**Bulk Shielding Facility Quarterly Report
April, May, and June of 1975**

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MASTER

OAK RIDGE NATIONAL LABORATORY

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OPERATIONS DIVISION

BULK SHIELDING FACILITY QUARTERLY REPORT
APRIL, MAY, AND JUNE OF 1975

JANUARY 1976

S. S. Hurt, III
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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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SUMMARY

The BSR operated at an average power level of 1,722 kw for 37.10% of the time during April, May, and June. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory.

The BSR was operated at low and variable power during this quarter for 91.566 hours as part of the training programs for nuclear engineering students from the University of Tennessee and Mississippi State University.

The PCA was also used in the above-mentioned training programs and was operated on seven occasions when the University of Kentucky or Mississippi State University students actively participated in training laboratories.

BULK SHIELDING REACTOR

Operations

During this quarter, the reactor operated 37.10% of the time primarily for the irradiation of research experiments. It was operated at low and variable power (11.30% of the operating time) to enable nuclear engineering students from the University of Tennessee and Mississippi State University to perform training labs described elsewhere in this report. Basic operating data for this period are given in Table 1.

Table 1. Basic Operating Data
(April, May and June of 1975)

	This Quarter	Last Quarter	Year To Date
Total energy, kwd	58,126	116,948	175,074
Average power, kw/operating hr	1,722	1,942	1,832
Time operating, %	37.10	66.95	52.02
Reactor availability, %	82.77	90.23	86.50
Reactor water radioactivity counts min ⁻¹ ml ⁻¹ (av)	2,657	2,016	2,336
Reactor water resistivity, ohm-cm (av)	932,000	1,031,000	982,000
Standard fuel elements depleted	1	4	5
Control fuel elements depleted	2	0	2
Research samples	28	17	45

Core loading 26 (Figure 1) was temporarily replaced by core loading 27 (Figure 2) on June 12, 1975, for special flux mapping for a proposed heavy steel experiment. Core loading 27 had an operating mass of 4691 g which provided an excess reactivity of 5.20% Δk . The core configuration was returned to core No. 26 on June 13, 1975.

Core loading 26 (Figure 1) was replaced by core loading 28 (Figure 3) on June 26, 1975, to provide adequate excess reactivity for versatile operation. The initial operating mass (4192 g ^{235}U) of core loading 26 had been reduced to 4030 g due to burnup, thereby reducing the excess reactivity from 5.70% Δk to $\sim 3.15 \Delta k/k$ ($\sim 0.60\%$ excess reactivity above xenon equilibrium).

Core loading 28 was accomplished by replacing one depleted BSF-series fuel element with a new MTR-series fuel element and installing two new control rod fuel elements. Core loading 28 had an initial operating mass of 4168 g which provided an excess reactivity of 5.45% $\Delta k/k$ (2.90% $\Delta k/k$ excess reactivity above xenon equilibrium).

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	17	986.584
Experiment insertion, removal, or data taking	1	18.717
Reactor Operations:		
Special	1	10.933
Decay for refueling and shim rod work	2	191.800
Refueling critical runs	9	5.350
Shim rod calibrations	2	82.750
Quarterly	<u>1</u>	<u>77.533</u>
Subtotal	33	1,373.667
Unscheduled		
Experimenters:	0	0.000
Reactor Operations:	<u>0</u>	<u>0.000</u>
Subtotal	<u>0</u>	<u>0.000</u>
Total	33	1,373.667

BSR CORE

26

LOADING NO.

February 10, 1975

DATE

Excess Reactivity - 5.70%

CRITICAL MASS

4192

OPERATING MASS

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	9.41	10.90
2	9.41	10.90
3	9.41	10.90
4	9.41	10.90
5	23.00	10.90
6	23.00	10.90

REMARKS:

East
D₂O
Tank

81	82	83	84	85	86	87	88	89
71	72	73	74	75	76	77	78	79
FZC 003T 203 61	BSF-S-7 65 62	BSF-36 153 63	BSF-S-8 65 64	FZC 003U 202 65	66	67	68	69
FZC 003N 195 51	M-194D 173 52	M-193-D 149 53	M-195-D 173 54	FZC 003U 195 55	56	West 57	58	59
BSF-34 153 41	BSF-S-11 76 42	M-192-D 146 43	BSF-S-12 75 44	BSF-35 151 45	46	D ₂ O 47	48	49
BSF-39 165 31	FZC 003R 203 32	BSF-38 149 33	FZE 003S 203 34	BSF-40 164 35	36	Tank 37	38	39
M-196-D 185 21	BSF-S-9 73 22	BSF-37 151 23	BSF-S-10 73 24	M-323-A 186 25	26	27	28	29
Exp. 11	BSF-28 136 12	FZC 003Q 197 13	BSF-30 134 14	Exp. 15	16	17	18	19

Fig. 1 Core Loading 26 - BSR

East
D₂O
Tank

BSF-33 133 81	F. C. 82	83	84	BSF-31 134 85	86	87	88	89
BSF-29 132 71	72	73	74	BSF-12 132 75	76	77	78	79
FZC 003T 197 61	BSF-S-7 62 62	BSF-36 148 63	BSF-S-8 62 64	FZC 003U 196 65	66	67	68	69
FZC 003N 188 51	M-194-D 165 52	M-193-D 142 53	M-195-D 165 54	FZC 003P 188 55	56	57 West	58	59
BSF-34 146 41	BSF-S-1 72 42	M-192-D 138 43	BSF-S-1 72 44	BSF-35 145 45	46	D ₂ O 47	48	49
BSF-39 159 31	FZC 003R 193 32	BSF-38 141 33	FZC 003S 193 34	BSF-40 158 35	36	Tank 37	38	39
M-196-D 179 21	BSF-S-9 71 22	BSF-37 145 23	BSF-S-10 71 24	M-323-A 181 25	26	27	28	29
BSF-23 130 11	BSF-28 132 12	FZC 003Q 191 13	BSF-30 130 14	Exp. 15	16	17	18	19

BSR CORE

27

LOADING NO.

6-12-75

DATE

Excess Reactivity - 5.20%

CRITICAL MASS

4691 gm

OPERATING MASS

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN
1	10.05
2	10.05
3	10.05
4	10.05
5	23.00
6	23.00

REMARKS:

Special core configuration and
Flux mapping for proposed heavy
steel experiment.

Figure 2. Core Loading 27 - BSR

East
D₂O
Tank

F. C.								
81	82	83	84	85	86	87	88	89
71	72	73	74	75	76	77	78	79
FZC 003T 197 81	BSF-S-9 71 62	BSF-36 148 63	BSF-S-10 71 64	FZC 003U 196 65	66	67	68	69
FZC 003N 188 51	M-194-D 165 52	M-193-D 142 53	M-195-D 165 54	FZC 003P 188 55	56	West 57	58	59
BSF-34 146 41	BSF-S-11 97 42	M-192-D 138 43	BSF-S-14 96 44	BSF-35 145 45	46	D ₂ O 47	48	49
BSF-39 159 31	FZC 003R 193 32	BSF-38 141 33	FZC 003S 193 34	BSF-40 158 35	36	Tank 37	38	39
M-196-D 179 21	BSF-S-12 72 22	BSF-37 145 23	BSF-S-12 72 24	M-323-A 181 25	26	27	28	29
Exp. 11	FZC 003W 201 12	FZC 003Q 191 13	BSF-30 130 14	Exp. 15	16	17	18	19

BSR CORE

28

LOADING NO.

6-26-75

DATE

Excess Reactivity - 5.45%

CRITICAL MASS

4168g

OPERATING MASS

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	9.92	11.27
2	9.92	11.27
3	9.92	11.27
4	9.92	11.27
5	23.00	11.27
6	23.00	11.27

REMARKS:

Figure 3. Core Loading 28 - BSR

Maintenance and Changes

Changes made in the reactor control instrumentation to improve operating conditions are documented by the BSR control-change memoranda system. Those changes which were made during this report period are listed in Table 3. Maintenance or changes on the instrumentation and mechanical components in the complex are listed in Tables 4 and 5. Table 6 presents the status of the ionization and fission chambers.

Table 3. Instrumentation and Controls Change Memoranda Completed During This Report Period.

Change Memo No.	Subject	General Description
BSR-2MW-43	Modification of BSR Magnet Switch Module	<p>Slight overheating of the etched wiring board of the BSR switch module was occurring because of the heat dissipated by two resistors. Modification to the output stage of the switch module allowed adjustment of resistor values and a corresponding reduction of their power dissipation. Calculations indicate that this modification will reduce the power dissipation in these two resistors by a factor of three, substantially reducing the circuit board heating. In addition, the power ratings of the resistors were increased.</p> <p>The change involves modification to improve reliability and does not change the function of the protection system.</p>

Table 4. Maintenance and Changes, Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
4-3-75	Facility radiation and contamination monitoring system	Routine	Quarterly checkout.
4-1-75	Servo ionization chamber	Routine checks	Ionization characteristics checks were completed on the servo chamber with satisfactory results.
4-28-75 through 4-30-75	Instrumentation	Routine	Quarterly checks.
4-30-75	Nos. 1 and 2 sigma amplifiers	Did not meet specifications	Replaced the 5692 electronic tubes.
4-30-75	No. 3 sigma amplifiers	Scram catcher inoperative	Replaced the 6BN6 electronic tube.
5-12-75	Dual ionization chamber PCP-III-106, SN-66-1	Chamber noisy	The chamber was removed from position B and placed in temporary storage in the north pool area.
5-12-75	Dual ionization chamber PCP-III-106, SN-72-1	Installed in position B	The new dual chamber was installed in position B for the servo. Saturation characteristics checks were satisfactory.
5-21-75	Servo on chamber power supply	Replaced one VR50 electronic tube with VR150 electronic tube	To give proper ion chamber voltage on the new ionization chamber.

Table 4. (continued)

Date	Component	Trouble or Change	Reason or Maintenance
6-2-75	Facility radiation and contamination monitoring system	False alarm received at Emergency Control Center	The cause of the false alarm is being investigated.
6-5-75	Facility radiation and contamination monitoring system	Routine	The quarterly check was performed.
6-4-75, 6-9-75 and 6-19-75	Magnet switch module Nos. 1, 2, 3, 4, 5 and 6	Made changes in accordance with Reactor Instrument & Controls Design Change Memo No. BSR-2MW-43	Slight overheating of the etched wiring board of the BSR switch module was occurring because of the heat dissipated by two resistors. Modification to the output stage of the switch module allowed adjustment of resistor values and a corresponding reduction of their power dissipation. Calculations indicate that this modification will reduce the power dissipation in these two resistors by a factor of three, substantially reducing the circuit board heating. In addition, the power ratings of the resistors were increased. The change involves modification to improve reliability and does not change the function of the protection system.
6-5-75	Secondary pH channel	Equipment updating	New underground signal leads and new pH probes were installed.
6-17-75	Cell-ventilation system	Routine	The flow recorder was recalibrated.

Table 5. Maintenance and Changes, Mechanical System

Date	Component	Trouble or Change	Reason or Maintenance
6-23-75 through 6-25-75	Shim-rod assemblies Nos. 1, 2, 3, 4, 5 and 6	Routine inspection	The shim-rod assemblies were removed to the underwater work platform for inspection as follows: Visual inspection - no evidence of cracks; Straight edge inspection - results satisfactory; Gauged, using 0.010 in. and 0.020 in. oversized gauges and feeler gauges - results satisfactory. Rust was cleaned from the armatures and magnets. The clutch switches were cleaned and the guide tubes brushed. See Appendix B for a detailed inspection report.
6-23-75 through 6-25-75	Shim-rod assembly No. 1 from CP-22	Refueling	The assembly containing control-rod fuel element BSF-S-9 was transferred to CP-62 to become No. 5 shim rod.
6-2-75	Shim-rod assembly No. 2 from CP-24	Refueling	The assembly containing control-rod fuel element BSF-S-10 was transferred to CP-64 to become No. 6 shim rod.
6-5-75	Shim-rod assembly No. 3 from CP-42	Refueling	The assembly containing control-rod fuel element BSF-S-11 was transferred to CP-22 to become No. 1 shim rod.

Table 5 (continued)

Table 5. (continued)

Date	Component	Trouble or Change	Reason or Maintenance
6-23-75 through 6-25-75	Shim-rod assembly No. 4 from CP-44	Refueling	The assembly containing control-rod fuel element BSF-S-12 was transferred to CP-24 to become No. 2 shim-rod.
	Shim-rod assembly No. 5 from CP-62	Refueling	The spent control-rod fuel element BSF-S-7 was replaced with a new element BSF-S-13 and the assembly transferred to CP-42 to become No. 3 shim-rod.
	Shim-rod assembly No. 6 from CP-64	Refueling	The spent control-rod fuel element BSF-S-8 was replaced with a new element BSF-S-14 and the assembly transferred to CP-44 to become No. 4 shim-rod.

Table 6. Status of Ionization Chambers

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
Chambers in Service				
CTC-3 (J-118)	Position A, No. 2 safety	10-8-69	LITR	The chamber was modified for underwater service in 1969.
PCP-III-106, SN-72-1	Position B, servo	5-12-75	None	This new chamber was installed in the BSR in May, 1975.
CTC-4 (C-771)	Position C, No. 1 safety	12-1-69	LITR	The chamber was modified for underwater service in 1969.
PCP-III-106A, SN-72-2	Position D, Log-N and No. 3 safety	11-13-73	None	This new dual chamber was in- stalled in the BSR in November, 1973.
C-1045	CP-81, fission chamber	10-1-69	PCA	This fission chamber assembly was transferred to the BSR from the PCA in October, 1969.
Chambers Not in Service				
PCP (old type, no serial number)	Warehouse storage		BSR	This chamber is of the old type and will be repaired if needed.
CIC (No. 62)	BSR storage		BSR	This chamber is reserved for the PCA but can be used in an emergency for the BSR.

Table 6 (continued)

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
Chambers Not in Service				
CIC (no. 63)	BSR storage		BSR	This chamber is reserved for the PCA but can be used in an emergency for the BSR.
PCP (Q975), No. 2)	BSR storage		BSR	This chamber is reserved for the PCA but can be used in an emergency for the BSR.
PCP-III-106, SN-56-1	BSR storage		BSR	The uncompensated section of this dual chamber failed on June 16, 1969, while in service as the No. 2 safety and servo. While in service as servo the noise to signal ratio increased to an unsatisfactory level and in May, 1975, the chamber was removed for repairs.
PCP-III-106, SN-66-3	ORR beam tube storage		BSR and ORR	This dual chamber was installed in the BSR in December, 1967. In March, 1969, the chamber was removed for repairs due to failure of the uncompensated section. In November, 1969, the chamber was installed in the BSR. In April, 1970, the uncompensated section failed.

Table 6 (continued)

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
Chambers Not in Service				
PCP-III-106, SN-66-3	ORR beam tube storage		BSR and ORR	The chamber was removed for repairs. In May, 1971, the chamber was installed in the ORR. In November, 1971, the chamber was removed for repairs. In October, 1972, the chamber was installed in the BSR as a spare chamber. In January, 1973, the chamber was transferred from position E (spare chamber location) to position D. In November, 1973, the chamber was removed for repairs due to failure of the uncompensated section.
PCP-III-106, SN-66-4	ORR instrument shop		BSR	This dual chamber was installed in the BSR in June, 1968. In May, 1969, the uncompensated section failed. The chamber was removed for repairs. In August, 1970, the chamber was reinstalled in the BSR. In January, 1973, the chamber was removed from position D for maintenance. The uncompensated section had an abnormal condition of not being fully saturated on saturation characteristic checks.

Fuel

Changes in the fuel inventory are reflected in Table 7.

Table 7. Fuel and Shim Rod Status

	This Quarter	Last Quarter	Year To Date
Fuel elements depleted	1	4	5
Control-rod fuel elements depleted	2	0	2
New fuel elements placed in service	1	4	5
New control-rod fuel elements placed in service	2	0	2
New fuel elements available for use	12	13	12
New control-rod fuel elements available for use	6	8	6
Partially depleted fuel elements available for use	0	0	0
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 8. The tubes of the east D_2O tank are not permanently assigned; they are used by various Laboratory personnel for short-term sample irradiations.

Table 8. Facilities Assignment

Facility	Location	Division or Sponsor
Liquid helium cryostat	Southwest corner of pool using west D_2O tank	Solid State
Liquid nitrogen cryostat	On instrument bridge	Solid State
Ambient temperature facility	North face of core	Solid State
Front-face tube	North face of core	Solid State
Fast-neutron tube	Core position 15	Solid State
Water-cooled tube	Core position 11	Solid State
Dry thermal-neutron tubes*	East D_2O tank	Operations
Dry thermal-neutron tubes* (east, center, southwest, and northwest)	East D_2O 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 9 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 9. Demineralizer Performance Data

Run No.	Initiation Date	Termination Date	Throughput (gal.)	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	5.8	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	In Service	2,400,000	2,712	174	5.7	5.8	937,000	1,823,000

*The reactor was shutdown during the entire run.

**New resin was placed in the demineralizer.

Operating Manual

Changes which were made in the BSR operating manual during this quarter are listed in Table 10.

Table 10... Revisions to BSR Operating Manual (ORNL-TM-2676)

Date	Section	Remarks
6-17-75	Section 11 Auxiliary Equipment	Incorporates a checklist for operation of the mobile catwalk bridge.

Efficiency Tests

Tests were performed by Inspection Engineering on the cell-ventilation filters. Details are given in Table 11.

Table 11... Efficiency Tests Results, Filters

Date	Unit	Type Test	Efficiency (%)
6-12-75	North Bank	Elemental Iodine	99.995
6-13-75	North Bank	Diocetyl Phthalate	99.998
6-13-75	Center Bank	Diocetyl Phthalate	99.998
6-13-75	South Bank	Diocetyl Phthalate	99.996
6-26-75	North Bank	Methyl Iodide	99.09
6-26-75	Center Bank	Methyl Iodide	23.70
6-26-75	South Bank	Methyl Iodide	44.85

Special Programs

The University Nuclear Engineering Department Experiments

The BSR was used for training labs for university nuclear engineering students on seven occasions as described below.

Attenuation Experiment - The reactor was operated at variable power levels (on May 5, 6, 7, 8 and 9, 1975) by the Operations Division staff while the University of Tennessee students, under the auspices of the Operations Division training supervisor, performed a neutron and gamma attenuation experiment. Basically, the experiment was an exercise in measuring neutron and gamma levels from an operating nuclear reactor as a function of distance through light-water medium.

Xenon Buildup and Decay Experiment - On April 11, 1975, and also on May 16, 1975, following operation at 2 Mw to achieve xenon equilibrium, the power level of the BSR was reduced to 4 kw to begin an experiment for students from Mississippi State University and the University of Tennessee to study the buildup and decay of xenon in the BSR core. The students performed all activities associated with the experiment under the direct supervision of an Operations Division supervisor. The experiment, performed on a 24-hr-day schedule until completion, was an exercise in: (1) maintaining the reactor critical at 4 kw, (2) determining the reactivity worth of a shim rod under varying concentrations of xenon, and (3) determining the reactivity worth of xenon in the core as a function of time.

Operation Activities

Date	Remarks
4-28-75	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 room.
5-1-75	The valve pit was inspected. The previously reported water leak via the grout-filled annulus in the concrete wall for the exit primary water line continues to leak from the pool into the valve pit as previously reported. The leak rate is ~10 gal/day.
5-1-75	The containment system quarterly functional checks were performed with satisfactory results.
5-20-75	The annual pipe-to-soil potential corrosion control survey on the BSR cooling water lines was conducted. The purpose of the annual survey is to determine if the existing corrosion control facilities are providing an adequate level of cathodic protection on the underground cooling water lines. The six sacrificial anodes installed to provide cathodic protection for the 8 inch stainless steel cooling water lines at the BSR are providing 310 milliamps which should be enough current to protect these lines. No recommendations are made at this time for additional corrosion control facilities.

Shim-Rod Calibrations

The BSR shim rods were calibrated after core loading 28 had been established. The results are shown in Appendix A. The total worth of all six rods was 11.560% $\Delta k/k$. The operating limit requirement that the reactor be operated with the ganged rods (all six) withdrawn at least 50% of their worth thus requires the rods be ≥ 10.70 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 can be withdrawn to 9.40 in. to comply with the same operating limit. Appendix A also shows the comparison of rod worths for January, 1971; October, 1971; January, 1972; and September, 1974.

POOL CRITICAL ASSEMBLY

Operations

The PCA was used 66.3 hours as an experiment facility for the benefit of nuclear engineering students from the University of Kentucky and Mississippi State University. Operational activities in preparing the facility for use included a check-out of the reactor control instrumentation and preparation of the required loadings. The operational activities are listed in Table 12. (Usage of Pool Critical Facility).

Table 12. Usage of Pool Critical Facility

Date	Operational Activity	Purpose	Hours Used
4-1-75	Training and reactor startups	Training lab for the ORR-BSR Reactor Controller trainee.	2.7
4-7-75	Established Core No. 168 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Mississippi State University nuclear engineering students	11.9
4-8-75	Established Core No. 169 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Mississippi State University nuclear engineering students	11.0
4-9-75 and 4-10-75	Established Core No. 77 to permit calibration of the regulating rod and the performance of the important function experiment.	Training lab for the Mississippi State University nuclear engineering students	12.5
4-16-75	Established Core No. 170 to obtain a critical mass following the standard approach-to-critical procedure. Established Core No. 171 to permit calibration of the regulating rod.	Training lab for the University of Kentucky nuclear engineering students	13.5

Table 12. (continued)

Date	Operational Activity	Purpose	Hours Used
4-17-75	Established Core No. 172 to obtain a critical mass following the standard approach-to-critical procedure. Established Core No. 173 to permit calibration of the regulating rod.	Training lab for the University of Kentucky nuclear engineering students.	14.7

Experiments

Experiments were conducted at the PCA by students from the Nuclear Engineering Departments of Mississippi State University and the University of Kentucky as indicated in Table 12. 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 nuclear engineering students 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 nuclear engineering students.

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 supervisor, the experiment was performed by the nuclear engineering students.

APPENDIX A
INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

July 17, 1975

TO: F. T. Binford
FROM: T. P. Hamrick
SUBJECT: Calibration of BSR Shim Rods

The BSR shim rods were calibrated following the refueling operation to establish BSR loading No. 28. The resulting reactivity worth curves are attached, along with a plot of excess reactivity remaining versus the ganged rod position of rods 1-4. Loading 28 resulted in a core with 5.45% $\Delta k/k$ excess reactivity.

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

1. All six rods ganged at 10.70 inches withdrawn; and
2. Rods 5 and 6 at 23 inches withdrawn, rods 1-4 ganged at 9.40 inches withdrawn.

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

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

Rod No.	Jan. 1971	Oct. 1971	Jan. 1972	Sept. 1974	June 1975
1	1.762	1.710	1.944	1.697	1.934
2	1.914	1.690	1.864	1.873	1.259
3	3.011	2.716	3.018	2.942	3.086
4	3.010	2.714	2.962	2.966	2.931
5	0.910	0.922	0.852	0.946	0.940
6	0.928	0.866	0.872	0.937	0.910
1-4	9.697	8.830	9.788	9.478	9.710
5-6	1.829	1.788	1.724	1.883	1.850
Total	11.526	10.618	11.512	11.361	11.560

T. P. Hamrick
T. P. Hamrick

TPH:dsp

Attachments

cc: C. B. Gaither
S. S. Hurt
E. D. Lance
J. R. Thomas
BSR Control Room

APPENDIX B

BSR SHIM ROD INSPECTION

I. Shim-rod identity BS-1, core position CP-62, shim rod No. 5.

A. Measurements previous to installation of new shim rod, January 4, 1967.

1. Micrometer readings (out of water)

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.864 in.	2.228 in.
Middle	0.867 in.	2.232 in.
Top	0.867 in.	2.238 in.

2. Straight edge inspection (out of water) -- irregular surface to 0.010 in.

B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 24, 1975.

1. 0.885 in. gauge minus feeler gauge (flat side); 2.260 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.879 in.	2.246 in.
Middle	0.879 in.	2.248 in.
Top	0.879 in.	2.248 in.

2. Straight edge inspection of flat side - irregular surface to 0.012 in.

3. Straight edge inspection of edge side - irregular surface to 0.012.

4. Visual inspection using magnifying glass - no evidence of cracks.

II. Shim-rod identity BS-2, core position CP-64, shim rod No. 6.

A. Measurements previous to installation of new shim rod, January 4, 1967.

1. Micrometer readings (out of water)

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.873 in.	2.226 in.
Middle	0.871 in.	2.229 in.
Top	0.873 in.	2.235 in.

2. Straight edge inspection (out of water) -- irregular surface to 0.005 in.

B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 25, 1975.

1. 0.895 in. gauge minus feeler gauge (flat side); 2.270 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.888 in.	2.251 in.
Middle	0.887 in.	2.250 in.
Top	0.888 in.	2.250 in.

2. Straight edge inspection of flat side - irregular surface to 0.004 in.

3. Straight edge inspection of edge side -- irregular surface to 0.008 in.

4. Visual inspection using magnifying glass - no evidence of cracks.

III. Shim-rod identity BS-3, core position CP-42, shim rod No. 3.

A. Measurements previous to installation of new shim rod, January 4, 1967.

1. Micrometer readings (out of water)

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.861 in.	2.236 in.
Middle	0.866 in.	2.235 in.
Top	0.866 in.	2.243 in.

2. Straight edge inspection (out of water -- irregular surface to 0.005 in.

B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 23, 1975.

1. 0.885 in. gauge minus feeler gauge (flat side); 2.260 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.882 in.	2.254 in.
Middle	0.880 in.	2.255 in.
Top	0.880 in.	2.254 in.

2. Straight edge inspection of flat side - irregular surfaces to 0.005.
3. Straight edge inspection of edge side - irregular surfaces to 0.014.
4. Visual inspection using magnifying glass - no evidence of cracks.

IV. Shim-rod identity BS-4, core position CP-44, shim rod No. 4.

- A. Measurements previous to installation of new shim rod, January 4, 1967.

1. Micrometer readings (out of water)

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.860 in.	2.233 in.
Middle	0.861 in.	2.234 in.
Top	0.862 in.	2.231 in.

2. Straight edge inspection (out of water) -- irregular surface to 0.003 in.

- B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 24, 1975.

1. 0.885 in. gauge minus feeler gauge (flat side); 2.260 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.875 in.	2.254 in.
Middle	0.877 in.	2.252 in.
Top	0.877 in.	2.254 in.

2. Straight edge inspection of flat side - irregular surfaces to 0.012 in.
3. Straight edge inspection of edge side - irregular surfaces to 0.010.

4. Visual inspection using magnifying glass - no evidence of cracks.

V. Shim-rod identity BS-5, core position CP-22, shim rod No. 1.

- A. No measurements were made previous to installation of new shim rod.
- B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 24, 1975.

1. 0.895 in. gauge minus feeler gauge (flat side); 2.270 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.887 in.	2.260 in.
Middle	0.883 in.	2.258 in.
Top	0.885 in.	2.259 in.

2. Straight edge inspection of flat side - irregular surfaces to 0.011 in.
3. Straight edge inspection of edge side - irregular surfaces to 0.009 in.
4. Visual inspection using magnifying glass - no evidence of cracks.

VI. Shim-rod identity BS-6, core position CP-24, shim rod No. 2.

- A. No measurements were made previous to installation of new shim rod.
- B. Underwater inspection and measurements using oversized gauges along with feeler gauges and a straight edge, June 25, 1975.

1. 0.885 in. gauge minus feeler gauge (flat side); 2.260 in. gauge minus feeler gauge (edge side).

	<u>Flat Side</u>	<u>Edge Side</u>
Bottom	0.879 in.	2.250 in.
Middle	0.881 in.	2.250 in.
Top	0.882 in.	2.251 in.

2. Straight edge inspection of flat side - irregular surfaces to 0.004 in.
3. Straight edge inspection of edge side - irregular surfaces to 0.006 in.

4. Visual inspection using magnify glass - no evidence of cracks.

Remarks: The shim rods, when inspected prior to installation in the reactor, were found to vary considerably in thickness and width. It is ver difficult to measure the rods under water (micrometer versus oversized gauges and feeler gauges); however, it is apparent that the dimensions have not changed more than a few thousandths of an inch.

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