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**Bulk Shielding Facility
Quarterly Report
July, August, and
September 1980**

S. S. Hurt
E. D. Lance
J. R. Thomas

OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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OPERATIONS DIVISION

BULK SHIELDING FACILITY QUARTERLY REPORT
JULY, AUGUST, AND SEPTEMBER 1980

S. S. Hurt
E. D. Lance
J. R. Thomas

SPONSOR: J. H. Swanks
Director, Operations Division

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CONTENTS

SUMMARY	1
BULK SHIELDING REACTOR	1
Operations	1
Shutdowns	3
Shim-Rod Calibrations	8
Maintenance and Changes	9
Fuel	13
Experiment Facilities Assignment	13
Demineralizer Performance	14
Special Tests	16
Efficiency Tests	16
Operational Activities	16
Summary of Surveillance Tests at the BSR	17
POOL CRITICAL ASSEMBLY	19
Operations	19
Summary of Surveillance Tests at the PCA	21
DISTRIBUTION	23

FIGURE LIST

Figure

1	Core Loading 77 BSR	4
2	Core Loading 78 BSR	5
3	Core Loading 79 BSR	6
4	Core Loading 80 BSR	7

TABLE LIST

Table

1	Basic Operating Data	2
2	Analysis of Shutdowns	9
3	Maintenance and Changes, Instrumentation and Controls . . .	10
4	Maintenance and Changes, Mechanical System	11
5	Maintenance and Changes, Process System	12
6	Fuel and Shim-Rod Status	13
7	Facilities Assignment	14
8	Demineralizer Performance Data	15
9	Efficiency Tests Results, Filters	16
10	Operational Activities	16
11	Summary of Surveillance Tests at the BSR	17
12	Usage of Pool Critical Facility	19
13	PCA Maintenance	20
14	Summary of Surveillance Tests at the PCA	21

BULK SHIELDING FACILITY QUARTERLY REPORT
JULY, AUGUST, AND SEPTEMBER OF 1980

S. S. Hurt, E. D. Lance, J. R. Thomas

SUMMARY

The Bulk Shielding Reactor (BSR) operated at an average power level of 1919 kW for 85.74% of the time during July, August, and September. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory.

The Pool Critical Assembly (PCA) was operated on three occasions for the Pressure Vessel Simulator Benchmark experiment.

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 1980)

	This Quarter	Last Quarter	Year To Date
Total energy, kWd	151,400	110,698	397,019
Average operating power, kW	1919	1907	1931
Time operating, %	85.74	63.83	74.98
Reactor availability, %	87.09	68.98	80.71
Reactor water radioactivity counts min ⁻¹ ml ⁻¹ (av)	1914	1941	1930
Reactor water resistivity, ohm-cm (av)	1,259,000	986,000	1,131,000
Research samples	15	10	38

Core loading 77 (Fig. 1) was temporarily converted to core loading 78 (Fig. 2) on July 28, 1980, for Low Temperature Irradiation Facility (LTIF) irradiations. Core loading 78 was accomplished by replacing the 166 g U-235 fuel element in CP-55 with an aluminum core piece. Core loading 78 had an initial operating mass of 5109 g which, when against the LTIF experiment complex, provided an excess reactivity of 4.95% $\Delta k/k$ (2.40% $\Delta k/k$ excess reactivity above xenon equilibrium). Core loading 78 was converted back to core loading 77 on August 6, 1980, after completion of the LTIF experiment irradiations.

Core loading 77 was converted to core loading 79 (Fig. 3) September 15, 1980, to provide excess reactivity for versatile operation. The initial operating mass (5275 g U-235) of core loading 77 had been reduced to 5108 g due to burn-up, thereby reducing the excess reactivity from 5.52% $\Delta k/k$ to 3.25% $\Delta k/k$ (0.70% $\Delta k/k$ excess reactivity above xenon equilibrium).

Core loading 79 was accomplished by removing the two Naval Research Laboratory (NRL) experiments (program completed) and two low weight (139 g and 142 g U-235) fuel elements from the core. Four aluminum cans were installed in the core to complete the reloading. Core loading 79 is essentially a repeat of core loading 40. Core loading 79 had an initial operating mass of 4948 g U-235, which provided an excess reactivity of 4.80% $\Delta k/k$ (2.25% $\Delta k/k$ excess reactivity above xenon equilibrium).

The BSR shim rods were calibrated after core loading 79 had been established. Core loading 79 was temporarily converted to core loading 80 (Fig. 4) on September 29, 1980, for LTIF irradiations. Core loading 80 was accomplished by replacing the 160 g U-235 fuel element in CP-55 with an aluminum core piece. Core loading 80 had an initial operating mass of 4788 g which, when against the LTIF experiment complex, provided an excess reactivity of 4.75% $\Delta k/k$ (2.20% $\Delta k/k$ excess reactivity above xenon equilibrium).

Shutdowns

There were seven unscheduled shutdowns during the quarter.* Table 2 gives an analysis of both scheduled and unscheduled shutdowns.

*Two caused by instrumentation, one caused by an experiment, and four caused by shim-rod drops

BSR CORE

LOADING NO.	77
DATE	June 25, 1980
EXCESS REACTIVITY	5.52% $\Delta k/k$
OPERATING MASS	~ 5275 g

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	8.93	10.60
2	8.93	10.60
3	8.93	10.60
4	8.93	10.60
5	23.00	10.60
6	23.00	10.60

REMARKS:

81	82	83	84	85	86	87	88	89
				FC	YZP 0044 142	BSF A-5 182	YZP 003W 142	A1 CAN
71	72	73	74	75	76	77	78	79
				M-57-H 202	E NRL	A1 Solid	E NRL	M-58-H 203
61	62	63	64	65	66	67	68	69
	EAST D ₂ O TANK			M-59-H 195	B-198-C 51	M-15-H 143	B-199-C 54	M-51-H 196
51	52	53	54	55	56	57	58	59
				YZP 0042 156	M-12-H 152	M-18-H 161	YZP 0047 157	YZP 0046 170
41	42	43	44	45	46	47	48	49
				BSF A-1 193	BSF-S-17 88	YZP 003Y 147	BSF-S-18 89	BSF A-6 194
31	32	33	34	35	36	37	38	39
				BSF A-2 181	YZP 0040 161	YZP 0048 154	YZP 0041 165	BSF A-3 187
21	22	23	24	25	26	27	28	29
				YZP 0043 203	BSF-S-15 72	M-16-H 141	BSF-S-16 72	YZP 0045 197
11	12	13	14	15	16	17	18	19
				AL PLUG	BSF A-9 219	YZP 003X 142	BSF A-8 215	M-5-H 139

Fig. 1. Core Loading 77 BSR

81	82	83	84	85	86	87	88	89
				FC	YZP 0044 142	BSF A-5 182	YZP 003W 142	A1 CAN
71	72	73	74	75	76	77	78	79
				M-57-H 202	E NRL	A1 SOLID	E NRL	M-58-H 203
61	62	63	64	65	66	67	68	69
	EAST D ₂ O			M-50-H 195	B-198-C 51	M-15-H 143	B-199-C 54	M-51-H 196
51	52	53	54	55	56	57	58	59
	TANK			A1 CAN	M-12-H 152	M-18-H 161	YZP 0047 157	YZP 0046 170
41	42	43	44	45	46	47	48	49
				BSF A-1 193	BSF-S-17 88	YZP 003Y 147	BSF-S-18 89	BSF A-6 194
31	32	33	34	35	36	37	38	39
				BSF A-2 181	YZP 0040 161	YZP 0048 154	YZP 0041 165	BSF A-3 187
21	22	23	24	25	26	27	28	29
				YZP 0043 203	BSF-S-15 72	M-16-H 141	BSF-S-16 72	YZP 0045 197
11	12	13	14	15	16	17	18	19
				AL PLUG	BSF A-9 219	YZP 003X 142	BSF A-8 215	M-5-H 139

BSR CORE

LOADING NO. 78	
DATE July 28, 1980	
EXCESS REACTIVITY 4.95% Δk/k	
OPERATING MASS ~5109 g	
ROD POSITIONS AT CRITICAL (With Operating Mass)	
ROD NO.	IN. WITHDRAWN
1	9.90
2	9.90
3	9.90
4	9.90
5	23.00
6	23.00
REMARKS: Core 78 used for LTIF experiment.	

Fig. 2. Core Loading 78 BSR

BSR CORE

				FC	A1 CAN	A1 CAN	A1 CAN	M-57-H 198
81	82	83	84	85	86	87	88	89
				A1 CAN	A1 CAN	A1 CAN	BSF A-7 205	M-58-H 199
71	72	73	74	75	76	77	78	79
	EAST			M-50-H 188	B-198-C 49	BSF A-5 179	B-199-C 52	M-51-H 190
61	62 D ₂ O	63	64	65	66	67	68	69
	TANK			YZP 0042 160	M-12-H 145	M-18-H 153	YZP 0047 149	YZP 0046 164
51	52	53	54	55	56	57	58	59
				BSF A-1 186	BSF-S-17 85	BSF A-6 187	BSF-S-18 86	YZP 003Y 140
41	42	43	44	45	46	47	48	49
				BSF A-2 174	YZP 0040 154	YZP 0048 147	YZP 0041 157	BSF A-3 181
31	32	33	34	35	36	37	38	39
				YZP 0043 198	BSF-S-15 71	M-16-H 136	BSF-S-16 70	YZP 0045 192
21	22	23	24	25	26	27	28	29
				AL PLUG	BSF A-9 214	BSF A-4 192	BSF A-8 211	M-5-H 136
11	12	13	14	15	16	17	18	19

LOADING NO.
79
DATE
September 15, 1980
EXCESS REACTIVITY
4.40% $\Delta k/k$
OPERATING MASS
~4948 g

ROD POSITIONS AT CRITICAL (With Operating Mass)

ROD NO.	IN. WITHDRAWN	
1	9.85	11.68
2	9.85	11.68
3	9.85	11.68
4	9.85	11.68
5	23.00	11.68
6	23.00	11.68

REMARKS:

Fig. 3. Core Loading 79 BSR

				FC	A1 CAN	A1 CAN	A1 CAN	M-57-H 198
81	82	83	84	85	86	87	88	89
				A1 CAN	A1 CAN	A1 CAN	BSF A-7 205	M-58-H 199
71	72	73	74	75	76	77	78	79
	EAST D ₂ O TANK			M-50-H 188	B-198-C 49	BSF A-5 179	B-199-C 52	M-51-H 190
61	62	63	64	65	66	67	68	69
				A1 CAN	M-12-H 145	M-18-H 153	YZP 0047 149	YZP 0046 164
51	52	53	54	55	56	57	58	59
				BSF A-1 186	BSF-S-17 85	BSF A-6 187	BSF-S-18 86	YZP 003Y 140
41	42	43	44	45	46	47	48	49
				BSF A-2 174	YZP 0040 154	YZP 0048 147	YZP 0041 157	BSF A-3 181
31	32	33	34	35	36	37	38	39
				YZP 0043 198	BSF-S-15 71	M-16-H 136	BSF-S-16 70	YZP 0045 192
21	22	23	24	25	26	27	28	29
				AL PLUG	BSF A-9 214	BSF A-4 192	BSF A-8 211	M-5-H 136
11	12	13	14	15	16	17	18	19

BSR CORE

LOADING NO. 80	
DATE September 29, 1980	
EXCESS REACTIVITY 4.75% $\Delta k/k$	
OPERATING MASS ~4788 g	
ROD POSITIONS AT CRITICAL (With Operating Mass)	
ROD NO.	IN. WITHDRAWN
1	9.30
2	9.30
3	9.30
4	9.30
5	23.00
6	23.00
REMARKS: LTIF experiment core	

Fig. 4. Core Loading 80 BSR

Shim-Rod Calibrations

The BSR shim rods were calibrated after core loading 79 had been established. The total worth of all six rods is 10.437% $\Delta k/k$. 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 ≥ 10.20 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 8.40 in. to comply with the same operating limit.

Table 2. Analysis of Shutdowns

Description of Shutdown	Number	Downtime (hrs)
<u>Scheduled</u>		
Experimenters:		
No request to operate	1	5.600
Experiment insertion, removal or data taking	2	11.800
Repositioning of the reactor	3	3.500
Reactor Operations:		
Xenon decay for refueling	1	56.000
Refueling critical runs	4	2.000
Shim-rod calibrations	1	9.050
BSR quarterly shutdown and maintenance	5	224.300
Subtotal:	17	312.250
<u>Unscheduled</u>		
Instrumentation	2	0.283
Experiments	1	0.350
Rod drops	4	2.016
Subtotal:	7	2.649
TOTAL:	<u>24</u>	<u>314.899</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
7-28-80	Miscellaneous temperature recorder, TR-16	Inoperable	The drive cable was replaced.
8-6-80	Facility radiation and contamination alarm system	Routine	Bimonthly checks
8-22-80	Magnet control bin No. 1	Nos. 1 and 2 rods had dropped	The power supply was replaced.
9-8-80 through 9-12-80	Instrumentation	Routine	Quarterly checks
9-12-80	Counting rate channel	Did not meet specifications	The log count-rate meter was replaced.
9-12-80	No. 2 safety channel	Sensitivity switch faulty	A broken wire to the switch was repaired.
9-12-80	Secondary pH recorder	Inoperable	A broken wire in the recorder was repaired.
9-12-80	Log-N channel	Unsteady	The Log-N amplifier was retubed.

Table 4. Maintenance and Changes, Mechanical System

Date	Component	Trouble or Change	Reason or Maintenance
9-8-80 through 9-10-80	Shim-rod assemblies 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.

Table 5. Maintenance and Changes, Process System

Date	Component	Trouble or Change	Reason or Maintenance
7-16-80 through 7-18-80	Reactor secondary tower north fan	Excessive vibration	Replaced the bearings and welded the cracked motor support.
7-17-80	Control Room air-condi- tioning unit	Inoperable	The control transformer was replaced.
7-28-80 and 7-29-80	Cell ventilation system	Low flow	South bank filters - cleaned the first stage iodine filters, replaced the prefilter, abso- lute charcoal, and absolute filters. Center bank filters - cleaned the screens and replaced the prefilter. Cleaned the flow probes and calibrated the flow transmitters FT25A and 25B.
8-4-80 and 8-5-80	Demineralizer	Routine regeneration	The cation and anion columns were regenerated and the unit returned to service.
9-8-80	Secondary cooling tower basin	Routine cleaning and inspection	The secondary tower basin was drained, cleaned, and refilled.

Fuel

Changes in the fuel inventory are shown in Table 6.

Table 6. Fuel and Shim-Rod Status

	This Quarter	Last Quarter	Year To Date
Fuel elements depleted	0	2	4
Control rod fuel elements depleted	0	0	0
New fuel elements placed in service	0	5	7
New control rod fuel elements placed in service	0	0	0
New fuel elements available for use	19	13	19
New control rod fuel elements available for use	6	0	6
Partially depleted fuel elements available for use (includes core)	31	31	31
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	1	1	1

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
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
Steel Specimen experiment	Core positions 76 and 78	Naval Research Laboratory
Dry thermal-neutron tubes ^a (D-3-1 and -2)	East D ₂ O tank	Operations
Wet thermal-neutron tubes ^a (D-4-1 and -2, D-6-1, -2, -3, -4, and -5)	East D ₂ O tank	Operations

^aThese 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		pH		Specific Resistance	
				(Counts min ⁻¹ ml ⁻¹)				(ohm-cm)	
				In	Out	In	Out	In	Out
42 ^a	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	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	3-6-78	2,950,000	1,585	134	5.5	5.7	1,191,000	1,953,000
51	3-8-78	8-2-78	2,350,000	2,112	122	5.6	5.8	1,030,000	1,634,000
52 ^a	8-15-78	9-18-78	950,000	2,077	157	5.7	5.9	1,363,000	2,209,000
53	9-19-78	12-19-78	2,580,000	2,194	163	5.6	5.8	1,194,000	3,207,000
54	12-19-78	4-10-79	3,040,000	1,964	134	5.6	5.9	1,183,000	1,910,000
55	4-11-79	7-24-79	2,750,000	2,188	164	5.5	5.7	1,006,000	1,675,000
56	7-27-79	11-19-79	2,800,000	1,801	138	5.3	5.5	971,000	1,743,000
57	11-20-79	4-8-80	2,750,000	1,866	134	5.3	5.5	1,084,000	2,038,000
58	4-9-80	5-29-80	1,000,000	1,979	123	5.3	5.5	808,000	1,832,000
59	5-30-80	6-2-80	5,000	1,950	125	5.3	5.6	774,000	1,538,000
60 ^a	6-3-80	8-4-80	1,750,000	1,929	106	5.4	5.7	1,278,000	3,466,000
61	8-5-80	In-Service	1,350,000	1,900	118	5.4	5.7	1,240,000	3,249,000

^a New resin in the demineralizer columns.

Special Tests

Efficiency Tests

Tests were performed by Quality Assurance and Inspection Department personnel on the cell ventilation filters. Details are given in Table 9.

Table 9. Efficiency Tests Results, Filters

Date	Unit	Type Test	Efficiency (%)
7-28-80	South Bank	DOP	99.997
7-29-80	South Bank	Elemental Iodine	99.99
7-31-80	North Bank	Methyl Iodide	87.29
7-31-80	Center Bank	Methyl Iodide	21.54
7-31-80	South Bank	Methyl Iodide	99.62

Operational Activities

The operational activities are reflected in Table 10.

Table 10. Operational Activities

Date	Remarks
7-13-80	BSR strainer cage - the half-inch mesh screen was installed around the reactor core.
8-25-80	The skimmer filters were changed.
9-8-80 through 9-10-80	All fuel elements including shim-rod fuel elements were visually inspected with satisfactory results.
9-12-80	The containment system quarterly functional checks was performed with satisfactory results.

Summary of Surveillance Tests at the BSR

Table 11 is a tabulation of the completion dates of the surveillance tests required by the Technical Specifications. This table contains all the surveillance tests scheduled for frequencies of one test per month or longer. Other surveillance requirements, which are not reported, are satisfied by routine completion of daily and weekly check sheets, start-up check lists, hourly data sheets, the operating log book, and miscellaneous quality assurance tests.

Table 11. Summary of Surveillance Tests at the BSR

Test	Most Recent Test	Previous Test
<u>Biennial Tests</u>		
Inspection of the shim-safety rods	9-12-80	5-3-79
<u>Annual Tests</u>		
Calibration of shim-safety rods	9-16-80	12-7-79
Core ΔT channel calibration	9-15-80	8-9-79
Primary coolant flow channel calibration	9-10-80	8-9-79
Pool water level channel calibration	6-19-80	12-4-79
Maximum rate of reactivity addition by the shim-safety rods	9-12-80	6-25-80
Reactivity assigned to the servo-control system	3-5-80	2-27-79
Subcriticality with each shim-safety rod at its upper limit while all other shim-safety rods are fully inserted	9-12-80	6-25-80

Table 11. Summary of Surveillance Tests (Cont'd)

Test	Most Recent Test	Previous Test
<u>Semiannual</u>		
Cell ventilation filter efficiency		
A. Methyl Iodide	7-31-80	2-29-79
B. Elemental Iodine	7-29-80	6-10-80
C. Dioctyl Phthalate	7-28-80	6-9-80
Radiation monitoring equipment calibration	8-6-80	6-4-80
Stack radiation monitor calibration	7-30-80	3-19-80
<u>Quarterly</u>		
Safety channel No. 1 calibration	9-9-80	6-17-80
Safety channel No. 2 calibration	9-9-80	6-17-80
Safety channel No. 3 calibration	9-9-80	6-17-80
Log-N channel calibration	9-9-80	6-17-80
Fission chamber channel calibration	9-9-80	6-17-80
Flapper valve position channel functional test	9-12-80	6-19-80
Measurement of release time and flight time for the safety-shim rods	9-12-80	6-25-80
Containment closure system functional test	9-12-80	6-20-80
In-leakage during containment mode	9-12-80	6-20-80

POOL CRITICAL ASSEMBLY

Operations

The PCA was used 8.4 hours for the Pressure Vessel Simulator Benchmark experiment. 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 12 (Usage of the Pool Critical Facility). The PCA maintenance is listed in Table 13.

Table 12. Usage of Pool Critical Facility

Date	Operational Activity	Purpose	Hours Used
9-29-80 and 9-30-80	Established core 286 for the Pressure Vessel Simulator Benchmark experiment	Experiment data	8.4

Table 13. PCA Maintenance

Date	Component	Trouble or Change	Reason or Maintenance
8-12-80 through 8-18-80	Instrumentation	Routine	Quarterly checks
8-14-80	Pico-Ammeter	Did not meet specifications	The unit was retubed.
8-14-80	Primary counting channel	Would not calibrate	The log count rate meter was retubed.
8-14-80	Trouble monitor	Faulty relay	The K-11 relay was replaced.
8-14-80	Auxiliary counting rate channel	Did not meet specifications	The recorder amplifier was replaced.
9-29-80	Servo channel	Faulty servo power supply	The servo power supply was replaced.
9-29-80	Safety trouble monitor	Faulty relay	Replaced trouble monitor relay RT-11.

Summary of Surveillance Tests at the PCA

Table 14 is a tabulation of the completion dates of the surveillance tests required by the Technical Specifications. This table contains all the surveillance tests scheduled for frequencies of one test per month or longer. Other surveillance requirements, which are not reported, are satisfied by routine completion of daily and weekly check sheets, start-up check lists, hourly data sheets, the operating log book, and miscellaneous quality assurance tests.

Table 14. Summary of Surveillance Tests at the PCA

Test	Most Recent Test	Previous Test
<u>Annual</u>		
Reactivity assigned to the servo-control system	4-17-80	2-20-80
Subcriticality with each safety-shim rod at its upper limit and all other shim-safety rods fully inserted	8-18-80	2-29-80
<u>Semiannual</u>		
Monitron calibration ^a	9-29-80	9-24-80
Radiation monitoring equipment calibration	8-6-80	6-4-80
<u>Quarterly^b</u>		
Safety channel No. 1 calibration	8-18-80	2-28-80
Safety channel No. 2 calibration	8-18-80	2-28-80
Safety channel No. 3 calibration	8-18-80	2-28-80
Log-N channel calibration	8-15-80	2-28-80
Fission chamber channel calibration	8-14-80	2-28-80
Measurement of release time and flight time for the safety-shim rods	8-18-80	2-29-80

^aThis test is performed the first operating day of each week.

^bQuarterly checks delayed due to an extended shutdown period.

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