**Bulk Shielding Facility Quarterly Report
July, August, and September of 1977**

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MASTER

OAK RIDGE NATIONAL LABORATORY
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Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy \$5.25; Microfiche \$3.00

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Contract No. W-7405-eng-26

OPERATIONS DIVISION

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Date Published - February 1978

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SUMMARY

The BSR operated at an average power level of 1,868 kW for 23.58% of the time during July, August, and September. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory.

The PCA was used in training programs and was operated on two occasions when the Oak Ridge Associated Universities' students actively participated in training laboratories.

BULK SHIELDING REACTOR

Operations

During this quarter, the reactor operated primarily for the irradiation of research experiments. Basic operating data for this period are given in Table 1.

Table 1. Basic Operating Data
(July, August, and September of 1977)

	This Quarter	Last Quarter	Year To Date
Total energy, kWd	40,515	65,947	240,635
Average power, kW/operating hr	1,868	1,821	1,888
Time operating, %	23.58	39.82	46.29
Reactor availability, %	85.87	72.09	82.92
Reactor water radioactivity, counts min ⁻¹ ml ⁻¹ (av)	1,673	1,948	1,846
Reactor water resistivity, ohm-cm (av)	1,203,000	1,067,000	1,114,000
Standard fuel elements, depleted	0	0	0
Control fuel elements, depleted	0	0	0
Research samples	60	70	190

Core loading 34 (Figure 1) was converted to core loading 35 (Figure 2) on August 3, 1977, using the same fuel elements repositioned four rows west in the grid plate. The initial operating mass (4,772 g ^{235}U) of core loading 34 had been reduced to 4,723 g due to burnup, thereby reducing the excess reactivity from 5.35% $\Delta k/k$ to 4.85% $\Delta k/k$ (2.30% $\Delta k/k$ excess reactivity above xenon equilibrium). A new east D_2O tank was attached to the reactor structure. Core 35 had an initial mass of 4,723 g which provided an excess reactivity of 4.75% $\Delta k/k$. This core configuration is arranged for a HSST-2 experiment consisting of three sections of steel which will be irradiated at the north and west sides of the reactor core.

Core 35 (Figure 2) was temporarily converted to core loading 36 (Figure 3) on August 19, 1977 for neutron flux measurements in mock-ups of HSST experiment capsules and NRL-1 core piece monitors in CP-67. Core loading 36 was accomplished by replacing the BSF series fuel element in CP-67 with the NRL-1 core piece, and replacing two partially depleted BSF series fuel elements with two heavier MTR series fuel elements. Core loading 36 had an initial mass of 4,661 g which provided an excess reactivity of 3.92% $\Delta k/k$. Core loading 36 was converted back to core loading 35 on August 22, 1977 after completion of the neutron flux measurements.

Core loading 35 (Figure 2) was temporarily converted to core loading 37 (Figure 4) on August 31, 1977 for neutron flux measurements on NRL-1 core piece monitors in CP-67. Core loading 37 was accomplished by replacing the BSF series fuel element in CP-67 with the NRL-1 core piece, and replacing the Al core piece in CP-77 with a MTR series fuel element. Core 37 had an initial mass of 4,760 g which provided an excess reactivity of 3.55% $\Delta k/k$. Core loading 37 was converted back to core loading 35 on September 2, 1977 after completion of the NRL-1 neutron flux measurements.

Core loading 35 (Figure 2) was temporarily converted to core loading 38 (Figure 5) on September 7, 1977 for LTIF irradiations. Core loading 38 was accomplished by replacing three MTR series fuel elements in CP-78, CP-79, and CP-89 with Al core pieces. Core loading 38 had an initial operating mass of 4,168 g which provided an excess reactivity

BSR CORE

34
LOADING NO.

May 23, 1977
DATE

Excess Reactivity 5.35%

4,772 gm
OPERATING MASS

ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	9.23	10.73
2	9.23	10.73
3	9.23	10.73
4	9.23	10.73
5	23.00	10.73
6	23.00	10.73

REMARKS:

Figure 1. Core Loading 34 BSR

81	82	83	84	Al.	F. C.	Al.	Al.	M-15-H 199
71	72	73	74	Al.	Al.	Al.	M-7-H 178	M-6-H 178
61	62	63	64	M-1-H 162	BSF-S-9 59	BSF-36 121	BSF-S-10 59	M-2-H 160
51	52	53	54	M-13-H 181	M-194-D 132	M-3-H 157	M-14-H 178	M-195-D 134
41	42	43	44	BSF-39 132	BSF-S-13 80	M-17-H 187	BSF-S-14 79	BSF-40 128
31	32	33	34	M-20-H 199	M-10-H 172	M-16-H 181	M-11-H 171	M-19-H 200
21	22	23	24	M-196-D 155	BSF-S-11 62	M-12-H 185	BSF-S-12 61	M-323-A 153
11	12	13	14	PLUG	M-9-H 176	M-18-H 202	M-8-H 179	BSF-28 123

BSR CORE

35		
LOADING NO.		
August 3, 1977		
DATE		
Excess Reactivity 4.75%		
4,723 gm		
OPERATING MASS		
ROD POSITIONS AT CRITICAL (With Operating Mass)		
ROD NO.	IN. WITHDRAWN	
1	10.30	11.64
2	10.30	11.64
3	10.30	11.64
4	10.30	11.64
5	23.00	11.64
6	23.00	11.64
REMARKS:		

Figure 2. Core Loading 35 BSR

81	82	83	34	85	36	87	88	89
				Al.	F. C.	Al.	Al.	M-15-H 199
71	72	73	74	75	76	77	78	79
				Al.	Al.	Al.	M-7-H 178	M-6-H 178
61	62	63	64	65	66	67	68	69
				M-1-H 162	BSF-S-9 59	NRL I	BSF-S-10 59	M-2-H 160
51	52	53	54	55	56	57	58	59
				M-13-H 181	M-194-D 132	M-3-H 157	M-14-H 178	M-195-D 134
41	42	43	44	45	46	47	48	49
				M-5-H 158	BSF-S-13 80	M-17-H 187	BSF-S-14 79	M-4-H 161
31	32	33	34	35	36	37	38	39
				M-20-H 199	M-10-H 172	M-16-H 181	M-11-H 171	M-19-H 200
21	22	23	24	25	26	27	28	29
				M-196-D 155	BSF-S-11 62	M-12-H 185	BSF-S-12 61	M-323-A 153
11	12	13	14	15	16	17	18	19
				PLUG	M-9-H 176	M-18-H 202	M-8-H 179	BSF-28 123

BSR CORE

36
LOADING NO.

August 19, 1977
DATE

Excess Reactivity 3.92%

4,661 gm
OPERATING MASS

ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	12.05	12.81
2	12.05	12.81
3	12.05	12.81
4	12.05	12.81
5	23.00	12.81
6	23.00	12.81

REMARKS:

Figure 3. Core Loading 36 BSR

				Al.	F. C.	Al.	Al.	M-15-H 199
81	82	83	84	85	86	87	88	89
				Al.	Al.	M-4-H 158	M-7-H 178	M-6-H 178
71	72	73	74	75	76	77	78	79
				M-1-H 162	BSF-S-9 59	NRL I	BSF-S-10 59	M-2-H 160
61	62	63	64	65	66	67	68	69
	EAST D2C			M-13-H 181	M-194-D 132	M-3-H 157	M-14-H 178	M-195-D 134
51	52	53	54	55	56	57	58	59
	TANK			BSF-39 132	BSF-S-13 80	M-17-H 187	BSF-S-14 79	BSF-4C 128
41	42	43	44	45	46	47	48	49
				M-20-H 199	M-10-H 172	M-16-H 181	M-11-H 171	M-19-H 200
31	32	33	34	35	36	37	38	39
				M-196-D 155	BSF-S-11 62	M-12-H 185	BSF-S-12 61	M-323-A 153
21	22	23	24	25	26	27	28	29
				Al. PLUG	M-9-H 176	M-18-H 202	M-8-H 179	BSF-28 123
11	12	13	14	15	16	17	18	19

BSR CORE

37
LOADING NO.

August 31, 1977
DATE

Excess Reactivity 3.55%

4,760 gm
OPERATING MASS

ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	12.35	13.23
2	12.35	13.23
3	12.35	13.23
4	12.35	13.23
5	23.00	13.23
6	23.00	13.23

REMARKS:

Figure 4. Core Loading 37 BSR

				Al.	F. C.	Al.	Al.	Al.
81	82	83	84	85	86	87	88	89
				Al.	Al.	Al.	Al.	Al.
71	72	73	74	75	76	77	78	79
				M-1-H 162	BSF-S-9 59	BSF-36 121	BSF-S-10 59	M-2-H 160
61	52	63	64	65	66	67	68	69
	EAST D ₂ O			M-13-H 181	M-194-D 132	M-3-H 157	M-14-H 178	M-195-D 134
51	52	53	54	55	56	57	58	59
	TANK			BSF-39 132	BSF-S-13 80	M-17-H 187	BSF-S-14 79	BSF-40 128
41	42	43	44	45	46	47	48	49
				M-20-H 199	M-10-H 172	M-16-H 181	M-11-H 171	M-19-H 200
31	32	33	34	35	36	37	38	39
				M-196-D 155	BSF-S-11 62	M-12-H 185	BSF-S-12 61	M-323-A 153
21	22	23	24	25	26	27	28	29
				PLUG	M-9-H 176	M-18-H 202	M-8-H 179	BSF-28 123
11	12	13	14	15	16	17	18	19

BSR CORE

38		
LOADING NO		
September 7, 1977		
DATE		
Excess Reactivity 5.15%		
4,168 gm		
OPERATING MASS		
ROD POSITIONS AT CRITICAL (With Operating Mass)		
ROD NO.	IN. WITHDRAWN	
1	10.32	11.33
2	10.32	11.33
3	10.32	11.33
4	10.32	11.33
5	23.00	11.33
6	23.00	11.33
REMARKS:		

Figure 5. Core Loading 38 BSR

of 5.15% $\Delta k/k$ (2.60% $\Delta k/k$ excess reactivity above xenon equilibrium).

Core loading 38 (Figure 5) was converted to core loading 39 (Figure 6) on September 19, 1977. The initial operating mass (4,168 g ^{235}U) of core loading 38 had been reduced to 4,152 g due to burnup, thereby reducing the excess reactivity from 5.15% $\Delta k/k$ to $\sim 4.60\%$ $\Delta k/k$ ($\sim 2.05\%$ $\Delta k/k$ above xenon equilibrium).

Core loading 39 was accomplished by replacing the three A1 core pieces in CP-78, CP-79, and CP-89 with three partially depleted MTR series fuel elements and removing the partially depleted BSF series fuel element from CP-19 for a CP-19 experiment facility run. Core 39 had an initial operating mass of 4,584 g ^{235}U which provided an excess reactivity of 4.17% $\Delta k/k$ (1.62% $\Delta k/k$ excess reactivity above xenon equilibrium). At the end of the quarter, the excess reactivity was $\sim 3.96\%$ $\Delta k/k$ ($\sim 1.41\%$ $\Delta k/k$ excess reactivity above xenon equilibrium).

Shim Rod Calibrations

The BSR shim rods were calibrated after core loading 35 had been established. The results are shown in Appendix A. The total worth of all six rods is 11.128% $\Delta k/k$. The operating limit requirement that the reactor be operated with the ganged rods (all six) withdrawn at least 50% of their worth thus requires that the rods be ≥ 10.80 in. withdrawn when the reactor becomes critical for power operation. With rods 5 and 6 at 23 in. withdrawn, rods 1, 2, 3, and 4 must be withdrawn to 9.20 in. to comply with the same operating limit. Appendix A also shows the comparison of rod worths for January 1972, September 1974, June 1975, June 1976, November 1976, and August 1977.

The BSR shim rods were also calibrated after core loading 38 had been established. The results are shown in Appendix B. The total worth of all six rods is 11.002% $\Delta k/k$. The operating limit requirement that the reactor be operated with the ganged rods (all six) withdrawn at least 50% of their worth thus requires that the rods be ≥ 10.80 in. withdrawn when the reactor becomes critical for power operation. With rods 5 and 6 at 23 in. withdrawn, rods 1, 2, 3, and 4 must be withdrawn

BSR CORE

39
LOADING NO.

September 19, 1977
DATE

Excess Reactivity 4.17%

4,584 gm
OPERATING MASS

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	11.56	12.80
2	11.56	12.80
3	11.56	12.80
4	11.56	12.80
5	23.00	12.80
6	23.00	12.80

REMARKS:

Figure 6. Core Loading 39 BSR

to 9.70 in. to comply with the same operating limit. Appendix B also shows the comparison of rod worths for January 1972, September 1974, June 1975, June 1976, November 1976, August 1977, and September 1977.

Shutdowns

There were no unscheduled shutdowns during the quarter. Table 2 gives an analysis of the scheduled shutdowns.

Table 2. Analysis of Shutdowns

Description of Shutdown	Number	Downtime (hrs)
Scheduled		
Experimenters:		
No request to operate	12	1,051.067
Experiment insertion, removal or data taking	3	322.350
Repositioning of the reactor	3	2.150
Reactor Operations:		
Xenon decay for refueling	2	126.000
Refueling critical runs	18	36.867
Shim rod calibrations	2	33.950
BSR quarterly shutdown and maintenance	<u>1</u>	<u>115.000</u>
Subtotal:	41	1,687.384
Unscheduled		
Experimenters:	0	0
Reactor Operations:	<u>0</u>	<u>0</u>
Subtotal:	<u>0</u>	<u>0</u>
TOTAL:	<u>41</u>	<u>1,687.384</u>

Maintenance and Changes

Maintenance or changes to the instrumentation and mechanical components in the complex are listed in Tables 3, 4, and 5.

Table 3. Maintenance and Changes, Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
7-18-77 through 7-20-77	Instrumentation	Routine	Quarterly checks.
7-18-77	No. 3 safety channel	Recorder insensitive	The recorder amplifier was replaced.
7-19-77	No. 1 safety channel	Faulty scram catcher	The No. 1 Sigma amplifier was replaced.
8-1-77	Log-N channel	Erratic recorder readout	The Log-N amplifier was replaced.
8-1-77	No. 2 safety channel	Downscale spikes	The No. 2 safety amplifier was replaced.
8-3-77	Facility radiation and contamination monitoring system	Routine	Bimonthly checkout.
8-4-77	Nos. 1, 2, and 3 safety channels	Temporarily changed signal resistors	To temporarily increase the sensitivity of each channel by a factor of two during a startup test run with new Core 35 and chamber configuration.
8-31-77	Log-N channel	Period recorder spiking	Replaced the Log-N amplifier.

Table 4. Maintenance and Changes, Mechanical System

Date	Component	Trouble or Change	Reason or Maintenance
7-12-77	Reactor secondary tower fans	Routine	The gear box oil was replaced.

Table 5. Maintenance and Changes, Process System

Date	Component	Trouble or Change	Reason or Maintenance
7-8-77	Secondary tower basin	Faulty process water makeup valve	The ball float valve was replaced.
7-12-77	Skimmer bypass filters	Routine	New filters were installed.
9-13-77	H ₂ SO ₄ acid storage tank	Small leak at flanges	New Teflon gaskets were installed on three flanges.

Fuel

There were no changes in the number of components in the fuel inventory; however, the fuel inventory is listed in Table 6.

Table 6. Fuel and Shim Rod Status

	This Quarter	Last Quarter	Year To Date
Fuel elements depleted	0	0	0
Control-rod fuel elements depleted	0	0	0
New fuel elements placed in service	0	3	4
New control-rod fuel elements placed in service	0	0	0
New fuel elements available for use	14	14	14
New control-rod fuel elements avail- able for use	6	6	6
Partially depleted fuel elements available for use	9	9	9
New shim rods placed in service	0	0	0
Boron stainless steel shim rods in use	6	6	6
Boron stainless steel shim rods available for use	2	2	2

Experiment Facilities Assignment

Facility assignments are listed in Table 7. The tubes of the east D₂O tank are not permanently assigned; they are used by various laboratory personnel for short-term sample irradiations.

Table 7. Facilities Assignment

Facility	Location	Division or Sponsor
Liquid helium cryostat	Southwest corner of pool using west D ₂ O tank	Solid State
Liquid nitrogen cryostat	On instrument bridge	Solid State
Ambient temperature facility	North face of core	Solid State
Heavy Section Steel Experiment	North and west face of core	Metals and Ceramics
Fast-neutron tube	Core position 15	Solid State
Water-cooled tube	Core position 15	Solid State
Dry thermal-neutron tubes* (D-3-1 and -2)	East D ₂ O tank	Operations
Wet thermal-neutron tubes* (D-4-1 and -2; D-6-1, -2, -3, -4, and -5)	East D ₂ O tank	Operations

*These facility tubes are for sample irradiations and are used by personnel of several divisions, primarily Analytical Chemistry and Solid State Divisions.

Demineralizer Performance

Table 8 gives detailed information on the condition of the primary water system for the preceding year and pertinent data on the performance of the bypass demineralizer.

Table 8. Demineralizer Performance Data

Run No.	Initiation Date	Termination Date	Throughput (gallons)	Gross Gamma (Counts min ⁻¹ ml ⁻¹)		pH		Specific Resistance (ohm-cm)	
				In	Out	In	Out	In	Out
33	1-4-73	3-5-73	1,614,000	1,280	115	5.7	5.8	1,008,000	1,430,000
34	3-6-73	4-30-73	1,393,200	1,848	181	5.7	5.7	873,000	1,363,000
35	5-2-73	7-2-73	2,060,000	2,072	120	5.8	5.8	896,000	1,209,000
36	7-3-73	9-4-73	1,900,000	1,672	116	5.8	5.8	792,000	1,270,000
37	9-4-73	11-12-73	1,300,000	2,021	107	5.9	6.0	682,000	1,144,000
38	11-14-73	1-7-74	1,692,000	1,353	98	5.7	5.7	738,000	1,102,000
39	1-9-74	3-13-74	1,320,000	1,931	101	6.2	6.0	666,000	908,000
40*	3-15-74	7-30-74	1,400,000	9	0	6.2	6.0	364,000	1,132,000
41	8-16-74	12-4-74	1,500,000	2,316	385	5.8	5.3	630,000	895,000
42**	12-17-74	4-15-75	3,850,000	2,116	119	5.8	6.0	1,018,000	1,611,000
43	4-16-75	7-7-75	2,550,000	2,712	174	5.7	5.3	937,000	1,823,000
44	7-10-75	1-5-75	2,750,000	2,528	144	5.7	5.9	968,000	1,428,000
45	11-5-75	4-29-76	2,325,000	2,146	154	5.3	5.5	902,000	1,593,000
46	4-30-76	9-2-76	2,800,000	1,430	124	5.4	5.6	1,085,000	1,808,000
47	9-2-76	1-27-77	3,450,000	1,700	126	5.4	5.6	975,000	1,548,000
48	2-1-77	4-22-77	2,000,000	2,026	146	5.6	5.7	1,052,000	1,971,000
49	4-25-77	9-21-77	2,700,000	2,005	140	5.6	5.8	1,054,000	1,815,000
50	9-22-77	In Service	300,000	1,673	152	5.3	5.5	1,203,000	2,040,000

*The reactor was shut down during the entire run.

**New resin in the demineralizer columns.

Special Tests

During the quarter, the following reactivity worth checks were made at low power (4 kW) runs.

Reactivity Changes Due to Displacing Water

Date	Remarks	% $\Delta k/k$
8-17-77	New east D ₂ O tank	+ 0.75
8-31-77	NRL-1 core piece in CP-67	- 0.23
8-31-77	HSST experiment dummy capsules	- 0.07
9-7-77	LTIF with portable D ₂ O tank between the reactor core and LTIF	+ 1.15

Operational Activities

Date	Remarks
7-12-77	The skimmer filters were changed.
7-18-77	The emergency electrical power quarterly test was completed with satisfactory results. The test was performed by turning the emergency power transfer switch (circuit 18 in electrical power panel DP-1) to "OFF", thereby starting the ORR diesel generator which supplied electrical power to designated circuits in the control and pool rooms.
7-20-77	The containment system quarterly functional checks were performed with satisfactory results.
8-3-77	All fuel elements including shim rod fuel elements were visually inspected with satisfactory results.

POOL CRITICAL ASSEMBLY

Operations

The PCA was used 17.0 hours as a training facility for the benefit of personnel from the Oak Ridge Associated Universities. Operational activities in preparing the facility for use included a checkout of the reactor control instrumentation and preparation of the required loadings. The operational activities are listed in Table 9 (Usage of Pool Critical Facility). The PCA maintenance is listed in Table 10.

Table 9. Usage of Pool Critical Facility

Date	Operational Activity	Purpose	Hours Used
7-20-77	Established Core No. 216 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Oak Ridge Associated Universities' personnel.	9.1
7-21-77	Established Core No. 77 to permit calibration of the regulating rod and the performance of the importance function experiment.	Training lab for the Oak Ridge Associated Universities' personnel.	7.9

Table 10. PCA Maintenance

Date	Component	Trouble or Condition	Action
7-12-77 through 7-14-77	Instrumentation	Routine	Quarterly checks were completed with satisfactory results.
7-13-77	No. 1 shim rod assembly	The seat switch had electrical leakage to ground	The shim rod assembly was removed and the faulty seat switch was replaced.

Experiments

Experiments were conducted at the PCA by students from the Oak Ridge Associated Universities as indicated in Table 9. These experiments are described briefly and were directly supervised by the training supervisor of the Operations Division.

Approach-to-Critical

To demonstrate the technique of assembling a reactor core, a critical mass was loaded by the trainees following the standard approach-to-critical procedure.

Regulating-Rod Calibration

A technique used in calibrating reactor control rods was demonstrated by using the period method in calibrating the regulating rod. The exercise was performed by the trainees.

Statistical Weight

An experiment was performed to determine the effect of absorbers on the reactivity as a function of position in a special fuel element located in the reactor core. Using guidelines provided by the Operations Division supervisor, the experiment was performed by the trainees.

APPENDIX A

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

August 24, 1977

To: T. P. Hamrick and F. T. Binford

From: S. S. Hurt and E. D. Lance

Subject: Calibration of BSR Shim Rods

The BSR shim rod worths were measured following the refueling to establish Core 35, a suitable core for the HSST-2 capsule irradiation. In this loading, the new D₂O tank is also positioned on the east side of the grid with the fuel moved to the four rows farthest west. As expected, there were no great changes in rod reactivity worths.

As determined from this most recent calibration of the shim rods, the minimum position of the shim rods at critical is as follows:

1. All six rods ganged at 10.80 inches withdrawn; and
2. Rods 5 and 6 at 23 inches withdrawn, rods 1-4 ganged at 9.20 inches withdrawn.

Rod worths determined during the six most recent calibrations are compared in Table 1 below:

Table 1. Comparison of BSR Rod Worths (% $\Delta k/k$)

Rod No.	Jan. 1972	Sept. 1974	June 1975	June 1976	Nov. 1976	Aug. 1977
1	1.944	1.697	1.934	1.755	-	1.923
2	1.864	1.873	1.259	1.843	-	2.003
3	3.018	2.942	3.086	2.512	-	2.778
4	2.962	2.966	2.931	2.854	-	2.700
5	0.852	0.946	0.940	0.854	1.145	0.776
6	0.872	0.937	0.910	1.159	0.885	0.992
1-4	9.788	9.478	9.710	8.964	8.964	9.404
5-6	1.724	1.883	1.850	2.013	2.030	1.768
Total	11.512	11.361	11.560	10.977	10.994	11.128

S. S. Hurt
S. S. Hurt

E. D. Lance
E. D. Lance

SSH:EDL:ksm

Attachments

cc: C. D. Cagle J. R. Thomas
G. H. Coleman BSR Control Room

APPENDIX B

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

October 14, 1977

TO: F. T. Binford
 FROM: T. P. Hamrick and E. D. Lance
 SUBJECT: Calibration of BSR Shim Rods

The BSR shim rod worths were measured following a refueling to establish Core No. 38 for the LTIF irradiations. In this loading, the new D₂O tank is positioned on the east side of the core and the west side of the core positioned against the portable D₂O tank (formally the west D₂O tank) which in turn was positioned against the LTIF. The resulting reactivity worth curves are attached, along with a plot of excess reactivity remaining versus the ganged rod position of rods 1-4.

As determined from this calibration of the shim rods, the minimum position of the shim rods at critical are:

1. All six rods ganged at 10.80 inches withdrawn; and
2. Rods 5 and 6 at 23 inches withdrawn, rods 1-4 ganged at 9.70 inches withdrawn.

Rod worths determined during the seven most recent calibrations are compared in Table 1 below:

Table 1. Comparison of BSR Rod Worths (% $\Delta k/k$)

Rod No.	Jan. 1972	Sept. 1974	June 1975	June 1976	Nov. 1976	Aug. 1977	Sept. 1977
1	1.944	1.697	1.934	1.755	-	1.923	1.988
2	1.864	1.873	1.259	1.843	-	2.003	2.254
3	3.018	2.942	3.086	2.512	-	2.778	2.657
4.	2.962	2.966	2.931	2.854	-	2.700	2.775
5	0.852	0.946	0.940	0.854	1.145	0.776	0.617
6	0.872	0.937	0.910	1.159	0.885	0.992	0.711
1-4	9.788	9.478	9.710	8.964	8.964	9.404	9.674
5-6	1.724	1.883	1.850	2.013	2.030	1.768	1.328
Total	11.512	11.361	11.560	10.977	10.994	11.128	11.002

T. P. Hamrick
 T. P. Hamrick

E. D. Lance
 E. D. Lance

Attachments

cc: C. D. Cagle J. R. Thomas
 G. H. Coleman BSR Control Room
 S. S. Hurt

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