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OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT JANUARY, FEBRUARY, AND MARCH OF 1967

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SUMMARY

The ORR operated 83.6% of the time during the quarter, at an average operating power level of 29.8 Mw.

There were fifteen shutdowns, seven of which were scheduled. Included were two end-of-cycle shutdowns, one of which was extended approximately two days to permit installation of the No. 2 molten salt loop at HN-1. Two shutdowns were for training purposes.

The dual-purpose chamber for the No. 2 safety channel apparently failed. This chamber will be removed for inspection and tests early in the next quarter.

Portions of the piping for the pool cooling system, particularly those sections which penetrated the pipe chase or pool walls, were replaced with new stainless steel pipe. This action followed the discovery of a leak in the pump suction line at a point in the concrete wall approximately three feet behind the aluminum liner.

The No. 1 rod drive was replaced after debris was found in the shock absorber. The unit was functioning correctly but was replaced in lieu of a routine maintenance and inspection replacement. No unusual wear or corrosion was found, and the unit was reassembled and placed in standby as a spare.

Two aluminum core pieces were found to be bowed, apparently due to neutron damage. These, specifically the N_F tray from core position A7 and the No. 2 hydraulic tube from core position D8, were removed from the core and subsequently measured in the hot cell. Maximum deflections toward the high flux area were 0.029 and 0.060 in. for the hydraulic tube (A7) and the N_F tray (D8), respectively.

Reactivity worth measurements indicated that the average void coefficient for rather large voids in the fuel region is $-2.9 \times 10^{-4} \% \Delta k/k/cm^3$.

Thermal flux measurements at the poolside P9 position confirmed that this facility would be suitable as a substitute location for the HN-2 pneumatic tube.

INTRODUCTION

Operating experience, instrument and process maintenance, and experiment activities for the quarter are summarized in Tables 1 through 12 of this report. Figures 1 through 4 supplement this information. Items of particular interest or importance are designated in descending order by the letters A, B, or C at the left of the tables. Discussion of this portion of the report is minimized.

Special tests or unusual occurrences are, by contrast, discussed in some detail in the back portion of the report.

OPERATIONS

Table 1. ORR Basic Operating Data
Period January through March, 1967

	This Quarter	Last Quarter	Year To Date	January - March 1966
Total energy, Mwd	2244.2	2449.9	2244.2	2533.6
Average power, Mw/operating hr	29.8	29.9	29.8	29.9
Time operating, %	83.6	89.1	83.6	94.0
Reactor water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	30,900	34,100	30,900	30,900
Pool water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	530	680	530	840
Reactor water resis- tivity, ohm-cm (av)	1,113,000	1,150,000	1,113,000	1,120,000
Pool water resis- tivity, ohm-cm (av)	1,020,000	1,180,000	1,020,000	645,000
Fuel elements depleted	26	44	26	29
Shim rods depleted	4	2	4	2
Research samples	36	32	36	6
Radioisotope samples	151	172	151	214

Table 2. ORR Cycles of Operation

Cycle No.	Date Begun	Date Ended	Accumulated Energy (Mwd)
70	November 19, 1966	January 8, 1967	1474.84*
71	January 15, 1967	March 5, 1967	1406.90
72	March 10, 1967	In progress	612.29

*Energy accumulated this quarter (cycle 70), 225.00 Mwd.

SHUTDOWNS AND POWER REDUCTIONS

Table 3. Summary of ORR Shutdowns

Description or Reason	Number	Downtime (hr)
Scheduled		
Regular, end of cycle	2	305.384
Regular, midcycle isotope work	1	19.000
Regular, refueling and limited experiment work	1	18.350
Special, training	2	0.500
Special, core change to adjust flux	<u>1</u>	<u>0.467</u>
Subtotal	7	343.701
Unscheduled		
Experiment failure, mechanical	1	3.067
Instrument trouble, experiment	3	6.284
Electrical power outage or surge	3	0.483
Human error	<u>1</u>	<u>0.650</u>
Subtotal	<u>8</u>	<u>10.484</u>
Total	15	354.185

FIG. 1 SHIM-ROD POSITION Vs TIME (CYCLE No. 70)

FIG. 2 SHIM-ROD POSITION Vs TIME (CYCLE No. 71)

FIG. 3 SHIM ROD POSITION Vs TIME (CYCLE No. 72)

Table 4. Unscheduled Shutdowns of the ORR, Details

Date	Duration (hr)	Remarks
1-24-67	0.133	This shutdown resulted from maintenance to the alarm system at the stack area. The control circuit for the pressurizable off-gas (POG) blower was inadvertently opened, causing the loss of power to the blower. High pressure in the POG system resulted in a power reduction to below 1% of full power.
1-31-67	0.117	A temperature recorder (TR-2) at the B-9 experiment panel malfunctioned, driving upscale to the setback point. The power sagged below N_L .
C 3-11-67	3.067	High radiation levels occurred in the GCR Loop 1 gas system soon after startup beginning cycle 72. A gas sample from the loop was analyzed and found to contain fission products, indicating that the fuel cladding was ruptured. The reactor was shut down to facilitate withdrawing the experiment from the high flux zone.
3-19-67	0.250	This shutdown occurred when the instrument power circuit at the GCR-05 capsule was inadvertently shorted to ground, causing a scram. The short occurred during approved, necessary instrument repair.
3-20-67	0.650	Breaker No. 214 at substation 0901 was inadvertently tripped, resulting in an area electrical power outage for 15 minutes. On the return of electrical power, the reactor was started up; however, due to a transducer power supply failure at GCR capsule 05 (setback condition from low blanket gas-pressure indication), the maximum attainable power level was N_L .
3-20-67	5.900	The reactor was shut down to facilitate repairs to instrumentation for the GCR-05 capsule. A power supply for a pressure transducer was found to be faulty following the power outage of this date, described above. Refueling was required.
3-23-67	0.267	The reactor power sagged below N_L following a setback initiated from the GCR-05 capsule instrumentation. The trouble again was traced to a power supply for a pressure transducer.
3-28-67	<u>0.100</u>	A voltage surge, apparently caused by an electrical storm, caused loss of power to the pool cooling pump, thus effecting a reverse.
	10.484	Total

Table 5. ORR Scheduled Shutdowns, Details

	Date	Duration (hr)	End Cycle	Remarks
B	1-8-67	179.367	70C	This shutdown terminated operating cycle 70. Experiment work included changes at eight experiment facilities. Of most interest were the installation of a new facility tube for the GCR Loop 1 experiment (core position B-1) and the insertion of the No. 2 molten salt loop at HN-1. A section of the suction line for the pool cooling pump was replaced because of corrosion which had occurred in the pool wall. ¹ The new line was routed through the south standpipe to the pipe chase. The core was found to be tight due to bowing of the aluminum core pieces in positions D-8 and A-7 (hydraulic tube 2 and N _F tray). ² These facilities were removed from the lattice, thus freeing the core.
	1-16-67	0.467	71A	The fuel element in core position A-8 was replaced with an aluminum core piece to lower the neutron flux in the B-8 experiment. The flux in the B-8 facility had been increased by core changes effected during the end-of-cycle 70 shutdown.
	1-30-67	0.217		This shutdown simulated an unscheduled shutdown (for training and a practice startup).
	1-30-67	13.783	71B	The reactor was shut down for refueling and limited experiment work, including the addition of a fueled salt to the molten salt loop.

¹See the Process Systems section of this report.

²See the Special Tests section of this report.

Table 5. (Continued)

	Date	Duration (hr)	End Cycle	Remarks
B	2-13-67	19.000	71C	The reactor was refueled and midcycle isotope work was done. Limited experiment work included piping repairs at the molten salt loop (cooling water lines) and wiring changes for special tests at the GCR Loop 1. Debris was found in the shock absorber for the No. 1 shim rod after prestartup checks revealed that the rod was hard to move while in the shock. The rod drive was changed as part of the routine examination program.
	2-24-67	0.283		An unscheduled shutdown was simulated for training purposes.
	2-24-67	4.567	71D	The reactor was refueled and limited experiment work was accomplished, including the installation of the test containment vessel for the fuel meltdown experiment (F-9) and the replacement of the crystal at the HB-5 facility. A simulated hydraulic-tube facility was installed in core position D-9.
B	3-5-67	126.017	71F	Operating cycle 71 was terminated. Experiment work included the removal, installation or replacement of experiments in eleven facilities, and minor alterations to three others. The D-8 hydraulic-tube system was returned to normal service after a new in-tank section was installed, replacing the unit which was removed in January because of neutron damage. Operations maintenance included the replacement of a portion of the discharge line for the pool cooling pump.

Table 6. Reductions in ORR Power Not Resulting in Shutdowns

Date	Source of Signal	Type of Signal	Lowest Power (Mw)	Comments
1-27-67 2-8-67 2-23-67 2-24-67 ^a	GCR Loop 1	Setback	27	A voltage fluctuation initiated one or more setbacks on each of the dates listed. The voltage fluctuation was caused by startup of the compressor for the building cooling system.
2-24-67	GCR Loop 1	Setback	25.5	A voltage fluctuation occurred when the building cooling unit was started.
2-27-67	F-9 Experiment (Reactor Division)	Setback	28	This was an intentional, routine setback to check a tie-in to the reactor controls.
2-27-67	GCR Loop 1	Setback	3	Abnormal loop conditions resulted from a temporary failure of the clutch for the motor-generator set supplying power to one of the loop compressors. The clutch functioned properly when re-engaged, and no further trouble was detected.
3-3-67	F-9 Experiment (Reactor Chemistry)	Setback	6	A thermocouple opened during a routine experiment removal procedure. The upscale burnout feature of the recorder resulted in the setback signal.
3-19-67	GCR Capsule 07	Setback	22.5	The capsule temperature overshoot the setback point after the startup of this date. The overshoot was, in part, a result of a change in shim-rod position due to xenon poisoning.
3-19-67	ORR Console	Manual	27	The power level was lowered to prevent further trouble with overshoot of temperatures at the GCR capsules (see above).

^aThere were two setbacks on this date.

INSTRUMENTATION AND REACTOR CONTROLS

Table 7. Maintenance and Changes, Reactor Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance	
Safety System				
1-9-67	Magnet amplifier No. 2A	Unit replaced	The amplifier failed electronically on January 7, 1967. Amplifier 2B assumed the load as designed, and the system was operated with one amplifier until January 9, 1967.	
1-9-67	Time-of-flight timer	Unit replaced	The timer would not stop upon receipt of a stop signal and was removed for repairs.	
B 1-9-67	Safety-level sigma amplifier	Drop point shifted	The power level at which an electronic scram occurs (drop point) was lowered from 1.45 N _F , the setpoint for 30 Mw, to 1.25 N _F , for performance evaluation. The safety system operated quite satisfactorily with the lower setpoint.	14
3-10-67	Safety-level sigma amplifiers	Drop point shifted	The drop point was returned to 1.45 N _F .	
No. 1 Count-Rate Channel				
1-25-67	Count-rate meter	Unit replaced	This change was prompted by excessive noise in the system which was corrected.	
B 1-30-67	Fission chamber drive	Broken shear pin	The shear pin was replaced and the unit returned to service. The break probably occurred because the chamber was moved with the pool water at grating level.	

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
3-1-67	Period recorder	Loose drive train	The mechanical portions of the recorder were adjusted and tightened.
No. 2 Count-Rate Channel			
B 1-31-67	Fission chamber drive	Stripped gears	The gears were replaced. Damage was probably due to running the unit dry, i.e., with water at the grating level.
3-22-67	Count-rate meter	Unit replaced	An electronic component of the unit failed.
No. 1 Log-N Channel			
		No trouble	No maintenance was necessary.
No. 2 Log-N Channel			
1-22-67 2-28-67 3-30-67	Log-N period channel	Noise spikes	Period spikes to $\pm$ ~50 seconds were recorded on the three dates listed. The exact cause of the spikes was not determined; however, such spikes are not unusual, and no changes were shown by other instrumentation.
1-25-67	Log-N amplifier	Unit replaced	This replacement was made as an attempt to reduce noise in the channel.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
No. 1 Safety Channel			
		No trouble	No significant maintenance was necessary.
No. 2 Safety Channel			
2-11-67		Upscale spikes	Unexplained upscale spikes, the largest to 1.04 N _F , occurred. The channel was disconnected from the sigma bus temporarily to facilitate an investigation. No obvious trouble was found, and the channel was returned to service.
B 3-30-67	Chamber	Removed from service	Erratic readout, accompanied by occasional spikes, prompted a check of the channel components. The chamber was found to be faulty. Operation with two safety channels was authorized in accordance with accepted procedures. The chamber (dual PCP-II), which serves the No. 2 log-N channel also, was scheduled for replacement on April 4, 1967.
No. 3 Safety Channel			
		No trouble	No maintenance was necessary.
Micromicroammeter Channel			
		No trouble	Maintenance was not necessary.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
No. 1 Gamma Channel (South)			
1-12-67	Chamber and chamber guide	Unit relocated slightly	This change was made to provide room for the relocation of the suction line for the pool cooling pump.
No. 2 Gamma Channel			
		No trouble	Maintenance was not necessary.
North ¹⁶ N Channel			
3-28-67	Micromicroammeter	Sensitivity adjustment	The adjustment was necessary because of an erratic output signal.
South ¹⁶ N Channel			
B 3-14-67	Chamber or chamber leads	Removed from service	Tests indicated that unusual spikes exhibited at the recorder were due to a faulty chamber or chamber lead. Repairs were scheduled for April 4, 1967.
Reactor Noise Monitor			
		No trouble	No maintenance was necessary.
Radiation Detection Instrumentation			
1-24-67	Cell-ventilation electrometer (building)	False high-radiation indications	Electronic tubes in the amplifier were replaced to correct the trouble.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
2-27-67	POG activity recorder	Faulty recorder amplifier	The unit was replaced with a spare. This action corrected erratic readout at the recorder.
3-17-67	Cell-ventilation electrometer (duct)	One upscale spike	There was no obvious reason for the trouble, and no maintenance was done.
3-20-67	Reactor secondary activity monitor	Extremely erratic	The sensing element, which had been found wet on March 2, 1967, was replaced, correcting the trouble.
Process Instrumentation			
1-30-67	Pony motor alarm system	Replaced contacting volt-meters and ammeters	Corrected damage due to wear and usage.
Miscellaneous Instrumentation			
1-9-67	High wind alarm	New installation	This alarm will alert operating personnel when high winds occur, thus facilitating the acquisition of containment data.

PROCESS SYSTEMS

Table 8. Process Systems, Maintenance and Changes

Date	Component	Remarks
Reactor Primary System		
1-9-67	No. 3 primary pump	Bushings in the motor-to-pump coupling were replaced because of wear.
1-11-67	No. 3 pump outlet check valve	This Mission check valve was inspected and found to be satisfactory for continued service. Some wear was observed around the shaft bearing.
2-6-67	Gasoline-driven emergency pump	All bearings and seals were replaced to lessen water leakage.
3-6-67	No. 2 pump outlet check valve	This valve was inspected and found to be in fair condition. The valve flappers were replaced with a new design incorporating Stellite bearing inserts.
3-7-67	Primary pumps	A lightning arrestor system was installed for motor protection.
3-9-67	No. 3 primary pump	The pump-to-motor alignment was adjusted.
B 3-10-67	No. 1 primary pump outlet check valve	Flow checks indicated that this valve was not closing properly. The follow-up inspection revealed that the north flapper was dragging against the inside of the pipe. New flappers with Stellite bearing inserts were installed.

Table 8. (Continued)

Date	Component	Remarks
Reactor Secondary System		
1-11-67 and 3-8-67	Reactor tower	The tower was thoroughly inspected on the two dates listed and was found to be in satisfactory repair. Vibration tests indicated no significant problems.
Pool Primary System		
A 1-9-67 to 1-14-67	Pool cooling pump suction line	The leak in this line, discovered during routine checks on December 16, 1966, was confirmed to be approximately three feet inside the concrete at the south side of the reactor pool. The line was rerouted through the south standpipe, utilizing an existing stainless steel experiment penetration to the pipe chase. The abandoned line was blanked off in the pool and pipe chase and an off-gas connection provided.
A 1-25-67	Pool cooling pump discharge line	Installation of a new stainless steel line from the pipe tunnel to the reactor pool was begun. This line, located outside the reactor pool structure, was designed to replace that portion of the pool cooling pump discharge line which penetrated the pipe chase and the concrete walls of the pool.
A 3-6-67 to 3-10-67	Pool cooling pump discharge line	The new stainless steel portion of this line was completed, integrated into the system, and found to be satisfactory.
Pool Secondary System		
1-13-67	Electrical power supply to pool tower	The supply was switched from a transformer near the tower to a plant service line. This change made it possible to remove the transformer, creating a safer and neater installation.

Table 8. (Continued)

Date	Component	Remarks
1-12-67	Tower fan motor	The motor was replaced with a spare. The old motor was scheduled for maintenance in the motor shop.
		Cell-Ventilation System
1-12-67	Building vacuum-relief louvers	New louvers were installed high on the east wall of the building. The louvers were designed to control the negative pressure in the building above the design limit of 1 inch of H ₂ O.
2-5-67	Building vacuum-relief louvers	The new louvers were tested, adjusted, and placed in service. Results of the tests are given in the Special Tests portion of this report.
3-7-67	Absolute filter banks	Tests indicated a DOP removal efficiency of 99.978 and 99.977% for the north and south banks, respectively.
		Pressurizable Off-Gas System
1-11-67	Filter pit	The pit was inspected. Approximately 2 inches of water had accumulated in the north bank (not in service). No water was found in the south bank. The water found was not deep enough to wet the filters and was successfully drained.
B 3-7-67	Absolute filters	Tests indicated a DOP removal efficiency of 99.991 and 99.995% for the north and south banks, respectively.
3-7-67	Filter pit	The pit was inspected for water accumulation. An insignificant amount of water was found in both the north and south banks. The pits were drained and the north bank was placed in service.

Table 8. (Continued)

Date	Component	Remarks
Building Emergency Generator		
1-11-67	Starter-protection circuit	The new starter-protection circuit was placed in service; however, the breaker proved too small. The circuit was returned to the former status, and a large breaker was ordered.

REACTOR MECHANICAL COMPONENTS

Rod drive assembly H was removed from the No. 1 position after debris was found in the shock absorber. The unit was found to be in good repair, with no excessive wear or corrosion evident. Disassembly and subsequent reassembly proceeded without difficulty. The lower plunger section was replaced because of indentions due to contact by the balls. These indentions were later determined to be rather insignificant, and the plunger section was placed in standby as a spare part.

FUEL

Table 9. ORR Fuel Status

	This Quarter	Last Quarter	Year To Date
Depleted fuel elements transferred for chemical separation	54	45	54
Average % burnup of fuel elements	35.8	34.8	35.8
New fuel elements placed in service	19	25	19
New fuel elements available for use	249 (4)*	178 (4)*	
Depleted shim rods transferred for chemical separation	2	4	2
Average % burnup of shim rods	64.3	56.7	64.3
New shim rods placed in service	4	2	4
New shim rods available for use	2	4	2
New shim rod fuel sections available for use	15	19	

*The number of partial fuel elements is included in each total and is also given in parentheses.

EXPERIMENT FACILITIES AND LATTICE CONFIGURATION

Table 10. ORR Facilities Assignment

Facility	Access Flange	Nature of Experiment	Division or Other Sponsor
Lattice Positions			
A-1*	V-11	On standby	Operations
A-2	V-11	Uninstrumented and instrumented capsule irradiations	General Electric
F-5 and F-7		Radioisotope production	Isotopes
A-7		Fast neutron irradiations	Reactor Chemistry
A-9	V-2	Fuel tests	Reactor Chemistry
B-1	V-10	Gas-cooled loop No. 1	Reactor
B-8	V-1	Radiation-damage studies	Metals and Ceramics
B-9	V-2	Fuel tests	Reactor Chemistry
C-1	V-9	Fuel tests	Reactor Chemistry
C-3		(Half-fuel position, on standby)	Solid State
D-8	V-3	Hydraulic-tube No. 2	Isotopes--Chemistry
F-1	V-8	On standby	Reactor
F-2	V-6	Fuel tests, radiation damage tests	General Electric
F-3	V-7	Fuel-meltdown test samples, irradiation only	Reactor Chemistry
F-8	V-4	Hydraulic-tube No. 1	Isotopes--Solid State
F-9	V-5	Fuel-meltdown tests	Reactor Chemistry
Poolside Positions			
P-1, P-2, P-3, P-7, P-8, P-9		GCR capsule irradiations	Reactor

* Final experiment installation is incomplete.

Table 10. (Continued)

Facility	Access Flange	Nature of Experiment	Division or Other Sponsor
P-4		Radiation-damage studies	Metals and Ceramics
P-5		Radiation-damage studies	Metals and Ceramics
P-6		Radiation-damage studies	Solid State
Large Facilities			
HN-1		Molten salt loop experiment	Reactor Chemistry
HN-2		Pneumatic tube for high-speed rabbits (activation analysis)	Chemistry
HN-3		Pneumatic tube for activation analysis	Chemistry--Analytical Chemistry
HN-4		Neutron spectrometer	Solid State
HS		Gas-cooled loop No. 2 (on standby)	Reactor
Beam Holes			
HB-1		Fission fragments studies	Physics
HB-2		Neutron spectrometer	Solid State--Physics
HB-3		Neutron spectrometer	Solid State
HB-4		Neutron spectrometer	Chemistry
HB-5		Neutron spectrometer	Physics
HB-6		Time-of-flight (neutron spectrometer)	Physics

Table 11. Facility and/or Lattice Changes

	Facility or Lattice Position	Date	Remarks
A	Hydraulic tube No. 2 (D-8)	1-11-67	This facility was removed from the tank after it was found to be the cause of binding in the lattice. A new core piece and lead tube was fabricated and installed on March 10, 1967. The core piece from the old facility was found to be bowed. Details of contour measurements are presented in the Special Tests section of this report.
A	N _F tray (A7)	1-14-67	The hollow aluminum core piece for this facility was found to be bowed excessively and was not removed until January 30, 1967, when a replacement was installed. Beryllium was installed in this position during the interim.
	B-1	1-15-67	The in-pile section of the GCR loop experiment was installed.
	A-3	1-14-67	The iodine production facility was transferred to the F-7 core position. Beryllium was installed in core position A-3.
	C-2	1-14-67	Beryllium in this position was replaced with fuel.
	D-1	1-14-67	Fuel in this position was replaced by beryllium.
	E-1	1-14-67	Fuel in this position was replaced by beryllium.
	A-8	1-16-67	Fuel in this position was replaced with a solid aluminum piece.
B	D-9	2-24-67	Beryllium in this position was replaced with the N _F tray (from position A-7) thus simulating a hydraulic-tube facility in D-9. The N _F tray was replaced during this interval by a solid aluminum core piece. This move was made to provide information for experimenters at the HN-4 facility.

Table 12. Experiment Facility Usage

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
A-2	2-2-67		ORM-53 tensile and bend specimens of refractory metals	General Electric
A-3	1-1-67	1-14-67	Iodine production	Isotopes
A-7	1958*	1-14-67	Fast neutron irradiation facility (old holder)	Isotopes
A-7	1-30-67	2-24-67	Fast neutron irradiation facility (new holder)	Reactor Chemistry
A-7	3-10-67		Fast neutron irradiation facility (new holder)	Reactor Chemistry
A-9	9-23-66	1-8-67	Capsule A9-8, pyrolytic carbon coated UO_2 particles (0.212 g ^{235}U)	Reactor Chemistry
A-9	1-15-67	3-5-67	Capsule A9-9, carbon coated UO_2 and UC particles (0.18 g ^{235}U)	Reactor Chemistry
A-9	3-10-67		Capsule A9-10, pyrolytic carbon coated UO_2 (0.288 g ^{235}U)	Reactor Chemistry
B-1	1-15-67		The facility tube was installed	Reactor
B-1	3-10-67		Experiment No. 16 containing ~7.5 g of ^{235}U (heat generation ~11 kw) was installed.	Reactor
B-8	11-19-66	1-8-67	ORR-174, 64 stainless steel tensile specimens	Metals & Ceramics
B-8	1-15-67		ORR-176, 96 stainless steel tensile specimens	Metals & Ceramics
B-9	9-22-66	1-8-67	Capsule B9-32, pyrolytic carbon coated UO_2 (0.23 g ^{235}U)	Reactor Chemistry
B-9	1-15-67	3-5-67	Capsule B9-33, pyrolytic carbon coated UO_2 (0.16 g ^{235}U)	Reactor Chemistry
B-9	3-10-67		Capsule B9-34, pyrolytic carbon coated UO_2 and UC particles (0.153 g ^{235}U)	Reactor Chemistry

*Exact installation date not known.

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
C-1	2-9-66		Capsule C1-18, hollow cylinder of UO_2 (0.1 g ^{235}U) irradiated throughout the quarter	Reactor Chemistry
D-8	12-18-63	1-11-67	Hydraulic-tube No. 2 used for isotope production and short-term irradiation	Isotopes
D-8	3-10-67		Hydraulic-tube No. 2 used for isotope production and short-term irradiation. (new in-tank section)	Isotopes
F-2	11-19-66	1-8-67	ORR-F2 - refractory fuel test containing ~3 g ^{235}U	General Electric
F-2	3-10-67		ORR-F3 - refractory fuel test containing ~3 g ^{235}U	General Electric
F-3, position 1	3-10-67		Capsule 7A, 5.965 g of UO_2 (10.5% enriched) Zircaloy clad	Reactor Chemistry
F-3, position 2	3-10-67		Capsule 8A, 5.910 g of UO_2 (10.5% enriched) Zircaloy clad	Reactor Chemistry
F-3, position 4	3-10-67		Capsule 9A, 5.971 g of UO_2 (10.5% enriched) Zircaloy clad	Reactor Chemistry
F-7	1-14-67		Icdire production facility, transferred from A-3	Isotopes
F-8	6-2-64		Hydraulic-tube No. 1 for isotope production and short-term irradiation	Isotopes
F-9	11-19-66	1-4-67	FS-2 high burnup capsule experiment No. 2 UO_2 and UC in stainless steel primary container	Reactor
F-9	2-2-67	2-9-67	FS-2 high burnup capsule experiment No. 2	Reactor
F-9	2-15-67	2-27-67	FS-2 high burnup capsule experiment No. 2	Reactor
B F-9	2-27-67	3-3-67	FS fuel meltdown experiment (containment No. 1)	Reactor Chemistry

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
F-9	3-10-67		F9-2 high burnup capsule experiment No. 2 UO ₂ and UC ₂ in stainless steel primary container	Reactor
GCR-3	3-13-65		03-9 (MPRE capsule) UO ₂ fuel in stainless steel can with NaK blanket, irradiated throughout the quarter	Reactor
GCR-4	1-23-67	1-25-67	04-2 flux monitors	Reactor
GCR-4	1-25-67	1-27-67	04-3 flux monitors	Reactor
GCR-4	1-27-67	1-29-67	04-4 flux monitors	Reactor
GCR-4	3-10-67		04-P6 fast gas capsule containing ~18 g of ²³⁹ Pu and ~8 g of ²³⁵ U	Reactor
GCR-5	1-23-67	1-25-67	05-2 flux monitors	Reactor
GCR-5	1-25-67	1-27-67	05-3 flux monitors	Reactor
GCR-5	1-27-67	1-29-67	05-4 flux monitors	Reactor
GCR-5	3-10-67		05-11 capsule experiment	Reactor
GCR-7	10-21-65		Capsule 07A-10, extensiometer experiment UO ₂	Reactor
P4	11-19-66	1-8-67	ORR-173, 32 stainless steel tensile specimens	Metals & Ceramics
P4	1-15-67	3-5-67	ORR-177, 32 stainless steel tensile specimens	Metals & Ceramics
P4	3-10-64		ORR-182, 96 tensile specimens, Hastalloy, Incoloy, and stainless steel	Metals & Ceramics
P4 ^a	2-22-66	3-5-67	Cu crystals, Cd covered	Solid State (Hulett)
P5	11-19-66	1-8-67	Experiment ORR-171, 10 INOR-8 tube-burst specimens and 70 fatigue specimens	Metals & Ceramics
P5	1-15-67	3-5-67	ORR-178, 10 INOR tube-burst specimens	Metals & Ceramics

^aFirst piggy-back experiment

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
P5	3-10-67		ORR-183, 6 graphite bend-test specimens	Metals & Ceramics
P5 ^a	11-19-66	1-8-67	Experiment ORR-175, 47 stainless tensile specimens and 42 shim specimens	Metals & Ceramics
P5 ^a	1-15-67	3-5-67	ORR-180, 47 stainless steel tensile specimens	Metals & Ceramics
P5 ^a	3-10-67		ORR-185, ladder-type experiment containing 47 tensile specimens	Metals & Ceramics
P5 ^b	1-20-66	1-22-67	Semiconductors with flux monitors for Fundamental Methods Incorporated	Isotopes
P5 ^b	2-3-67	2-4-67	Semiconductors with flux monitors for Fundamental Methods Incorporated	Isotopes
P5 ^b	2-11-67	2-12-67	Semiconductors with flux monitors for Fundamental Methods Incorporated	Isotopes
P6	11-19-66	1-8-67	ORR-172, 10 INOR-8 tube-burst specimens	Metals & Ceramics
P6	1-15-67	3-7-67	ORR-179, 10 stainless steel tensile specimens	Metals & Ceramics
P6	3-10-67		ORR-134, 5 Mo creep specimens	Metals & Ceramics
P6 ^a	1-15-67	3-5-67	ORR-131, 47 stainless steel tensile specimens	Metals & Ceramics
P6 ^a	3-10-67		ORR-136, 47 stainless steel tensile specimens	Metals & Ceramics
Other pool-side	1-27-67	1-27-57	Flux monitors - for study of feasibility of using poolside for a pneumatic-tube installation (see Special Tests section)	Reactor Chemistry
HN-1	1-15-67		Molten salt loop No. 2	Reactor Chemistry

^aFirst piggy-back experiment^bSecond piggy-back experiment

Fig. 4 Research Assignments and Fuel Loading 3-31-67

SPECIAL TESTS

Water Content of the Purging Air at the Entrances and Exits
of the ORR Beam-Hole Liners - January 17, 1967

J. M. Miller

A deposit of white powder, principally aluminum oxide, was recently found in the bottom of the HB-1 liner.¹ A careful inspection revealed that there was no significant corrosion damage to the liner; however, speculation as to the source of the material prompted an investigation to determine the amount of water, if any, being deposited in the liner from the continuous air purge.

The purge is provided by drawing basement ambient air through the beam-hole liners to off-gas. A Drierite column is connected to the inlet line; however, the effectiveness of the column is doubtful. A test was designed to determine the amount of water entering the liners with the air stream, as compared with the amount leaving.

A wet test meter was used to measure the volume of air flow. A Nesbitt bulb, which was filled with $\text{Mg}(\text{ClO}_4)_2$, was used to measure the water content.

Two measurements were made at each available liner using the apparatus shown in Figure 5. The first measured the H_2O content of the liner's exit air. In this measurement, the Nesbitt bulb and the wet test meter were connected in series between the exit of the liner and the off-gas line. In the second, which measured the H_2O content of the entrance air, the Nesbitt bulb was connected between the Drierite column and the liner entrance; the wet test meter was connected between the exit side of the liner and the off-gas line.

The data presented in Table 13 indicate that very little water, if any, is accumulating in the liners as a result of the continuous purge of ambient air.

¹W. H. Tabor and S. S. Hurt, III, Oak Ridge Research Reactor Quarterly Report - July, August, and September of 1966, ORNL TM-1791 (March 1, 1967).

Table 13. Water Content of Beam Hole Liner Purge Air

Beam Hole	Location	Run Time (Min)	Volume of Air (Liters)		Weight of H ₂ O in Air		Amount of H ₂ O in Air (mg/liter)
			Run	Per Hour	Run	Per Hour	
HB-2	Exit	43	162.6	226.8	555.0	774.2	3.41
HB-2	Entrance	30	127.0	254.0	388.9	777.8	3.06
HB-3	Exit*	30	31.2	62.4	0.1	0.2	<0.01
HB-3	Entrance	30	158.6	317.2	476.1	952.2	3.00
HB-4	Exit	30	159.0	318.0	504.6	1009.2	3.17
HB-4	Entrance	30	140.4	280.8	465.7	931.4	3.32
HB-5	Exit	30	108.0	216.0	365.5	731.0	3.38
HB-5	Entrance	30	125.6	251.2	381.3	762.6	3.04

*The data for the HB-3 exit air stream is thought to be in error.

Fig. 5. Apparatus for Measuring Water Content of Purge Air -
ORR Beam Hole Liners

Reactivity Worth Measurements

T. P. Hamrick

Several reactivity worth measurements were made by noting the change in critical rod position caused by the insertion or removal of standard and special core components as described in Table 14. From the data, it is readily evident that the worth of the 241 cubic centimeter void in core positions D7 and C5 is -0.04 and -0.10% $\Delta k/k$, respectively. Since these positions represent high- and low-worth areas of the core, the average of the two values (0.07% $\Delta k/k$) may be assumed to approximate the average for the core. The void coefficient for the fuel region, then, for rather large voids in an average position ($\bar{\Phi}_1/\bar{\Phi}_c = 1.000$) is $-2.9 \times 10^{-4}\%$ $\Delta k/k/\text{cm}^3$.

Table 14. Results of Reactivity Worth Tests

Lattice Position	Worth % $\Delta k/k$	Measurement Made
D-2	-1.49	A 240-gram element was replaced by water.
B-2	-1.15	A standard beryllium-reflector piece was replaced by water.
D-7	+0.14	Water in the experiment opening of a standard ORR partial element (half-fuel element) was replaced by a solid aluminum "bayonet". ($\bar{\Phi}_1/\bar{\Phi}_c$ for this position is 1.008).
D-7	+0.10	Water in the experiment opening of a half-fuel element was replaced by a hollow aluminum "bayonet".
C-5	+0.20	Water in the experiment opening of a half-fuel element was replaced by a solid aluminum "bayonet". ($\bar{\Phi}_1/\bar{\Phi}_c$ for this position is 1.444).
C-5	+0.10	Water in the experiment opening of a half-fuel element was replaced by a hollow aluminum "bayonet".

Beryllium and Aluminum Damage Measurements, February, 1967

M. Saito* and S. S. Hurt

Damage to the aluminum section of the aluminum-cadmium shim rods from core positions F-4 and F-6 was reported in the previous quarterly report.¹ As in the case of beryllium, the damage takes the form of bowing due to the elongation of the side adjacent to the fuel. More recently, bowing of the aluminum N_F facility and the aluminum hydraulic-tube facility was confirmed. Data relative to aluminum damage measured to date is summarized in Table 15, and plots of the contour measurements for the N_F tray and the No. 2 hydraulic tube are shown in Figures 6 and 7.

Several beryllium pieces were also measured as a check of the effectiveness of the beryllium management program. While bowing of the beryllium has not been completely eliminated, the program has at least prevented any appreciable increase in damage to those units which have been checked. Previous bowing measurements are compared with the measurements made in February, 1967, in Table 16.

In general, bowing or correction of bowing has progressed as expected. Those hollow beryllium pieces used to house the ¹³¹I production sleeves (fuel sleeves ~2 in. in diameter), specifically Be R3 and Be RA3, tend to become concave on all four sides. Apparently, this effect is due to a higher fast flux within the hollow of the beryllium caused by fissions within the fuel sleeve. The beryllium management program will be altered to attempt to correct this damage, and future measurements will include a check of the internal dimensions of such hollow beryllium pieces.

* Alien guest in training from Japan.

¹ W. H. Tabor and S. S. Hurt, The Oak Ridge Research Reactor Quarterly Report - October, November, and December of 1966, ORNL TM-1843 (April 28, 1967).

Fig. 6. Contour Measurement of N_F Tray, Core Position A-7

Fig. 7. Contour Measurement of Hydraulic Tube Facility, Core Position D-8

Table 15. Irradiation Histories and Bowing Measurements
of Aluminum Lattice Components in the ORR

Component	Lattice Position	Mwd in Core	Bowing (10^{-3} inches)	Fast Flux NVT* >1.0 Mev
Al shim rod Al-3	F6	21,491	38.5	9.97×10^{21}
Al shim rod Al-4	F4	21,491	30.4	9.22×10^{21}
Hydraulic tube No. 2	D8	28,711	29.0	1.10×10^{22}
N _F tray	A7	~67,549	60.0	1.80×10^{22}

* Flux estimates are based on measurements at the outer edge of a fuel element adjacent to a beryllium reflector piece, as reported by H. A. O'Brien, Jr.¹

Flux Measurements at the Poolside P9 Position - January 27, 1967

The poolside P9 position has been proposed as an alternate location for the failed HN-2 pneumatic tube. Some doubt concerning the flux available at this position prompted measurements described herein.

Flux monitors were attached to a specially-constructed holder so as to provide three vertical traverses at varying distances from the reactor tank (poolside window) and one horizontal traverse at the reactor center-line. Only thermal flux measurements were made, as shown in Figure 8.

Xenon Growth Following A Power Reduction from 30 Mw to N_L

The growth of xenon poisoning was measured in terms of gang rod position for rods 3, 4, 5, and 6 as a function of time after power reduction. The data, presented as Figure 9, were accumulated on August 10, 1966, but were not previously reported.

¹H. A. O'Brien, Jr., Fast and Thermal Neutron Flux Measurements in the ORR and LITR, ORNL-TM-1163, (January, 1966).

Fig. 8. Flux Measurements at Poolside P9 Position

Fig. 9. Gang Rod Position Versus Time Following a Power Reduction From 30 Mw to N_L

Table 16. Bowing Measurements, ORR Beryllium, February, 1967

No./Type	Date Measured	Irradiation History				Bowing Measurements*			
		North Side	South Side	East Side	West Side	North Side	South Side	East Side	West Side
R3/hollow	2-12-64	Unknown	Unknown	Unknown	Unknown	-5.4	+7.8	+2.8	-2.6
	2-15-67	13 months, A3 and F1	None	6 months, A3	12 months, F1	-4.3	+1.2	-5.0	+2.8
R4/hollow	8-11-64	Unknown	Unknown	Unknown	Unknown	-3.0	+7.0	-10.0	+15.0
	2-16-67	17 months, C2 and B2	3 months, A3	15 months, C2 and A3	4 months, A5	-3.0	-3.5	-14.7	+13.0
R8/hollow**	8-11-64	Unknown	Unknown	Unknown	Unknown	+2.0	0.0	-14.0	+17.0
	2-10-67	None	None	None	None	-1.7	-3.5	-13.0	+12.5
R9/hollow	2-12-64	Unknown	Unknown	Unknown	Unknown	+2.7	+2.0	+2.0	-2.8
	2-14-67	9 months, D9	14 months, D9 and B2	6 months, B2	3 months, F7	-5.7	+2.6	-2.4	-2.9
R14/hollow**	8-11-64	Unknown	Unknown	Unknown	Unknown	-9.0	+11.0	+15.0	-10.0
	2-10-67	None	None	None	None	-9.0	+7.0	+10.0	-13.0
R16/solid	8-11-64	Unknown	Unknown	Unknown	Unknown	-2.0	0.0	-10.0	+10.0
	2-15-67	8 months, E5	10 months, E9	None	None	-3.9	+1.6	-10.5	+7.5
R18/solid	8-11-64	Unknown	Unknown	Unknown	Unknown	-5.0	+7.0	-1.0	+6.0
	2-15-67	8 months, A1	None	8 months, A1	18 months, G4	-9.0	+3.0	-7.0	+6.0
R20/solid	2-11-64	Unknown	Unknown	Unknown	Unknown	+4.0	+1.5	+4.5	-1.7
	2-14-67	None	None	None	30 months, G3	0.0	-4.0	-4.0	+2.0
R26/solid	8-11-64	Unknown	Unknown	Unknown	Unknown	+2.0	0.0	-3.0	+7.0
	2-14-67	None	None	None	18 months, G5	0.0	-2.6	-5.4	+4.8
R30/solid	8-11-64	Unknown	Unknown	Unknown	Unknown	+5.0	-7.0	-3.0	+5.0
	2-14-67	6 months, D9	17 months, D9	None	4.5 months, F7	+11.0	-15.0	-10.0	+5.0
RA3/hollow	2-14-67	6 months, A3	None	6 months, A3	15 months, G6	-2.0	-6.0	-3.0	-2.0

* Thousandths of an inch.

** R8 and R14 were not used in the core between measurements, and thus serve as controls. Measurements apparently agree to within ± 0.004 inches; however, the recent measurements are thought to be more accurate because of refinements to the measuring apparatus and methods.

Tests of New Relief Louvers (East Wall)

The building was placed in containment, and the old louvers on the first level, north and south, were taped closed. The out-flow of air was increased above normal containment conditions by running first one and then two overhead exhaust fans. Building negative pressures observed under these conditions are reported in Table 17. The new louvers were placed in service, without further adjustment, and the old louvers at the first level, south, were reset to open at a pressure of -0.5 in. of H_2O . These settings have proven to be quite satisfactory under all operating and test conditions encountered to date.

Table 17. Test Data New Relief Louvers, January 31, 1967

Condition for Tests	Negative Pressures (Inches of H_2O)			
	First Level South	First Level North	Second Level West	Third Level West
Normal containment mode	0.40	0.42	0.38	0.40
Containment plus one exhaust fan	0.55	0.50	Offscale*	0.52
Containment plus two exhaust fans	0.68	0.62	Offscale*	No data

*Range 0 to -0.5 inches of H_2O .

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