**Bulk Shielding Facility Quarterly Report
January, February, and March of 1976**

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MASTER

OAK RIDGE NATIONAL LABORATORY

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OPERATIONS DIVISION

BULK SHIELDING FACILITY QUARTERLY REPORT

JANUARY, FEBRUARY, AND MARCH OF 1976

Date Published: September 1976

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
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SUMMARY

The BSR remained shutdown until February 12, 1976 for completion of repairs to and fiberglassing and repainting of the pool walls and floor. This accounted for 58% of the downtime during January, February, and March. The BSR operated at an average power level of 1992 kw for 20.64% of the time during the quarter. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were no unscheduled shutdowns during the quarter.

The PCA was used in training programs and was operated on seventeen occasions when nuclear engineering students from the University of Tennessee, the University of Oklahoma, Louisiana State University, and Mississippi State University actively participated in training laboratories.

BULK SHIELDING REACTOR

Operations

During this quarter, the reactor operated 20.64% of the time primarily for the irradiation of research samples. Basic operating data for this period are given in Table 1.

Core loading 29 (Figure 1) was replaced by core loading 30 (Figure 2) on February 20, 1976, to provide adequate excess reactivity for versatile operation. The initial operating mass (4196 g ^{235}U) of core loading 29 had been reduced to 4085 g due to burnup, thereby reducing the excess reactivity from 5.25% $\Delta k/k$ to $\sim 4.00\%$ $\Delta k/k$ ($\sim 1.45\%$ excess reactivity above xenon equilibrium).

Core loading 30 was accomplished by replacing two partially depleted BSF-series fuel elements with two new MTR-series fuel elements. Core loading 30 had an initial operating mass of 4226 g which provided an excess reactivity of 5.30% $\Delta k/k$ excess reactivity above xenon equilibrium). At the end of the quarter, the excess reactivity was $\sim 4.42\%$ $\Delta k/k$ ($\sim 1.87\%$ $\Delta k/k$ excess reactivity above xenon equilibrium).

Table 1. Basic Operating Data
January, February, and March of 1976

	This Quarter	Last Quarter	Year To Date
Total energy, kwd	37,412	58,652	37,412
Average power kw/operating hr	1,992	1,996	1,992
Time operating, %	20.64	31.93	20.64
Reactor availability, %	43.83	32.13	43.83
Reactor water radioactivity counts min ⁻¹ ml ⁻¹ (av)	2,229	1,558	2,229
Reactor water resistivity, ohm-cm (av)	946,000	870,000	946,000
Standard fuel elements depleted	0	0	0
Control fuel elements depleted	0	0	0
Research samples	36	21	36

BSR CORE

29	
LOADING NO.	8-7-75
DATE	Excess Reactivity 5.25%
4196	
OPERATING MASS	
ROD POSITIONS AT CRITICAL (With Operating Mass)	
ROD NO.	IN. WITHDRAWN
1	10.15 11.40
2	10.15 11.40
3	10.15 11.40
4	10.15 11.40
5	23.00 11.40
6	23.00 11.40
REMARKS:	

Figure 1. Core Loading 29 - 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 191 61	BSF-S-9 68	BSF-S-36 143	BSF-S-10 68	FZC 003U 191 65				
FZC 003N 182 51	M-194-D 158	M-193-D 136	M-195-D 158	FZC 003P 181 55		West		
BSF-39 154 41	BSF-S-13 93	BSF-34 140	BSF-S-14 92	BSF-40 152		D ₂ O		
FZC 003X 203 31	FZC 003R 185 32	BSF-S-35 140	FZC 003S 184 34	FZC 003Y 202 35		Tank		
M-196-D 173 21	BSF-S-11 69	BSF-37 139	BSF-S-12 69	M-323-A 175				
Exp. 196 11	FZC 003W 196 12	FZC 003Q 195 13	FZC 003V 199 14	Exp 15	16	17	18	19

BSR CORE

30

LOADING NO.

2-20-76

DATE

Excess Reactivity 5.30%

4226

OPERATING MASS

ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN
1	10.20
2	10.20
3	10.20
4	10.20
5	23.00
6	23.00

REMARKS:

Figure 2. Core Loading 30 - BSR

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	9	469.516
Experiment insertion, removal, or data taking	4	23.284
Reactor Operations:		
Special	1	26.500
BSR pool repair	1	1008.000
Quarterly	1	205.100
Refueling critical runs	<u>2</u>	<u>0.883</u>
Subtotal	18	1733.283
Unscheduled		
Experimenters:	0	0.000
Reactor Operations:	<u>0</u>	<u>0.000</u>
Subtotal	<u>0</u>	<u>0.000</u>
Total	18	1733.283

Maintenance and Changes

Maintenance or changes on the instrumentation and mechanical components in the complex are listed in Tables 3 and 4. Table 5 presents the status of the ionization and fission chambers.

Table 3. Maintenance and Changes, Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
2-11-76 through 2-20-76	Instrumentation	Routine	Quarter checks
2-18-76	Counting rate channel	Did not meet specifications	Replaced the pulse amplifier.
2-18-76	No. 2 sigma amplifier	Did not meet specifications	Replaced the sigma amplifier.
2-19-76	Decay tank radiation monitor	Faulty readout	Replaced the probe to correct the trouble.

9

Table 4. Maintenance and Changes, Mechanical System

Date	Component	Trouble or Change	Reason or Maintenance
2-12-76 through 2-16-76	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 inch and 0.202 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 A for a detailed inspection report.

Table 5. 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 installed 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 5 (continued)

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
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 FCA but can be used in an emergency for the BSR.
PCP-III-106, SN-66-1	BSR storage		BSR	Used as No. 2 safety and servo. Safety section failed in June, 1969, servo section failed in May 1975.
PCP-III-106, SN-66-3	ORR beam tube storage		BSR and ORR	Used BSR and ORR, 1967 through 1973. Last removed November, 1973.
PCP-III-106, SN-66-4	ORR instrument shop		BSR	Used in the BSR from 1968 to January, 1973. Repaired 1969.

Fuel

Changes in the fuel inventory are reflected 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	2	0	2
New control-rod fuel elements placed in service	0	0	0
New fuel elements available for use	9	11	9
New control-rod fuel elements available for use	6	6	6
Partially depleted fuel elements available for use	4*	0	4
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

*Two previously listed as depleted, changed to partially depleted available for use.

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
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* (N-4 and S-3)	East D ₂ O tank	Unassigned
Dry thermal-neutron tubes* (east, center, southwest, and northwest)	East D ₂ O tank	Unassigned

*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 (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	7-7-75	2,550,000	2,712	174	5.7	5.8	937,000	1,823,000
44	7-10-75	11-5-75	2,750,000	2,528	144	5.7	5.9	968,000	1,428,000
45	11-5-75	In Service	1,700,000	2,229	190	5.4	5.6	946,000	1,759,000

* The reactor was shut down during the entire run.

** New resin in the demineralizer columns.

Special Tests

Efficiency Tests

Tests were performed by Inspection Engineering on the cell ventilation filters. Details are given in Table 9.

Table 9. Efficiency Tests Results, Filters

Date	Unit	Type Test	Efficiency (%)
2-13-76	North Bank	Elemental Iodine	99.99
2-19-76	North Bank	Methyl Iodide	98.95
3-11-76	South Bank	Elemental Iodine	99.91
3-17-76	Center Bank	Elemental Iodine	99.99

Operational Activities

Date	Remarks
2-20-76	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.
2-20-76	The containment system quarterly functional checks were performed with satisfactory results.
2-20-76	The skimmer filters were changed.

POOL CRITICAL ASSEMBLY

Operations

The PCA was used 130.4 hours as an experiment facility for the benefit of nuclear engineering students from the University of Tennessee, University of Oklahoma, Louisiana State University, 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 10 (Usage of Pool Critical Facility). The PCA maintenance is listed in Table 11.

Table 10. Usage of Pool Critical Facility

Date	Operational Activity	Purpose	Hours Used
2-12-76	Established Core. No. 174 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the University of Tennessee nuclear engineering students	9.2
2-13-76	Established Core No. 175 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the University of Tennessee nuclear engineering students	12.5
2-17-76 and 2-18-76	Established Core No. 77 to permit calibration of the regulating rod.	Training lab for the University of Tennessee nuclear engineering students	8.0
2-23-76 and 2-24-76	Used Core No. 77 to perform the Statistical Weight Experiment.	Training lab for the University of Tennessee nuclear engineering students	6.3
3-1-76 and 3-4-76	Training and Reactor startups.	Training lab for the ORR BSR and HFIR Reactor Controller Trainees	9.7

Table 10 (continued)

Date	Operational Activity	Purpose	Hours Used
3-8-76	Established Core No. 176 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the University of Oklahoma nuclear engineering students	11.0
3-9-76	Established Core No. 77 to permit calibration of the regulating rod and the performance of the experiment.	Training lab for the University of Oklahoma nuclear engineering students	6.2
3-10-76	Established Core No. 177 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the University of Oklahoma nuclear engineering students	9.5
3-11-76	Established Core No. 77 to permit calibration of the regulating rod and the performance of the importance function experiment.	Training lab for the University of Oklahoma nuclear engineering students	6.9
3-19-76	Ionization chamber tests	Test facility for ORMAC	4.0
3-22-76	Established Core No. 178 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Louisiana State University nuclear engineering students	11.7
3-23-76	Established Core No. 77 to permit calibration of the regulating rod and the performance of the importance function experiment.	Training lab for the lab Louisiana State University nuclear engineering students	7.3

Table 10 (continued)

Date	Operational Activity	Purpose	Hours Used
3-29-76	Established Core No. 179 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Mississippi State University nuclear engineering students	10.0
3-30-76	Established Core No. 180 to obtain a critical mass following the standard approach-to-critical procedure.	Training lab for the Mississippi State University nuclear engineering students	11.3
3-31-76	Established Core No. 77 to permit calibration of the regulating rod and the performance of the importance function experiment.	Training lab for the Mississippi State University nuclear engineering students	6.8

Table 11. Pool Critical Facility Maintenance

Date	Component	Trouble or Change	Reason or Maintenance
2-4-76 through 2-6-76	Instrumentation	Routine	Quarterly checks.
2-5-76	Primary counting rate channel	Would not calibrate	Replaced the count rate meter.
2-5-76	Primary counting rate channel	Low gain	Retubed the pulse amplifier.
2-5-76	Auxiliary counting rate channel	Would not calibrate	Replaced the count rate meter.
2-5-76	No. 2 shim rod drive assembly	Malfunction of the clutch switch	The drive tube was removed and the clutch push rod cleaned.
2-5-76	No. 3 shim rod assembly	Faulty operation of the seat switch	The shim rod unit was removed and the shock absorber piston was refaced to correct the trouble.
3-15-76	Servo channel	Incorrect readout	Retubed the servo amplifier.
3-15-76	Micro-micro ammeter	Insensitive	Retubed the micro-microammeter and rebuilt the power supply.
3-23-76	Log N channel	False fast period scrams	Replaced the log N amplifier and a voltage regulating tube in the log N power supply.

Experiments

Experiments were conducted at the PCA by students from the Nuclear Engineering Departments of the University of Tennessee, University of Oklahoma, Louisiana State University, and Mississippi State University as indicated in Table 10. 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

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, February 16, 1976.

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	0.877 in.	2.246 in.
Middle	0.877 in.	2.248 in.
Top	0.877 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 in.

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, February 13, 1976.

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.	2.250 in.
Middle	0.887 in.	2.250 in.
Top	0.887 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, February 16, 1976.

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	0.881 in.	2.254 in.
Middle	0.870 in.	2.254 in.
Top	0.878 in.	2.255 in.

2. Straight edge inspection of flat side--irregular surface to 0.006 in.

3. Straight edge inspection of edge side--irregular surface to 0.014 in.

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, February 13, 1976.

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	0.873 in.	2.250 in.
Middle	0.876 in.	2.250 in.
Top	0.873 in.	2.248 in.

2. Straight edge inspection of flat side--irregular surfaces to 0.012 in.
3. Straight edge inspection of edge side--irregular surfaces to 0.012 in.
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, February 16, 1976.

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.	2.256 in.

2. Straight edge inspection of flat side--irregular surfaces to 0.012 in.
3. Straight edge inspection of flat side--irregular surfaces to 0.006 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, February 13, 1976.
 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.	2.248 in.
Middle	0.879 in.	2.250 in.
Top	0.880 in.	2.248 in.

2. Straight edge inspection of flat side--irregular surfaces to 0.004 in.
3. Straight edge inspection of edge side--irregular surfaces to 0.004 in.
4. Visual inspection using magnifying 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 very difficult to measure the rods underwater (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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