OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL-TM-3355

DATE - March 16, 1971

BULK SHIELDING FACILITY QUARTERLY REPORT - OCTOBER, NOVEMBER, AND DECEMBER OF 1970

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SUMMARY

The BSR operated 75.2% of the time at an average power level of 1,477 kw during October, November, and December of 1970. Water-quality control in both the reactor primary and secondary cooling systems was very satisfactory.

There were four unscheduled shutdowns, three of which were caused by shim rods dropping and one by an experiment malfunction. Of the three unscheduled shutdowns caused by the dropping of shim rods, two were caused by the No. 3 shim rod and one by the No. 6 shim rod.

A change was made in the No. 5 shim-rod-drive unit, as authorized by Reactor Instrument and Controls Design Change Memo No. BSR-2Mw-26. This change authorized the installation of a nickel-plated armature on the No. 5 shim rod.

The PCA was operated for two days during this quarter as a training aid for students from the University of Kentucky.

BULK SHIELDING REACTOR

Operations

During this quarter, the reactor was operated 75.2% of the time, primarily for the irradiation of experiments, at an average power level of 1,477 kw. This average power level is lower than normal since the reactor was operated at 1.5 Mw for 9 days and at 1.0 Mw for 34 days to accommodate the liquid nitrogen cryostat experiment. Basic operating data for this period are given in Table 1.

Core loading 15 (Figure 1) was converted to core loading 16 (Figure 2) on October 28, 1970, to provide adequate excess reactivity for versatile operation. The initial operating mass ($\sim$3994 g) of core loading 16 was reduced to $\sim$3890 g due to burnup during the quarter, thereby reducing the excess reactivity from 4.13% $\Delta k/k$ to $\sim$3.67% $\Delta k/k$.

Table 1. Basic Operating Data
(October through December, 1970)

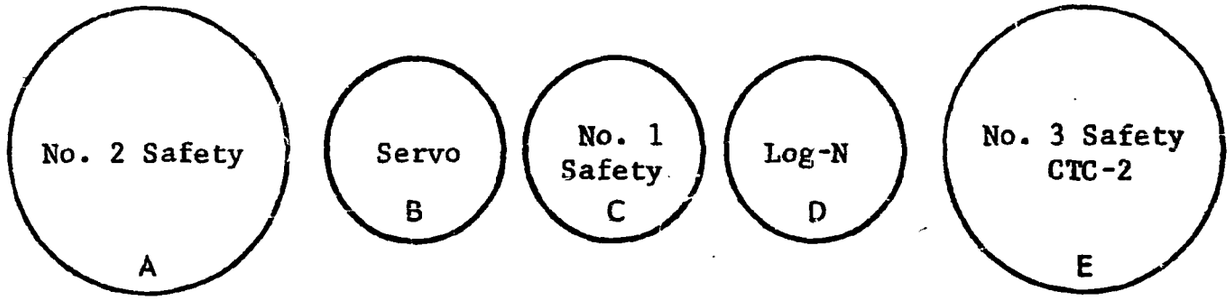
	This Quarter	Last Quarter	Year To Date
Total energy, kwd	102,290.0	102,763.8	403,338.2
Average power, kw/operating hr	1,477	1,966	1,538
Time operating, %	75.2	77.7	76.4
Reactor availability, %	95.5	81.4	88.4
Reactor water radioactivity, $\frac{c/min}{ml}$ (av)	721[a]	1,340	1,644
Reactor water resistivity, ohm-cm (av)	703,000	739,000	721,000
Standard fuel elements depleted	0	0	0
Control fuel elements depleted	0	0	2
Research samples	94	93	311

[a]The specific radioactivity for this quarter is lower than the average due to extended power operation at 1000 kw.

Shutdowns

Table 2 is a tabulation of the unscheduled shutdowns including the associated incident report numbers for the months of October, November, and December of 1970. Table 3 gives an analysis of both scheduled and unscheduled shutdowns.

ORNL DWG. 70-12029



FC 81	82	83	84	85	86	87	88	89
71	72	73	74	75	76	77	78	79
BSF-4 153.142 61	BSF-S-5 71.599 Shim Rod No. 5 62	BSF-33 190.240 63	BSF-S-6 71.782 Shim Rod No. 6 64	BSF-5 153.457 65	66	67	68	69
BSF-31 190.250 51	BSF-28 180.960 52	BSF-23 172.596 53	BSF-29 180.523 54	BSF-32 190.250 55	56	WEST D_2O TANK		59
BSF-10 154.031 41	BSF-S-7 90.091 Shim Rod No. 3 42	BSF-8 156.067 43	BSF-S-8 89.962 Shim Rod No. 4 44	BSF-9 154.963 45	46			49
BSF-20 159.906 31	BSF-24 168.867 32	BSF-22 154.885 33	BSF-25 168.713 34	BSF-21 159.327 35	36	37	38	39
BSF-17 157.716 21	BSF-S-1 69.282 Shim Rod No. 1 22	BSF-18 154.870 23	BSF-S-4 69.468 Shim Rod No. 2 24	BSF-16 160.349 25	26	27	28	29
11	BSF-26 176.886 12	BSF-30 180.366 13	BSF-27 175.714 14	15	16	17	18	19

EAST

D_2O TANK

BSR CORE

15
LOADING NO.

June 24, 1970
DATE

Excess reactivity = 5.30% Δk/k

4156.262
OPERATING MASS

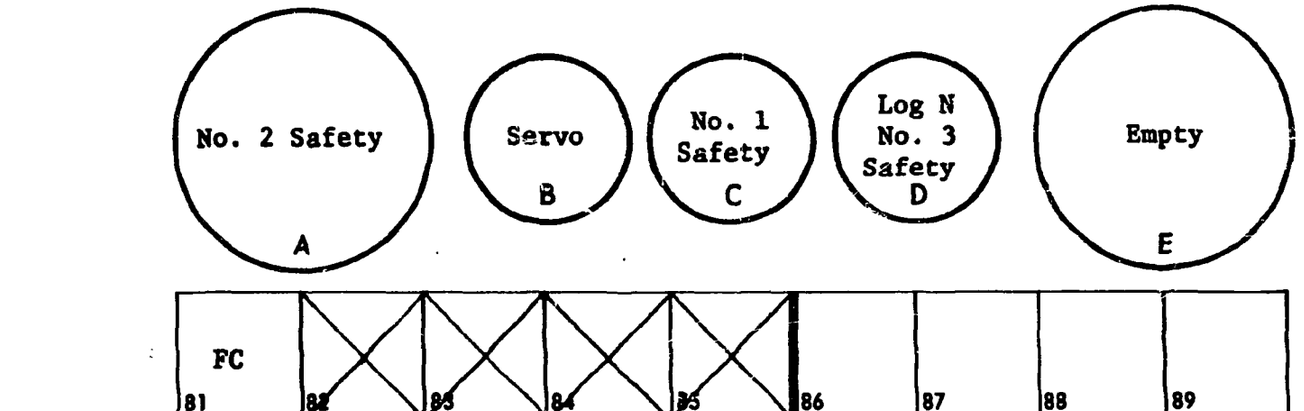
ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN
1	10.35
2	10.35
3	10.35
4	10.35
5	23.00
6	23.00

REMARKS:

Fig. 1. Core Loading No. 15 - BSR

ORNL DWG. 71-3410



BSR CORE

16
LOADING NO.

October 28, 1970
DATE

Excess reactivity = 4.13%

3994.413
OPERATING MASS

ROD POSITIONS AT CRITICAL
(With Operating Mass)

ROD NO.	IN. WITHDRAWN
1	12.27*
2	12.27*
3	12.27*
4	12.27*
5	21.47*
6	21.47*

REMARKS:

*Liquid nitrogen cryostat was in place--worth, 0.13% reactivity.
kWhr at beginning - 29,036,960

Fig. 2. Core Loading No. 16 - BSR

Table 2. Unscheduled Shutdowns

Date	Duration (hr)	Incident Report No.	Remarks
10-5-70	0.183	ORNL-70-42	Dropped No. 3 shim rod
10-14-70	0.133	ORNL-70-43	Dropped No. 3 shim rod
11-25-70	5.250	ORNL-70-51	Dropped No. 6 shim rod because of broken cable in wobble joint
12-11-70	1.300		High temperature setback from liquid nitrogen cryostat (experiment No. 3)

Table 3. Analysis of Shutdowns

Description of Shutdown	Number	Downtime (hr)
Scheduled		
Experimenters:		
Sample removal and/or insertion	1	0.633
No request to operate	12	405.632
Reactor Operations:		
To install rod-drive components	2	105.567
ORR shutdown requiring available manpower	2	27.950
Subtotal	17	539.782
Unscheduled		
Reactor Operations:		
Dropped shim rods	3	5.566
Experiments:		
High temperature setback from liquid nitrogen cryostat (experiment No. 3)	1	1.300
Subtotal	4	6.866
Total	21	546.648

Maintenance and Changes

Changes made in the reactor control instrumentation which alter the performance of the control system are documented by the BSR controls-change-memorandum system. Those changes which were made during this report period are listed in Table 4. Maintenance or changes on the instrumentation and mechanical components in the complex are listed chronologically in Tables 5, 6, and 7, while Table 8 presents the status of the ionization and fission chambers.

Table 4. Instrumentation and Controls Change Memoranda Completed During This Report Period

Change Memo No.	Subject	General Description
BSR-2Mw-26	BSR high-current nickel-plated magnet	A nickel-plated armature was installed in shim-rod-position No. 5.

Table 5. Maintenance and Changes, Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
10-7-70	Facility Radiation and Contamination Alarm System	Routine test	A functional check of the system was made by Instrumentation and Controls Division personnel; the results were satisfactory.
10-19-70	No. 3 magnet amplifier	Unit replaced	This was an attempt to prevent unscheduled drops of the No. 3 shim rod.
10-26-70	Low-voltage, high-current magnet and associated electronics	According to Reactor Instrument and Controls Design Change Memo No. BSR-2Mw-26	The magnet housing was nickel-plated in an effort to upgrade the reactor controls.
12-9-70	Facility Radiation and Contamination Alarm System	Routine test	A functional check of the system was made by Instrumentation and Controls Division personnel; the results were satisfactory.
12-27-70	Monitron and continuous air monitors in the Facility Radiation and Contamination Alarm System	Routine test	The components were checked with a source and each unit responded properly.

Table 6. Maintenance and Changes, Mechanical System

Date	Component	Trouble or Change	Reason or Maintenance
		Reactor Mechanical System	
11-25-70	No. 6 shim-rod universal (wobble) joint	Unit replacement	Broken cable.
11-25-70	No. 1 shim-rod-clutch switch	Clutch-switch actuator rod guides cleaned	The clutch-switch actuator rod was sticking.
11-25-70	No. 4 shim-rod-clutch switch	Clutch-switch actuator rod guides cleaned	The clutch-switch actuator rod was sticking.
12-2-70	No. 1 shim-rod magnet*	Replaced with magnet No. 5 from PCA shim-rod-position 2	This was a temporary move to permit upgrading of the reactor controls.
12-2-70	No. 6 shim-rod magnet*	Replaced with magnet No. 6 from PCA shim-rod position 1	This was a temporary move to permit upgrading of the reactor controls.

*The magnets removed will be modified, i.e., they will be made high-current, low-voltage magnets.

Table 7. Maintenance and Changes, Process System

Date	Component	Remarks
	Secondary Cooling Mechanical Components	
11-18-70	North fan	The pillow-block bearings were replaced because they were noisy.
12-1-70	Secondary cooling pump, packing gland	The packing gland was tightened to stop a water leak.
12-10-70	Skimmer pump drain line	The line was re-routed due to a plugged drain.
12-14-70	Secondary pH control	The secondary water line to the pH probes became plugged. The line was cleaned and flow to the probes was re-established.
12-27-70	South fan	The south fan became inoperative due to trouble with the Flexidyne coupling.
12-28-70	South fan	The stainless steel shot was replaced in the Flexidyne coupling.
12-30-70	Acid-addition-pump motor	The motor had lost torque to a point at which it would not operate at the currents that are required for pH control. The motor will be removed and taken to the motor shop.
	BSR Services	
12-3-70	Demineralized water line	Valve C-2 was installed between the process water line to the demineralized water line, and a demineralized water connection was provided for the liquid nitrogen cryostat experiment.

Table 8. Status of Ionization Chambers

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
		Chambers in Service		
PCP-III-106, SN-66-1	Position B, servo	1-29-68	None	The uncompensated section of this chamber failed on June 16, 1969. It was in service as the No. 2 safety at the time of failure.
PCP-III-106, SN-66-4	Position D, log N and No. 3 safety	8-26-70	No. 3 safety and log N at the BSR	This chamber was repaired on May 6, 1969, and returned to service.
Modified LITR chamber CTC-4	Position C, No. 1 safety	12-1-69	LITR	This chamber, which was used in the LITR dry-channel position, was recanned so it could be used in water-cooled reactors such as the ORR and BSR. Pre-operational checks, including a check of saturation characteristics, indicated that the chamber is performing satisfactorily.
Modified LITR chamber CTC-3	Position A, No. 2 safety	10-8-69	LITR	This chamber is similar to CTC-4. Pre-operational checks, including a check of saturation characteristics, indicated that the chamber is performing satisfactorily.

Table 8 (continued)

Chamber Serial No.	Location	Date Present Service Started	Previous Service	Remarks
		Chambers not in Service		
PCP-III-106, SN-66-3	Instrument repair shop		No. 1 safety and log N at the BSR	Both sections had failed.
PCP-III-106, SN-66-2	BSR storage		No. 3 safety and log N at the BSR	Both sections of the chambers have been repaired and pre-operational checks indicated satisfactory results.
PCP (old type with no serial number)	BSR storage		BSR	This is in reserve for the PCA but can be used in an emergency for the BSR.
PCP (old type with no serial number)	Warehouse storage		No. 2 safety at the BSR	This chamber is of the old type and will be repaired if and when it is needed.
CIC (old type with no serial number)	BSR storage		BSR	This chamber is in reserve for the PCA but can be used in an emergency for the BSR.
CIC (old type with no serial number)	BSR storage		BSR	This chamber is in reserve for the PCA but can be used in an emergency for the BSR.
Modified LITR chamber CTC-2	BSR storage (spare)	9-9-70	No. 3 safety at the BSR	This chamber was removed from service as the No. 3 safety since the uncompensated section of PCP-III-106, SN-66-4 could be used.

Fuel

Changes in the fuel inventory are reflected in Table 9.

Table 9. 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	2
New fuel elements placed in service	0	0	6
New control-rod fuel elements placed in service	0	0	2
New fuel elements available for use	13	13	--
New control-rod fuel elements available for use	12	12	--
Partially depleted fuel elements available for use	11	11	--
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 10. 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 10. 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* (N-4 and S-3)	East D_2O tank	Unassigned
Dry thermal-neutron tubes* (east, center, southwest, and northwest)	East D_2O 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 11 gives detailed information on the condition of the primary water system and pertinent data on the performance of the bypass demineralizer.

Table 11. 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
1	2-7-67	6-2-67	3,704,900	829	43	6.2	6.4	950,555	1,621,665
2	6-2-67	9-26-67	3,931,300	1,867	122	6.3	6.6	750,665	1,895,715
3	10-12-67	12-4-67	1,748,900	2,420	144	6.2	6.4	866,875	2,027,000
4	12-8-67	3-4-68	2,988,200	1,681	55	6.1	6.3	963,500	2,064,900
5	3-8-68	6-7-68	3,064,800	1,664	73	6.2	6.6	962,500	2,125,000
6	6-21-68	9-23-68	2,990,870	1,140	86	6.3	6.5	983,000	2,390,000
7	9-27-68	12-23-68	2,947,920	2,315	87	5.8	6.0	950,000	2,100,000
8	12-24-68	3-17-69	2,829,500	1,980	107	6.4	6.7	1,036,000	3,023,000
9	3-21-69	6-9-69	2,643,100	1,717	137	6.8[a]	6.9[a]	1,002,080	2,378,750
10	6-12-69	7-31-69	1,596,700	1,714	122	7.1[a]	7.2[a]	860,000	3,033,330
11	8-4-69	8-14-69[b]	278,500	1,253	134	7.3[a]	7.6[a]	800,000	2,500,000
12	8-19-69	10-21-69	2,166,200	1,622	124	6.0	6.1	1,000,000	2,500,000
13	10-24-69	11-17-69	682,900	1,644	93	5.8	5.9	864,000	1,420,000

[a]These values, as measured by field instruments, are ~0.6 pH high when compared to values obtained by laboratory instruments.

[b]The unit was removed from service for resin columns to be regenerated because of a high pH output. The conductivity was satisfactory.

Table 11 (continued)

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
14	11-22-69	12-5-69	394,400	1,325	172	6.4	6.4	720,000	1,267,860
15	12-24-69[c]	1-5-70	325,560	1,599	186	6.3	6.4	545,000	2,262,500
16	1-6-70	2-2-70	930,000	1,503	206	6.1	6.3	847,000	2,917,000
17	2-4-70	3-2-70	946,500	2,038	193	6.0	5.9	668,000	2,560,000
18	3-3-70	3-21-70	613,000	1,970	136	6.2	6.1	849,000	2,110,500
19	3-25-70	5-7-70	1,417,000	1,836	187	6.0	5.9	880,000	1,206,500
20	5-10-70	5-20-70	315,000[d]	1,600	180	5.6	5.4	810,000	1,450,000
21	5-20-70	7-15-70	1,756,300	1,960	190	6.1	6.0	900,000	2,100,000
22	7-17-70	9-2-70	787,000	1,168	93	6.0	5.9	633,850	1,443,870
23	9-10-70	In service	2,233,868	1,199	92	6.0	5.7	952,000	1,525,111

[c]The anion resin (21 cu ft) was replaced with resin formerly used in the LITR demineralizer (17.4 cu ft). This exchange was made after the BSR resin was inspected under magnification and found to be severely deteriorated (beads broken).

[d]The demineralizer was removed from service to regenerate the anion column after adding 3.6 cu ft of Ionac 540 resin.

Operating Manual

Changes which were made to the operating manual during this quarter are listed in Table 12.

Table 12. Revisions to BSR Operating Manual (ORNL-TM-2676)

Date	Section	Remarks
10-7-70	10.2c and 10.2d	These sections, which relate to the operation of the diesel engine, were revised to ensure clarity.
10-8-70	13.1	An addition entitled "Authorization and Documentation of Changes to the System, Operating Manual, and/or Operating Instructions Notebook" was added to provide a specific procedure for expanding the system.
12-9-70	2.4d, 3.2c, 3.5a, 9.2h, and 10.1d	These revisions were made to correct minor errors in the original printing.

Special Tests

Reactivity

The reactivity worth of the "old" liquid nitrogen cryostat experiment (equipped with a new shield) was measured on October 22, 1970, and found to be -0.13% Δk/k. This measurement was made by noting the position of the No. 4 shim rod with the reactor critical and the experiment in place (the experiment was "centered" against the north face of the BSR, loading 15) as compared with the reactor critical without the experiment; all other conditions remained unchanged.

Efficiency Tests

Tests were performed by Inspection Engineering on both HEPA and charcoal filters. Details are given in Table 13.

Table 13. Efficiency Test Results, Filters

Date	Unit	Remarks
10-28-70	Cell-ventilation system	Methyl iodide retention efficiency tests were performed. Results of the tests were: south bank, 62.5%; center bank, 70.1%.
10-29-70	Cell-ventilation system	Elemental iodine efficiency tests were performed. Results of the tests were: south bank, 99.900%; center bank, 99.994%.
11-4-70*	Cell-ventilation system	The charcoal absorbers in the north and south banks of the cell-ventilation system were tested for elemental iodine efficiency. Results of the tests were: south, 99.898%; north, 99.985%.
12-1-70	Cell-ventilation system	A DOP test was made with these results: north, 99.98%; center, 99.98%; south, 99.994%.

*The retest of the south bank was per request of Inspection Engineering. It will remain out of service until proven reliable.

Source

The ^{60}Co source, which is normally stored in the special source holder located in the northeast corner of the pool, was loaned to Instrumentation and Controls Division for special work at the TURF facility. A Phoenix carrier (X-4377) was used for the transfer and radiation readings on the outside of the carrier were: side, 60 mr/hr; top, 150 mr/hr (β, γ).

POOL CRITICAL ASSEMBLY

Operations

The PCA was operated as a low-power critical facility for two days during this quarter. Students from the University of Kentucky participated in the performance of two experiments under the direction of Operations Division supervision. Operational activities required to prepare the facility for use included a checkout of the reactor control instrumentation and preparation of the required loadings. The core loadings used for the experiments were similar to, but not identical with, previous core loadings used.

While completing the modifications for the BSR high-current magnets, the PCA magnets were transferred to the BSR for temporary service.

Revisions were made to the "Instrument Checkout Procedure", Appendix E of the PCA operating manual (ORNL-TM-2340) on December 11, 1970. These revisions were made to reflect improvements in techniques for accomplishing the checkouts.

Table 14. Usage of Pool Critical Facility

Date	Operational Activity	Purpose
11-2-70 through 11-6-70	Reassembled and installed shim-rod-drive units and completed instrumentation and controls checkout	Preparing for University of Kentucky experiments
11-16-70	Established core No. 104 to obtain a critical mass following an approach-to-critical procedure; calibrated the regulating rod after re-arranging to core No. 105	Conducting experiments for University of Kentucky nuclear engineering students
11-17-70	Established core No. 106 to obtain a critical mass following an approach-to-critical procedure; calibrated the regulating rod after re-arranging to core No. 107	Conducting experiments for University of Kentucky nuclear engineering students

Table 15. PCA Maintenance

Date	Trouble or Condition	Action
10-7-70	Routine gauging of the shim rods	After disassembling Nos. 1, 2, and 3 shim-rod-drive tubes to permit the removal of the shim rods, the shim rods were gauged with the following results: Nos. 1 and 2 shim rods would not pass through an 0.030-in. oversize gauge but did pass through the 0.095-in. oversize gauge; No. 3 shim rod did pass through the 0.030-in. oversize gauge.
12-2-70	Transferred magnets from Nos. 1 and 2 drives to BSR	These magnets were transferred to the BSR for temporary use while modifications for the BSR high-current magnets are in progress.
12-9-70	Transferred magnet from No. 3 drive to BSR	This magnet was transferred to the BSR for temporary use while modifications for the BSR high-current magnets are in progress.
12-9-70	Armatures are rusty	The armatures were removed from shim rods 1, 2, and 3 and are to be nickel-plated.

Special Activities

Two groups of undergraduate students from the University of Kentucky participated in the performance of two experiments in the PCA, "Loading a Critical Mass" and "Calibrating the Regulating Rod". The students actively participated in the experiments under the direction of Operations Division supervision.

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

April 27, 1971

To: Recipients of Subject Report

Report No.: ORNL-TM-3355 Classification: Unclassified

Author(s): W. H. Tabor and S. S. Hurt, III

Subject: Bulk Shielding Facility Quarterly Report - October, November, and December of 1970.

Request compliance with indicated action:

Please make the following changes in your copy(ies) of the subject report.

Page 5 (Table 1) - Time Operating, %, for Last Quarter should be 56.8 rather than 77.7; for Year to Date, should be 61.5 rather than 76.4.
Reactor availability, %, for Year to Date should be 85.8 rather than 88.4.

N. T. Bray, Supervisor
Laboratory Records Department
Technical Information Division

NTB:WCB:wm

UCN-430
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