146	145	155	163	159	144	166
1381	185	167	147	138	142	151	157	152	131	180	166	171	136	168	145	146	146	145	149	145
1401	148	151	152	156	156	160	154	204	262	248	272	331	365	379	343	298	203	185	141	145
1421	154	144	144	144	144	144	144	144	144	144	132	142	155	136	126	146	145	131	146	140
1441	153	140	152	142	156	142	156	142	156	142	130	127	133	116	122	158	125	110	110	133
1461	140	131	137	125	125	108	155	133	140	156	123	137	122	139	134	120	116	126	139	123
1481	114	133	135	115	127	110	120	140	118	133	105	127	135	123	118	125	136	112	134	126
1501	125	119	149	133	129	128	142	125	134	119	118	153	143	162	152	151	126	166	123	113
1521	127	139	128	127	125	132	136	102	147	124	140	112	108	116	127	112	123	130	111	132
1541	113	120	120	119	119	124	118	127	121	121	121	125	126	137	122	127	139	119	140	102
1561	114	127	138	122	120	112	117	116	103	117	118	132	112	129	114	122	146	120	99	122
1581	116	119	115	135	126	130	141	112	134	132	126	129	111	134	132	136	146	155	168	149
1601	123	117	116	115	102	108	123	106	141	123	110	120	117	109	120	106	109	110	133	110
1621	122	161	143	145	145	159	126	139	129	131	117	128	130	111	109	112	112	111	120	103
1641	129	130	133	102	114	126	121	127	113	122	112	118	127	114	123	106	106	118	120	104
1661	125	132	128	140	117	132	133	113	108	135	123	106	119	130	121	115	123	136	126	106
1681	126	139	126	131	114	136	132	132	119	132	133	112	124	130	121	119	128	113	96	115
1701	123	112	136	112	126	122	129	127	108	121	132	112	118	112	121	122	118	121	143	150
1721	113	134	136	116	110	134	128	120	102	144	123	135	131	147	122	162	123	135	115	122
1741	156	153	159	146	122	136	129	139	112	143	154	118	137	118	104	130	133	130	124	131
1761	138	123	104	110	106	124	103	91	92	91	75	78	77	71	92	74	74	78	73	55

[illegible]

PLOT CALLED FOR)

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-07 SPECTRUM NO. 4 DATA TAKEN 9/09/69 LIVE TIME 120. MIN. POSITION 41. IN. ENERGY (KEV) = 1.106 * CHAN -5.2

[illegible]

801	1608	1571	1578	1630	1599	1620	1565	1543	1553	1529	1562	1600	1520	1568	1528	1516	1437	1425	1484	1467
821	1475	1516	1446	1434	1421	1498	1469	1406	1424	1451	1379	1338	1312	1295	1290	1296	1317	1156	1207	1214
841	1234	1256	1166	1196	1109	1111	1136	1106	1089	1067	1101	1074	1099	1049	995	1053	1072	1025	1003	1014
861	1009	977	970	989	1028	974	998	993	974	940	946	942	931	948	952	898	942	927	969	934
881	890	901	892	877	928	894	827	863	894	868	840	854	882	797	814	792	824	823	820	819
901	786	767	792	866	879	820	815	817	825	827	806	881	885	845	815	819	766	717	731	747
921	781	742	725	766	737	790	769	732	741	700	805	752	703	713	765	735	733	774	758	733
941	729	757	779	753	758	833	852	992	1286	1752	2499	3771	5199	66950	6950	5956	3907	2248	1255	795
961	670	651	698	744	746	741	641	644	611	600	609	573	573	567	538	596	499	571	567	583
981	566	565	576	597	538	560	530	570	617	575	591	573	601	569	576	574	547	548	571	561
1001	559	526	557	570	518	604	552	560	571	548	546	594	565	570	636	543	544	589	661	801
1021	961	1247	1625	1883	1978	1704	1192	855	643	535	515	472	545	501	467	486	480	462	442	473
1041	536	479	433	474	496	504	476	434	472	456	481	495	530	574	569	645	688	671	628	580
1061	574	514	544	549	554	575	495	499	499	448	499	513	494	489	509	443	431	440	465	475
1081	504	518	578	656	611	581	496	477	413	417	401	440	387	404	434	435	365	436	415	428
1101	450	365	432	418	431	407	407	403	376	407	415	397	413	416	402	392	383	371	423	396
1121	407	412	387	424	388	416	399	433	369	401	411	377	421	382	424	379	386	416	384	389
1141	392	386	393	397	393	388	377	430	373	401	386	394	433	510	513	442	452	430	396	382
1161	337	366	369	362	332	311	352	357	361	361	368	379	333	343	342	313	352	292	374	387
1181	353	365	364	317	369	348	353	348	333	351	358	348	332	338	363	316	341	342	348	312
1201	306	356	349	319	396	352	377	364	384	370	357	316	307	362	295	271	311	314	346	317
1221	283	275	288	271	279	269	263	253	240	256	249	307	280	273	280	300	299	354	311	312
1241	277	286	257	245	249	269	253	254	265	231	259	251	251	255	273	276	283	277	250	237
1261	213	199	230	253	235	207	219	235	224	212	231	231	218	212	218	227	215	235	228	213
1281	209	199	223	209	217	246	220	207	217	196	214	205	205	206	193	220	236	200	193	198
1301	209	205	181	218	225	201	203	208	166	174	214	188	206	176	184	187	187	210	220	198
1321	194	167	197	173	215	197	186	179	183	180	180	192	179	181	163	206	176	205	181	183
1341	209	196	225	227	222	243	291	313	334	398	360	288	228	265	286	242	233	230	217	207
1361	179	168	204	174	166	185	177	171	162	165	157	186	178	158	164	173	168	177	148	175
1381	168	166	179	176	165	171	180	165	164	158	172	180	163	189	161	179	189	179	176	179
1401	166	185	155	150	174	172	194	185	243	262	298	342	366	446	567	536	436	341	244	192
1421	163	158	146	167	178	155	139	144	152	148	137	118	137	146	143	132	131	127	149	135
1441	137	139	156	142	122	155	146	142	143	146	136	138	144	142	149	137	132	163	136	137
1461	138	139	135	140	134	134	126	132	127	126	135	126	124	129	155	139	147	138	130	
1481	125	134	158	133	137	122	130	144	110	144	139	124	127	122	132	103	135	124	114	128
1501	112	128	135	134	140	128	130	129	134	148	146	133	138	130	125	145	136	128	125	125
1521	141	126	120	127	125	123	136	110	125	145	141	126	133	134	114	124	125	125	105	106
1541	116	118	126	119	117	116	119	111	114	123	136	123	105	110	119	99	123	105	127	113
1561	131	99	132	121	104	144	121	125	118	114	129	118	133	107	122	111	122	112	136	121
1581	97	153	116	114	124	116	97	124	136	118	132	138	143	121	132	136	150	161	156	166
1601	154	167	126	119	105	121	120	116	118	104	117	100	83	113	137	88	136	116	121	116
1621	131	130	136	156	140	145	183	138	172	124	116	116	119	103	107	115	111	115	92	110
1641	105	106	100	94	97	114	112	111	100	111	101	101	108	122	105	107	106	116	124	111
1661	108	103	110	129	127	101	114	111	110	118	118	105	97	113	128	120	99	106	113	126
1681	111	116	116	93	110	115	124	101	97	109	107	100	127	93	105	104	91	112	127	114
1701	117	123	102	93	95	114	113	104	112	105	112	129	117	110	104	90	112	108	96	92
1721	96	113	112	104	90	105	111	108	114	112	102	77	105	102	98	121	123	114	122	123
1741	113	112	141	132	132	126	111	120	168	106	90	115	122	103	115	108	100	96	94	102
1761	91	81	99	103	92	89	97	91	96	92	84	83	92	75	81	90	82	67	61	59

[illegible]

PLOT CALLED FOR)

GAMMA RAY SPECTRUM DATA

[illegible]

801	771	762	815	770	776	796	725	742	734	739	694	610	686	724	729	691	695	665	751	739
821	683	730	759	692	713	696	731	666	675	639	641	633	668	687	657	595	616	668	628	575
841	580	587	549	596	515	517	574	562	536	543	564	537	571	569	546	537	527	501	479	541
861	528	529	503	535	483	488	502	476	509	486	483	492	513	477	468	445	500	462	472	471
881	471	422	449	458	451	438	464	445	461	460	458	503	447	461	457	419	449	465	461	410
901	408	414	430	433	417	446	416	427	438	444	436	464	452	458	419	395	427	397	428	389
921	359	389	355	403	358	396	386	387	390	384	363	377	368	356	367	362	380	398	356	421
941	426	404	355	403	420	423	462	519	647	943	1287	1900	2451	2907	2759	2084	1335	710	464	352
961	336	309	319	317	376	321	344	341	309	321	289	303	307	323	303	324	294	285	308	300
981	302	296	308	317	285	320	307	309	303	315	283	314	297	294	278	294	276	280	265	345
1001	273	296	293	316	322	279	310	308	287	301	296	311	299	313	294	280	285	335	349	447
1021	522	652	791	828	820	674	513	345	287	282	235	258	267	259	292	233	241	273	266	222
1041	263	231	237	260	208	236	226	261	258	226	301	274	314	334	352	429	383	381	348	322
1061	306	290	282	289	284	302	274	223	243	254	247	282	250	219	207	252	223	231	228	275
1081	248	259	293	301	296	283	263	222	229	214	246	216	223	223	207	211	202	199	197	218
1101	203	211	226	213	233	187	210	196	202	213	211	210	220	196	211	222	200	208	203	199
1121	221	200	195	204	196	213	213	188	202	195	215	210	189	225	228	214	224	210	184	180
1141	220	197	212	174	193	197	222	211	217	200	229	247	231	230	243	265	234	240	226	209
1161	171	185	190	200	171	197	189	165	154	178	166	179	165	179	196	180	180	183	172	175
1181	171	159	176	173	169	162	191	189	170	181	162	175	137	174	179	155	145	130	145	171
1201	170	168	192	175	194	195	190	214	221	193	188	174	156	148	157	155	146	174	144	167
1221	143	155	120	130	136	158	124	126	149	123	141	143	159	154	158	185	189	193	188	157
1241	135	140	162	128	128	136	136	141	124	114	137	107	121	138	133	136	148	159	122	125
1261	116	108	112	111	128	109	104	108	114	121	135	122	102	1						

[illegible]

PLOT CALLED FOR)

D-29

GAMMA RAY SPECTRUM DATA

PRTR ROD FS-07 SPECTRUM NO. 8 DATA TAKEN 9/10/69 LIVE TIME 120. MIN. POSITION 45. IN. ENERGY(KEV)= 1.108*CHAN -5.9

[illegible]

801	514	527	524	553	561	565	554	506	498	478	509	500	489	557	486	506	524	492	517	518
821	474	485	508	502	475	457	511	451	475	500	484	448	493	448	476	451	426	419	437	435
841	433	423	410	414	405	414	425	392	411	426	438	430	425	407	362	377	383	410	383	394
861	408	376	407	381	361	382	384	355	379	352	381	368	364	383	341	385	367	396	357	338
881	351	341	339	326	372	331	350	335	374	333	348	316	326	343	311	322	286	314	337	349
901	281	339	336	410	370	328	344	383	346	308	344	366	373	373	347	307	298	316	336	284
921	290	303	302	271	305	289	330	272	305	337	308	300	287	301	293	301	295	283	301	312
941	293	323	335	328	326	336	346	368	472	664	840	1036	1482	1521	1346	948	610	396	274	283
961	285	265	267	283	307	274	243	275	248	253	251	249	267	213	245	260	242	261	257	233
981	220	243	251	215	243	262	226	250	270	230	222	261	231	242	236	232	214	242	231	243
1001	256	239	221	237	218	242	252	264	233	270	278	264	240	243	255	255	233	217	279	319
1021	360	482	497	525	492	360	271	257	233	249	213	224	202	191	205	215	196	196	222	190
1041	210	215	232	195	215	216	205	192	188	193	249	255	317	331	350	398	389	365	309	302
1061	285	257	271	279	271	255	208	196	195	183	197	196	189	173	165	182	171	191	159	205
1081	187	209	204	201	204	190	172	187	166	125	194	184	181	181	154	179	181	177	158	181
1101	175	195	193	176	192	195	173	170	188	171	177	150	165	161	154	171	150	155	160	175
1121	165	163	185	177	151	162	161	172	183	176	180	174	169	150	173	153	159	145	154	145
1141	166	198	157	147	163	166	145	151	155	227	174	212	217	238	233	234	236	189	178	140
1161	153	133	126	141	139	124	146	123	158	124	129	118	151	144	134	113	136	120	126	111
1181	140	130	143	135	114	151	146	136	116	111	126	117	132	132	111	105	121	104	141	111
1201	128	140	148	147	174	182	189	198	191	165	146	125	121	119	118	108	115	128	103	119
1221	194	131	118	112	100	103	109	107	101	107	98	94	144	132	174	176	151	158	142	141
1241	105	106	102	93	71	107	95	107	89	110	98	117	95	101	108	110	96	82	93	104
1261	100	88	93	95	87	95	103	78	78	91	94	91	80	96	87	89	78	88	90	100
1281	82	90	86	93	99	85	91	85	76	79	83	79	78	93	79	80	72	98	85	88
1301	77	84	65	80	75	83	68	85	85	76	68	69	108	69	84	74	75	98	87	67
1321	75	77	80	74	70	87	95	76	71	81	99	79	63	85	74	80	88	88	95	84
1341	89	103	117	138	144	165	209	213	203	205	178	133	81	95	88	73	86	93	78	84
1361	95	83	83	90	64	64	79	67	89	75	69	71	65	68	80	77	60	73	69	73
1381	83	81	66	69	75	81	60	69	94	72	79	59	73	78	76	75	66	61	63	68
1401	65	74	71	82	71	63	70	62	87	101	107	108	116	127	151	102	109	78	69	73
1421	59	67	80	67	71	67	70	60	52	59	81	63	65	65	83	47	58	59	52	53
1441	71	52	65	80	65	69	51	57	65	54	70	61	46	67	58	61	62	71	59	67
1461	51	55	60	51	50	72	61	77	66	62	47	54	63	73	54	56	76	62	50	50
1481	50	50	62	54	62	76	67	63	53	54	46	64	73	71	47	58	48	56	61	59
1501	73	77	73	63	58	74	67	73	74	57	69	74	68	76	75	88	58	57	59	59
1521	76	81	54	68	67	58	63	56	62	63	72	53	53	50	61	40	56	65	77	55
1541	57	55	68	52	67	78	71	55	63	60	62	53	60	53	57	52	64	64	51	65
1561	66	55	64	53	58	42	60	83	43	48	59	61	50	70	38	54	75	53	63	56
1581	59	64	55	62	60	62	70	58	58	79	62	60	56	64	62	73	83	59	71	64
1601	63	62	71	63	59	61	45	60	59	55	61	61	58	56	61	57	58	68	58	64
1621	64	71	64	73	77	76	66	60	60	60	63	62	57	54	58	59	64	58	66	51
1641	48	72	67	61	57	66	53	61	64	49	59	63	61	51	62	51	54	63	70	56
1661	71	62	75	55	50	64	66	68	60	52	65	51	69	68	72	59	81	79	63	59
1681	64	56	63	65	69	55	71	56	66	50	67	68	65	79	47	66	79	70	80	58
1701	60	68	73	70	76	57	56	75	70	67	74	74	71	59	59	67	60	68	61	65
1721	60	63	53	76	60	83	68	76	68	79	59	76	64	68	59	67	72	82	71	65
1741	70	59	86	86	62	70	67	61	65	61	64	83	62	75	83	75	67	81	57	64
1761	64	61	70	67	69	60	56	69	56	48	47	38	44	41	37	52	43	29	35	33

[illegible]

PLOT CALLED FOR)

GAMMA RAY SPECTRUM DATA

[illegible]

801	2116	2085	2107	2148	2109	2215	2159	2096	2108	2006	1987	2058	1981	2002	1977	1967	2027	1948	1988	1886
821	1889	1965	1915	1865	1931	1891	1900	1824	1856	1819	1823	1858	1852	1780	1732	1798	1786	1748	1848	1687
841	1679	1714	1710	1641	1659	1676	1622	1658	1619	1627	1684	1629	1756	1662	1668	1670	1585	1536	1604	1529
861	1609	1571	1552	1567	1475	1586	1458	1531	1578	1483	1472	1477	1496	1412	1433	1418	1458	1428	1429	1475
881	1346	1361	1342	1311	1365	1278	1351	1337	1305	1376	1310	1353	1325	1319	1291	1338	1260	1277	1243	1238
901	1266	1280	1343	1288	1326	1370	1331	1307	1266	1355	1305	1359	1329	1368	1301	1359	1283	1214	1223	1152
921	1177	1171	1235	1209	1121	1115	1176	1216	1116	1165	1175	1166	1151	1173	1139	1143	1158	1209	1142	1144
941	1194	1234	1248	1261	1269	1309	1276	1429	1477	1833	2458	3264	4240	4909	5113	4739	4005	3028	2009	1473
961	1136	1113	1081	1040	1126	1060	1054	1040	1081	1017	1011	971	1009	986	979	966	1013	992	963	938
981	994	992	983	972	934	941	939	960	978	988	967	992	969	1001	1002	928	942	973	946	971
1001	998	974	943	962	995	966	988	953	968	954	1008	957	940	963	933	891	954	967	954	1103
1021	1212	1388	1469	1740	1752	1658	1495	1328	1039	934	799	863	809	836	783	838	814	818	753	753
1041	759	774	793	792	804	775	740	739	740	793	827	872	979	1058	1180	1359	1333	1425	1363	1286
1061	1331	1202	1129	1262	1362	1192	1214	1124	985	861	812	768	711	729	733	671	689	667	697	675
1081	749	740	756	765	844	733	808	768	690	657	652	670	649	650	654	615	665	631	650	654
1101	658	604	647	619	637	633	652	611	627	619	653	680	625	590	654	597	605	622	614	628
1121	604	609	652	574	654	625	652	632	570	587	599	606	637	603	604	572	617	597	564	600
1141	589	585	589	555	587	610	600	565	606	605	630	657	632	650	724	731	700	683	588	614
1161	595	540	521	499	493	487	469	457	506	505	510	492	496	458	504	442	515	500	471	495
1181	478	493	537	486	477	511	487	468	489	500	474	508	491	501	485	455	528	447	448	481
1201	506	494	531	555	603	729	797	822	901	801	822	713	614	543	493	423	454	450	405	397
1221	407	416	427	439	402	363	391	366	379	385	398	393	430	437	525	555	538	565	550	502
1241	511	476	450	386	380	339	363	345	366	357	377</									

[illegible]

PLOT CALLED FOR)

[illegible]

801	1666	1791	1823	1744	1865	1692	1712	1633	1610	1608	1559	1588	1587	1493	1540	1586	1615	1481	1536	1494
821	1514	1596	1543	1553	1561	1454	1525	1425	1473	1463	1434	1462	1454	1442	1359	1359	1439	1395	1379	1333
841	1356	1323	1277	1297	1221	1276	1325	1324	1371	1371	1280	1332	1344	1327	1265	1194	1226	1270	1215	1189
861	1212	1206	1178	1205	1152	1199	1228	1202	1110	1123	1130	1182	1074	1107	1060	1095	1089	1156	1058	1052
881	1076	1076	1089	1087	1062	1049	1107	1101	1113	1111	1064	1097	1067	1022	1031	1035	1012	1016	1076	963
901	1007	1034	1044	1119	1090	1098	1000	1033	1040	1105	1139	1195	1192	1047	1003	928	948	908	912	937
921	915	917	936	957	902	962	952	952	880	949	934	955	939	927	892	923	895	969	910	959
941	1003	1015	970	981	980	961	1050	1222	1563	2175	3253	4556	5199	4595	3436	2170	1394	977	882	880
961	817	864	862	853	837	818	823	771	759	789	808	761	803	740	803	765	771	765	763	713
981	763	762	784	718	766	781	809	782	804	799	810	760	704	719	769	729	723	774	750	765
1001	704	700	717	724	768	738	730	702	755	756	763	700	727	762	721	648	700	745	855	1020
1021	1274	1572	1701	1467	1286	916	731	647	656	612	584	625	632	660	610	598	648	607	584	634
1041	651	592	659	627	596	569	562	617	620	656	686	854	952	1112	1305	1261	1173	1028	913	834
1061	872	876	970	986	867	755	712	616	608	598	572	577	554	553	555	525	567	557	588	578
1081	640	664	682	648	618	558	575	580	524	559	581	572	559	497	591	578	542	525	508	505
1101	518	500	531	531	521	513	540	516	521	540	534	536	508	507	499	531	518	465	530	504
1121	517	505	478	510	500	491	515	471	513	505	470	529	479	543	504	489	514	466	505	487
1141	484	508	462	479	459	489	462	444	480	496	520	588	654	714	734	655	583	510	501	382
1161	437	434	429	404	444	405	409	392	428	417	405	420	417	414	395	387	407	379	416	403
1181	392	373	364	399	418	364	397	382	382	386	388	396	422	355	366	407	390	393	408	402
1201	399	456	484	546	580	658	676	671	585	482	382	385	390	338	383	365	344	361	300	374
1221	338	378	360	327	340	319	331	311	358	309	349	370	365	424	469	473	457	451	379	333
1241	294	337	309	312	274	291	276	280	283	310	300	310	325	324	340	308	294	283	294	

[illegible]

PLOT CALLED FOR)

GAMMA RAY SPECTRUM DATA

PRTR ROD FE-74 SPECTRUM NO. 12 DATA TAKEN 9/15/69 LIVE TIME 840. MIN. POSITION 30. IN. ENERGY (KEV) = 1.109 * CHAN -6.9

[illegible]

801	2461	2457	2546	2468	2547	2466	2381	2361	2375	2224	2332	2334	2268	2244	2242	2305	2285	2241	2382	2311
821	2248	2293	2172	2272	2196	2223	2229	2138	2187	2128	2128	2035	2129	2057	2097	1945	2027	1959	2021	1894
841	2018	1890	1895	1837	1885	1896	1908	1867	1943	1970	1974	1960	1894	1884	1852	1712	1912	1832	1824	1823
861	1792	1760	1742	1768	1720	1716	1735	1773	1708	1682	1638	1716	1701	1641	1674	1620	1626	1518	1528	1535
881	1565	1585	1560	1525	1540	1541	1497	1545	1480	1512	1497	1509	1523	1431	1555	1565	1471	1466	1463	1480
901	1523	1578	1548	1612	1556	1555	1459	1495	1473	1605	1641	1595	1623	1503	1538	1374	1446	1417	1456	1380
921	1411	1403	1374	1411	1410	1368	1318	1340	1369	1380	1364	1384	1327	1366	1371	1398	1342	1382	1367	1369
941	1404	1469	1478	1412	1505	1490	1681	2094	2729	4164	5444	6522	6373	5488	5465	3162	2119	1498	1239	1173
961	1233	1191	1259	1261	1176	1176	1220	1167	1090	1067	1109	1109	1118	1177	1216	1100	1054	1103	1129	1105
981	1159	1134	1107	1103	1068	1110	1204	1144	1144	1059	1090	1118	1128	1146	1125	1071	1055	1120	1065	1077
1001	1128	1124	1094	1111	1083	1062	1104	1108	1093	1032	1002	1098	1074	1044	1058	1077	1101	1194	1364	1623
1021	1991	2178	2129	1995	1946	1403	1114	1053	1022	895	944	936	894	932	942	975	920	935	879	872
1041	963	923	932	936	900	907	903	847	939	963	1085	1322	1513	1643	1711	1578	1580	1528	1329	1318
1061	1406	1449	1442	1387	1273	1062	1048	901	895	819	832	845	829	804	846	788	788	836	851	937
1081	961	965	964	904	863	853	850	859	820	793	796	795	742	798	788	765	810	793	733	751
1101	740	797	752	744	771	734	755	755	752	783	785	771	762	726	767	769	800	743	784	712
1121	750	728	699	769	657	747	704	730	733	789	738	719	754	752	692	736	690	738	744	748
1141	723	753	700	690	692	685	694	686	749	749	820	908	944	896	914	888	784	679	646	672
1161	608	571	588	634	588	567	554	585	610	561	640	604	612	589	565	571	605	523	612	549
1181	542	550	583	555	556	537	552	560	574	612	573	545	553	564	545	524	551	587	581	614
1201	662	691	776	848	992	920	955	895	834	702	590	564	508	521	483	524	491	507	487	512
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1241	489	440	437	427	439	422	455	440	445	441	471	438	431	438	458	437	440	403	423	410
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1301	354	365	356	348	390	354	362	394	343	367	367	353	327	337	350	324	350	319	338	359
1321	323	345	363	360	356	339	362	354	349	353	331	329	341	353	368	326	361	341	385	369
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1381	347	318	312	262	299	314	345	293	297	334	327	998	308	287	288	296	303	274	311	285
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1601	301	290	264	265	284	262	263	264	253	260	269	276	264	284	262	278	267	287	279	307
1621	269	295	297	310	328	301	297	300	281	266	294	313	275	261	272	274	248	274	271	262
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1741	362	335	313	311	323	319	319	322	336	312	308	305	314	288	301	299	332	285	304	301
1761	291	288	279	280	264	254	243	229	226	247	228	209	205	212	188	168	193	163	161	170

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CHAN COUNT

801	1689	1792	1767	1653	1591	1571	1537	1612	1531	1539	1531	1498	1545	1508	1461	1555	1532	1494	1587	1509
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841	1308	1328	1312	1302	1289	1272	1334	1322	1371	1298	1338	1212	1297	1189	1276	1192	1181	1205	1253	1173
861	1210	1240	1127	1225	1200	1155	1242	1189	1076	1140	1117	1124	1098	1085	1108	1053	1069	1053	1050	1054
881	1067	1053	1006	1065	1124	1057	1049	1025	974	971	1000	1030	997	948	1000	998	1049	1025	961	1003
901	982	1009	986	1063	1014	982	998	1005	1055	1092	1004	1009	960	1010	970	955	899	873	888	905
921	940	919	936	879	956	949	982	931	966	955	890	976	920	855	853	913	944	916	905	934
941	978	984	938	938	1009	1201	1447	2063	3078	4251	4756	4341	3230	2205	1426	1070	875	830	835	811
961	872	862	854	817	757	786	754	745	738	745	762	752	703	732	801	773	769	757	742	738
981	770	754	734	764	716	792	782	782	741	759	740	748	787	800	752	729	757	711	732	719
1001	756	734	732	754	711	749	685	753	738	754	695	705	696	752	694	766	853	1041	1245	1494
1021	1583	1414	1112	901	726	685	605	622	597	639	610	613	596	604	614	610	604	621	615	613
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1061	1127	1130	1003	882	714	652	577	559	550	581	525	518	537	531	504	532	566	531	604	616
1081	623	591	570	496	510	533	506	534	520	563	558	481	495	507	521	517	472	501	473	511
1101	489	480	456	480	511	504	456	487	494	503	500	494	489	510	484	479	468	485	487	511
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1141	493	463	489	443	488	448	455	435	447	532	538	600	505	523	431	435	440	383	396	369
1161	403	417	372	394	414	404	343	350	390	379	373	359	371	387	357	384	383	343	371	340
1181	405	366	408	368	373	372	406	420	389	375	391	356	371	372	361	382	434	428	443	506
1201	554	625	800	865	784	681	544	452	376	337	310	315	313	343	307	351	299	322	308	327
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1241	269	294	271	300	287	268	286	265	286	312	291	294	294	292	283	309	270	261	271	264

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GAMMA RAY SPECTRUM DATA

PRTR ROD FE-69 SPECTRUM NO. 13 DATA TAKEN 9/16/69 LIVE TIME 840. MIN. POSITION 30. IN. ENERGY (KEV) = 1.109 * CHAN -6.9

[illegible]

801	1476	1492	1512	1521	1499	1434	1500	1489	1387	1462	1399	1394	1397	1448	1420	1453	1348	1487	1451	1358
821	1335	1444	1300	1317	1410	1354	1379	1353	1371	1354	1376	1309	1259	1282	1226	1247	1306	1242	1224	1264
841	1198	1201	1177	1129	1186	1155	1191	1222	1205	1183	1179	1176	1169	1206	1147	1172	1094	1105	1103	1110
861	1136	1122	1079	1055	1103	1101	1072	1055	1063	1114	1043	1020	1096	991	1029	1103	994	912	994	992
881	997	932	949	930	880	944	936	933	956	907	885	967	893	913	956	944	856	918	900	928
901	927	896	944	917	968	952	896	954	898	935	909	935	921	924	846	816	814	833	825	878
921	835	817	868	825	822	820	836	867	832	815	819	816	797	814	821	854	785	802	833	844
941	878	878	947	874	873	929	1026	1211	1521	2182	3189	3855	4020	3523	2501	1624	1114	858	771	761
961	785	811	744	795	768	765	731	683	738	609	703	714	713	715	624	684	689	730	729	694
981	735	663	611	708	682	713	692	695	721	718	724	728	730	686	689	671	658	645	674	684
1001	710	702	697	696	686	702	681	641	708	706	649	670	651	684	625	590	665	666	792	1027
1021	1205	1427	1372	1251	923	750	655	592	545	545	555	554	557	531	540	543	570	581	578	555
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1381	170	185	199	186	194	191	174	162	171	198	182	180	168	185	175	151	173	188	165	178
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1421	171	176	152	172	155	169	172	168	156	188	158	190	167	166	166	166	162	178	182	184
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1541	146	140	155	160	156	157	157	151	153	165	170	121	145	145	162	155	176	153	155	164
1561	138	140	166	165	146	138	157	161	157	154	161	164	163	164	152	152	161	154	178	193
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1701	144	167	194	155	172	170	161	167	158	190	183	174	207	167	178	174	184	176	163	178
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1761	178	166	151	154	177	161	152	127	149	110	114	126	100	108	109	114	99	113	89	99

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