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OAK RIDGE
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MARTIN MARIETTA

Oak Ridge Research Reactor Quarterly Report January, February, and March 1986

T. P. Hamrick
M. K. Ford

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Operations Division
Reactor Operations Section

OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT JANUARY, FEBRUARY, AND MARCH 1986

T. P. Hamrick
M. K. Ford

SPONSOR: J. H. Swanks
Operations Division

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OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT
JANUARY, FEBRUARY, AND MARCH 1986

SUMMARY

The ORR operated at an average power level of 29.8 MW for 75.9% of the time during January, February, and March of 1986.

The reactor was shut down on eleven occasions, five of which were unscheduled. Reactor downtime needed for refueling and checks was normal. The reactor remained available for operation 96.7% of the time.

Maintenance activities, both mechanical and instrument, were essentially routine in nature.

Special tests completed during the quarter included: (1) the RERTR whole-core demonstration, initiated this quarter through transitional insertions of low-enriched fuel elements on demand (two per fuel cycle), and (2) core physics measurements, completed during the quarter to gather purposeful data to accomodate the RERTR whole core demonstration.

POWER HISTORY

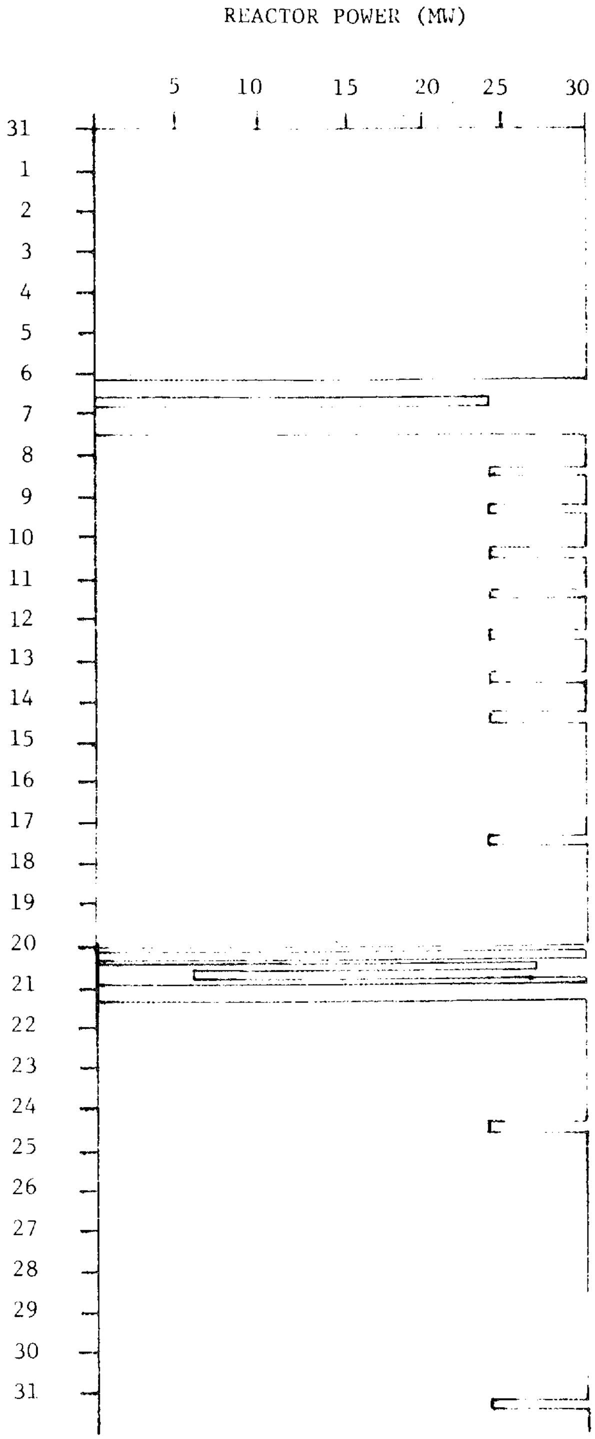
The power history for the quarter is displayed in Figs. 1 through 3.

OPERATIONS

The basic operating data presented in Table 1 indicate that the ORR operation for the quarter was normal.

Details relative to cycles of operation during the quarter are given in Table 2.

ORNL/DWG-86-11157



1-6	4:00 a.m.	Down (End cycle 174-C)
1-6	6:25 p.m.	24 MW
1-6	7:26 p.m.	Down (Plugged gas line, MFE-7J)
1-7	4:38 p.m.	30 MW
1-8	8:36 a.m.	24 MW (MFE-7J continuity test)
1-8	8:41 a.m.	30 MW
1-9	8:08 a.m.	24 MW (MFE-7J test)
1-9	8:14 a.m.	30 MW
1-10	8:10 a.m.	24 MW (MFE-7J test)
1-10	8:15 a.m.	30 MW
1-11	8:24 a.m.	24 MW (MFE-7J test)
1-11	8:30 a.m.	30 MW
1-12	8:03 a.m.	24 MW (MFE-7J test)
1-12	8:14 a.m.	30 MW
1-13	8:28 a.m.	24 MW (MFE-7J test)
1-13	8:33 a.m.	30 MW
1-14	8:30 a.m.	24 MW (MFE-7J test)
1-14	8:33 a.m.	30 MW
1-17	8:18 a.m.	24 MW (MFE-7J test)
1-17	8:24 a.m.	30 MW
1-20	8:20 a.m.	Down (Dropped rods checking safety system)
1-20	8:43 a.m.	30 MW
1-20	10:23 a.m.	Down (Dropped rods checking safety system)
1-20	10:50 a.m.	27 MW
1-20	10:53 a.m.	6 MW (Setback outlet temperature recorder)
1-20	11:22 a.m.	30 MW
1-20	12:44 p.m.	Down (Dropped rods checking safety system)
1-21	10:06 a.m.	30 MW
1-24	8:31 a.m.	24 MW (MFE-7J test)
1-24	8:37 a.m.	30 MW
1-31	8:15 a.m.	24 MW (MFE-7J test)
1-31	8:20 a.m.	30 MW

Fig. 1. Reactor power history - January 1986.

ORNL/DWG-86-11156

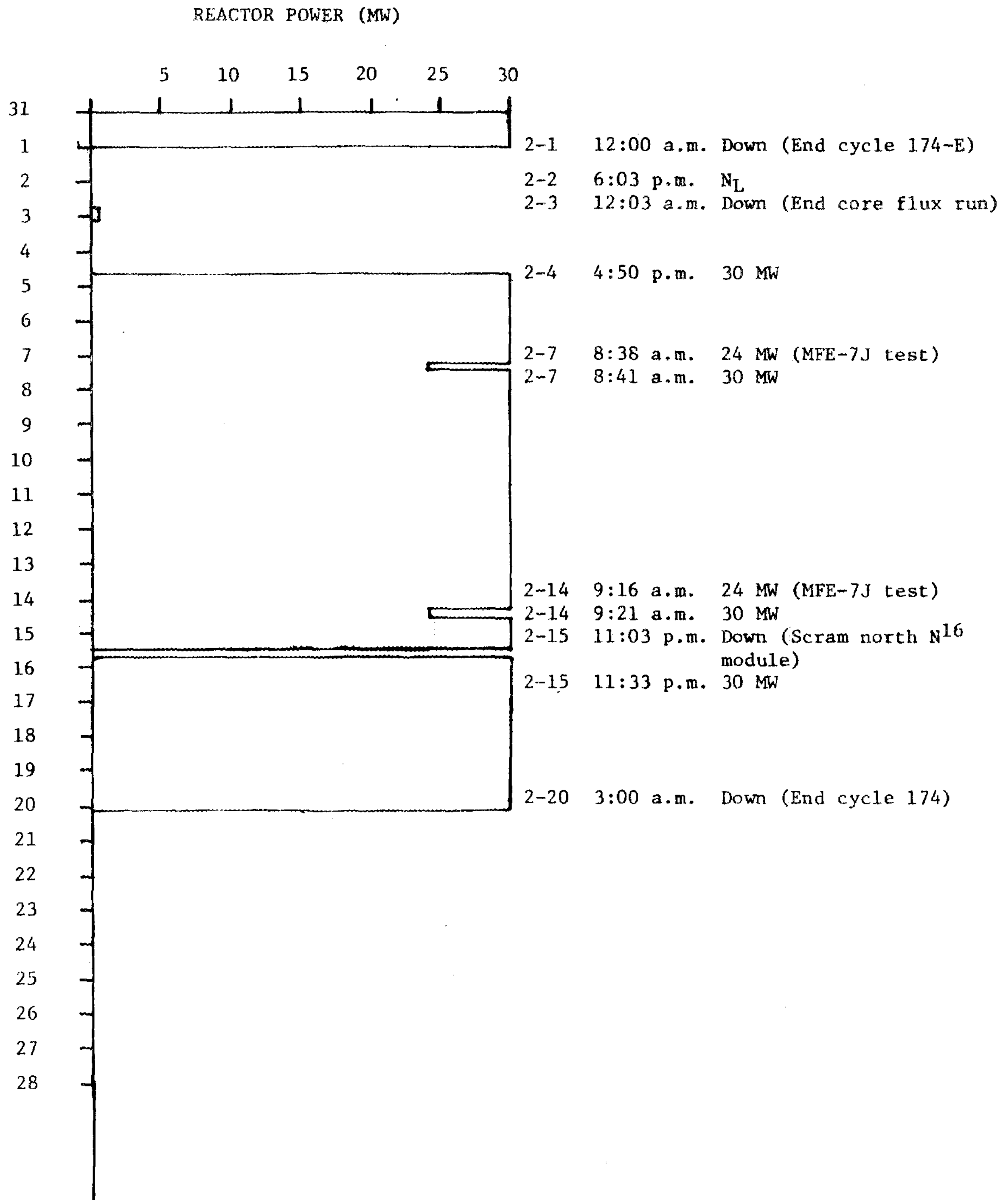


Fig. 2. Reactor power history - February 1986.

ORNL/DWG-86-11158

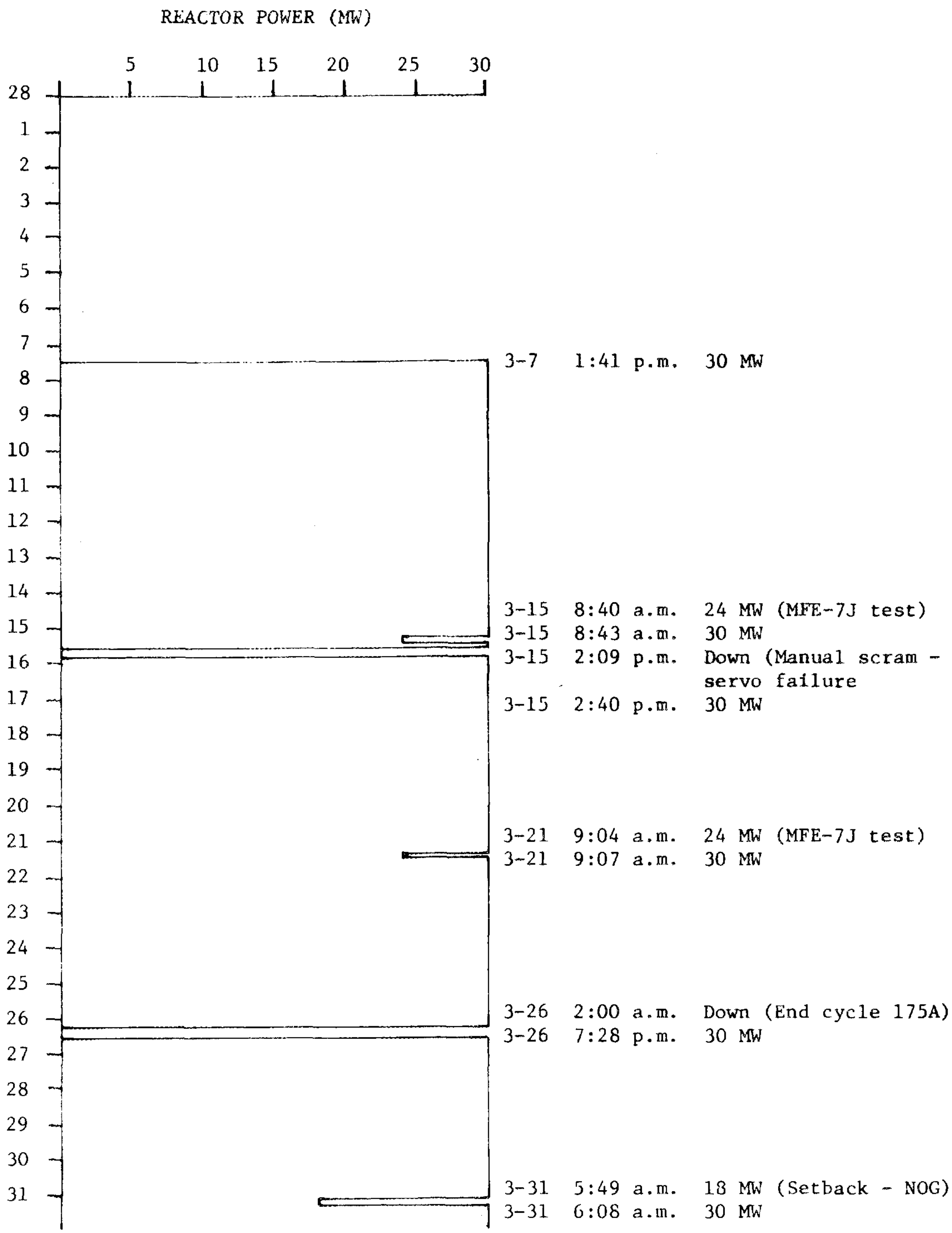


Fig. 3. Reactor power history - March 1986.

Table 1. Basic operating data
(January-March 1986)

	This quarter	Last quarter	Jan.-March 1986	Jan.-March 1985
Total energy, MWd	2,034.1	1,787.6	2,034.1	1,929.8
Average power, MW	29.8	29.7	29.8	29.9
Time operating, %	75.9	65.5	75.9	71.8
Availability, %	96.7	73.3	96.7	74.1
Reactor water radioactivity, cpm/ml (av)	38,400	33,900	38,400	32,000
Pool water radioactivity, cpm/ml (av)	1,280	1,180	1,280	870
Reactor water resistivity, ohm-cm (av)	1,249,000	1,182,000	1,249,000	1,444,000
Pool water resistivity, ohm-cm (av)	933,000	963,000	933,000	1,145,000
Fuel elements depleted	14	13	14	14
Average burnup of fuel elements depleted, %	48.5	47.7	48.5	43.4
Shim-safety rods depleted	2	2	2	2
Average burnup of shim-safety rods depleted, %	77.5	77.5	77.5	83.0
Radioisotope samples	0	0	0	0
Research samples	37	6	37	0

Table 2. Cycles of operation

Cycle No.	Date begun	Date ended	Accumulated energy (MWd)
174	November 27, 1985	February 20, 1986	1,321.8[a]
175	March 7, 1986	In progress	712.3

[a]MWd this quarter

FUEL USAGE AND INVENTORY

HIGH-ENRICHED URANIUM (HEU)

Two new HEU fuel elements and shim safety rods were placed in service this quarter.

LOW-ENRICHED URANIUM (LEU)

Twenty-seven new LEU fuel elements and four new LEU shim-safety rods were placed in service this quarter. Sixty-one new LEU fuel elements[a] and twelve new LEU shim-safety rods were received from the vendor.

Other details of fuel usage and inventory may be found in Table 3.

[a]Twenty new LEU fuel elements were received during the fourth quarter of 1985. This brings the total number of LEU elements received at eighty-one.

Table 3. Fuel status

	This quarter	Last quarter	Jan.-March 1986	Jan.-March 1985
<u>HEU</u>				
Depleted fuel elements transferred for chemical recovery	0	31	0	0
Average percent burnup of fuel elements transferred	—	46.9	—	47.9
New elements start of quarter	141	142	141	54
New elements received	0	15	0	21
New elements placed in service	2	16	2	17
New elements end of quarter	139	141	139	58
Special or test elements	21	21	21	21
Depleted shim-safety rod elements transferred for chemical recovery	0	3	0	4
Average percent burnup of shim-safety rods transferred	0	73.3	0	79.3
New shim-safety rod elements start of quarter	10	12	10	7
New shim-safety rod elements received	0	0	0	2
New shim-safety rod elements placed in service	2	2	2	2
New shim-safety rod elements end of quarter	8	10	8	7

Table 3. (continued)

	This quarter	Last quarter	Jan.-March 1986	Jan.-March 1985
LEU				
Depleted fuel elements transferred for chemical recovery	0	0	0	0
Average percent burnup of fuel elements transferred	--	--	--	--
New elements start of quarter	20	0	20	0
New elements received	61	20	61	0
New elements placed in service	27	0	27	0
New elements end of quarter	54	20	54	0
Special or test elements	0	0	0	0
Depleted shim-safety rod elements transferred for chemical recovery	0	0	0	0
Average percent burnup of shim-safety rods transferred	--	--	--	--
New shim-safety rod elements start of quarter	0	0	0	0
New shim-safety rod elements received	12	0	12	0
New shim-safety rod elements placed in service	4	--	4	--
New shim-safety rod elements end of quarter	8	--	8	--

SHUTDOWNS AND POWER REDUCTIONS

Reactor downtime (power level $<N_L$) totaled approximately 520 hours. A summary of the shutdowns is given in Table 4, and details of each scheduled shutdown are contained in Table 5. Table 6 describes unscheduled shutdowns, while Table 7 describes power reductions which did not result in shutdowns.

Table 4. Analysis of shutdowns

Description of shutdown	Number	Downtime (h)
Scheduled		
Regular, end of cycle	1	368.417
Regular, refueling and experiment	2	29.900
Special, refueling and flux measurements	2	81.950
Subtotal:	5	480.267
Unscheduled		
Equipment failure, experiment	1	20.033
Instrument failure, reactor	5	19.450
Subtotal:	6	39.483
TOTAL:	11	519.750

Table 5. Scheduled shutdowns, details

Date	Duration (h)	End cycle	Remarks
1-6-86	14.150	174C	The reactor was refueled and measurements were made on the HFED experiment
2-1-86	42.050	174E	The reactor was refueled and flux monitors were loaded for a whole-core flux map
2-3-86	39.900	—	Completed a six-hour core flux map run at N_L. HFED was reconfigured and measured
2-20-86	368.417	174	Shutdown activities included: (1) refueling, (2) cleaning the primary side of the pool heat exchanger, and (3) completed various measurements for the low-enriched fuel program
3-26-86	15.733	175A	The reactor was refueled and the HSST experiment retracting mechanism repaired

Table 6. Unscheduled shutdowns, details

Date	Duration (h)	End cycle	Remarks
1-6-86	20.033	---	The gas sweep line on the MFE-7J experiment became plugged during reactor startup. The reactor was shut down until repairs could be made
1-20-86	0.217	---	Rods 1 and 5 dropped when the safety system channel B was checked for chamber undervoltage
1-20-86	0.233	---	Rods 1, 5, and 6 dropped when safety system channel B was checked for chamber undervoltage(s)
1-20-86	18.417	174D	All rods were dropped when the safety system channel C chamber undervoltage monitor was checked
2-15-86	0.250	---	Received a scram when a spike on the north ^{16}N channel occurred
3-14-86	0.333	---	The reactor was manually scrammed when the servo chamber power supply failed

Table 7. Reductions in power not resulting in shutdowns

Date	Source of signal	Type of signal	Lowest power (MW)	Comments
1-8-86 thru 1-14-86	Manual	Demand decrease	24	The power was momentarily lowered each day for pressure continuity checks on MFE-7J
1-17-86	Manual	Demand decrease	24	The power was momentarily lowered for MFE-7J continuity checks
1-20-86	Outlet temperature	Setback	6	The secondary bypass valve failed open, resulting in a setback from reactor outlet temperature
1-24-86	Manual	Demand decrease	24	The power was momentarily lowered for MFE-7J continuity checks
1-31-86	Manual	Demand decrease	24	Power was momentarily lowered for MFE-7J continuity checks
2-7-86	Manual	Demand decrease	24	Power was momentarily lowered for MFE-7J continuity checks
2-14-86	Manual	Demand decrease	24	The power was momentarily lowered for MFE-7J continuity checks
3-14-86	Manual	Demand decrease	24	Power was momentarily lowered for MFE-7J continuity checks
3-21-86	Manual	Demand decrease	24	Power was momentarily lowered for MFE-7J continuity checks
3-31-86	Normal off-gas	Setback	18	During routine testing the exit check valve on the steam blower malfunctioned resulting in NOG high pressure

INSTRUMENTATION AND REACTOR CONTROLS

The performance of the instrumentation for the facility was satisfactory, and maintenance required is indicated in Table 8. One instrumentation and controls design change memorandum was completed this quarter as shown in Table 9.

PROCESS SYSTEM

The performance of the process system was satisfactory, and maintenance required is indicated in Table 10.

MECHANICAL COMPONENTS

The performance of the mechanical components was satisfactory.

EXPERIMENT FACILITIES, GASEOUS WASTE FILTERS, AND CORE CHANGES

Experiment facility usage is given in Table 11. Table 12 summarizes the results of efficiency tests of the various gaseous-waste filters. The core configurations used during the quarter are shown in Figs. 4, 5, 6, 7, 8, and 9.

Table 8. Maintenance and changes, instrumentation and controls

Date	Component	Trouble or change	Reason or maintenance
1-21-86	Safety system	Shim-safety rod drops during on-line testing	Transient suppression diodes were installed across chamber undervoltage relays
2-20-86	Log N and fission chambers	Special test	The chambers were adjusted to accomodate the RERTR critical runs
3-3-86	Log N and fission chambers	Special test	The chambers were returned to normal operating position following RERTR critical runs
3-4-86	No. 1 Log N channel	Channel failure	The balance motor and amplifier were changed
3-4-86	Rod drop test channel	Channel failure	The time-of-flight meter was replaced
3-6-86	Primary flow, core ΔT, and reactor exit temperature channels	Upgrading	The setpoints were adjusted to accommodate the LEU whole-core demonstration
3-17-86	Seismic alarm channel	Incorporation of a new detection channel	A strong-motion accelograph was installed and actuated and the associated annunciator tested
3-19-86	No. 1 Log N channel	Erratic	The period recorder amplifier was replaced and adjusted

Table 9. Instrumentation and controls design change memorandums

Change memo number	Title of change	Reason for change	General description of change
ORR-138	Set point changes on reactor primary flow, ΔT, and outlet temperature	LEU whole-core demonstration	Adjustments were completed to primary low, core ΔT, and reactor exit temperature set points to reflect differences in the heat fluxes expected from upcoming transitional cores leading to the RERTR whole-core demonstration. The changes were made to provide the same margin of safety obtained from the previous set points with respect to reactor coolant flow versus heat power

Table 10. Process systems, maintenance and changes

Date	Component	Remarks
		Reactor primary cooling system
2-24-86	Degasifier	A leak was repaired on the level control differential pressure cell
		Emergency cooling system
2-25-86	No. 3 dc unit	The voltage monitor alarm and low-voltage relay were replaced
		Miscellaneous
2-10-86	Basement spring water drum	The spring water in the basement process sump was rerouted directly to the storm drain system
2-19-86	Bldg. 3004 neutralization tank	The sparge line was repaired

Table 11. Experiment facility usage

Facility	Access flange	Date installed	Date removed	Description of experiment	Division or sponsor
C-3	V-10	6-28-85		Material test, fusion program (MFE-7J)	Engineering Technology
C-7	V-2	6-28-85		Material test, fusion program (MFE-6J)	Engineering Technology
E-3	None	6-28-85		Aluminum-base, dispersion-type fuel plates (HFED)	Engineering Technology
Poolside[a] facility	None	12-13-85		Material test (HSST-6, Nos. 1 and 2)	Engineering Technology
HB-1	None	9-78		Neutron spectrometer	Solid State Physics
HB-2	None	11-1-58		Neutron diffraction experiments	Solid State Physics
HB-4	None	9-78		Neutron spectrometer	Solid State Physics
HB-6	None	4-76		Neutron small-angle scattering facility	Solid State Physics
HN-3	None	11-59		Activation analysis	Analytical Chemistry
HN-4	None	12-15-63		Neutron diffraction experiment	Instrumentation and Controls
South facility	None	12-16-63		Cold-finger plug[b]	Operations

[a]The LWR metallurgical pressure-vessel benchmark facility was installed on 4-21-80. The Heavy Section Steel Technology (HSST) Program uses the facility for irradiations.

[b]The facility is on standby.

Table 12. Status of filters, gaseous waste systems

Type filter	Bank designation	Date last changed	Date last tested	Type test	Retention efficiency (%)
		Cell-ventilation system			
CWS	Overall[a]	North, 4-16-80 South, 8-14-85	3-7-86	DOP	99.993
Charcoal	Both banks	North, 11-9-83 South, 8-14-85	12-10-85	Elemental iodine	99.962
		Basement hood exhaust			
CWS	South	3-11-80	3-7-86	DOP	99.993
CWS	North	3-11-80	3-7-86	DOP	99.995
		Normal off-gas			
CWS	West[b]	8-14-85	3-7-86	DOP	99.980
Charcoal	West[b]	8-14-85	12-3-85	Elemental iodine	99.968
CWS	East	5-1-85	3-7-86	DOP	99.986
Charcoal	East	5-1-85	12-5-85	Elemental iodine	99.995
		Pressurizable off-gas[c]			

[a]The CWS filters in the cell-ventilation system were checked in series.
[b]Not in service.
[c]The POG system is on standby; therefore, all filter tests have been discontinued.

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Lattice loading

For fuel cycles 174-C

	1	2	3	4	5	6	7	8	9
A	Be	F	F	F	F	F	F	F	Be
B	Eu	Be	F	SR	F	SR	F	Be	Eu
C	Be	F	MFE 7J E	F	F	F	MFE 6J E	F	Be
D	Eu	F	F	SR	F	SR	F	F	Eu
E	Be	F	HFED E	F	Ir	F	Ir	F	Be
F	Eu	Be	F	SR	F	SR	F	Be	Eu
G	Be	Be	Be	Be	Be	Be	Be	Be	Be

Lattice component	Number
Fuel (F)	27
Shim-safety rod (SR)	6
Beryllium (Be)	19
Experiment (E)	3
Europium (Eu)	6
Iridium (Ir)	2

Fig. 4. Lattice configuration - January 1-6, 1986.

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Lattice loading

For fuel cycles 174-D, E, FX, F, and 175-A, B

	1	2	3	4	5	6	7	8	9
A	Be	F	F	F	F	F	F	F	Be
B	Be	Be	F	SR	F	SR	F	Be	Be
C	Be	F	MFE 7J E	F	F	F	MFE 6J E	F	Be
D	Eu	F	F	SR	F	SR	F	F	Eu
E	Be	F	HFED E	F	Ir	F	Ir	F	Be
F	Eu	Be	F	SR	F	SR	F	Be	Eu
G	Be	Be	Be	Be	Be	Be	Be	Be	Be

Lattice component	Number
Fuel (F)	27
Shim-safety rod (SR)	6
Beryllium (Be)	21
Experiment (E)	3
Europium	4
Iridium (Ir)	2

Fig. 5. Lattice configuration - January 7-February 20, and March 7-31, 1986.

ORNL/DWG-86-11148

Lattice loading

For fuel cycles LEU-1

	1	2	3	4	5	6	7	8	9
A									
B									μμa Cham- ber
C			MFE 7J E				MFE 6J E		
D			F	SR	F	SR	F		
E			F	F	F	F	F		
F	*		F	SR	F	SR	F		**
G									

*Fission chamber No. 2.
**Fission chamber No. 1.

Lattice component	Number
Fuel (F)	11
Shim-safety rod (SR)	4
Experiment (E)	2
Fission chamber	2
μμa chamber	1

Fig. 6. Lattice configuration - February 24, 1986.

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Lattice loading

For fuel cycles LEU-2

	1	2	3	4	5	6	7	8	9
A									
B									μμa Cham- ber
C		Be	MFE 7J E	Be	Be	Be	MFE 6J E	Be	
D		Be	Be	SR	F	SR	Be	Be	
E		Be	Be	F	F	F	Be	Be	
F	*	Be	Be	SR	F	SR	Be	Be	**
G		Be	Be	Be	Be	Be	Be	Be	

*Fission chamber No. 2.
**Fission chamber No. 1.

Lattice component	Number
Fuel (F)	5
Shim-safety rod (SR)	4
Beryllium (Be)	24
Experiment (E)	2
Fission chamber	2
μμa chamber	1

Fig. 7. Lattice configuration - February 25, 1986.

ORNL/DWG-86-11150

Lattice loading

For fuel cycles HEU-1

	1	2	3	4	5	6	7	8	9
A									
B									μμa Cham-ber
C			MFE 7J E				MFE 6J E		
D			F	SR	F	SR	F		
E			F	F	F	F	F		
F	*		F	SR	F	SR	F		**
G									

*Fission chamber No. 2.
**Fission chamber No. 1.

Lattice component	Number
Fuel (F)	11
Shim-safety rod (SR)	4
Experiment (E)	2
Fission chamber	2
μμa chamber	1

Fig. 8. Lattice configuration - February 27, 1986.

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Lattice loading

For fuel cycles HEU-2

	1	2	3	4	5	6	7	8	9
A									
B									μμa Cham-ber
C		Be	MFE 7J E	Be	Be	Be	MFE 6J E	Be	
D		Be	Be	SR	F	SR	Be	Be	
E		Be	Be	F	F	F	Be	Be	
F	*	Be	Be	SR	F	SR	Be	Be	**
G		Be	Be	Be	Be	Be	Be	Be	

*Fission chamber No. 2.
**Fission chamber No. 1.

Lattice component	Number
Fuel (F)	5
Shim-safety rod (SR)	4
Beryllium (Be)	24
Experiment (E)	2
Fission chamber	2
μμa chamber	1

Fig. 9. Lattice configuration - March 1, 1986.

SPECIAL TESTS

A series of measurements on small cores consisting of all fresh (no fission products) LEU and HEU fuel elements were conducted during February 2 through March 2. These measurements are to be used in benchmarking the neutronics codes and models currently being used by ANL to predict the performance of ORR cores operating on HEU and LEU fuel.

Measurements performed on LEU-1 and HEU-1 (Figs. 6 and 8) included: (1) approach to critical, (2) shim-safety rod calibrations, (3) reactivity worth of MFE-6J, (4) core flux mapping by activation of cobalt-vanadium wires, and (5) the ratio of the effective delayed neutron fraction, β_{eff} to prompt neturon generation time, ℓ.

Measurements performed on HEU-2 and LEU-2 included: (1) approach to critical, (2) shim-safety rod calibrations, and (3) reactivity worth of MFE-6J.

The results of the comparison between calculated values and the measured data are not fully completed at this time.

SUMMARY OF SURVEILLANCE TESTS

Table 13 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 quarter or longer. Other surveillance requirements which are not reported are satisfied by routine completion of daily and weekly check sheets, start-up checklists, hourly data sheets, the operating logbook, and miscellaneous quality assurance tests.

Table 13. Summary of surveillance tests

Test	Most recent	Previous
Biennially		
Primary cooling flow channel calibration		
Direct flow channel	8-8-85	8-15-84
Core ΔP channel	8-14-85	8-15-84
^{16}N channel calibration	2-25-86	11-22-85
North-facility flow channel calibration	4-25-84	7-27-83
South-facility flow channel calibration	4-25-84	7-27-83
Normal off-gas vacuum monitor calibration	8-12-85	7-26-84
Pressurizable off-gas vacuum monitor calibration	Out of service	
Building ventilation flow monitor calibration	11-22-85	10-25-84
The dc pony motor battery bank		
Load-test No. 1 bank	11-3-85	8-8-85
Load-test No. 2 bank	11-3-85	5-1-85
Load-test No. 3 bank	2-20-86	11-3-85
Annually		
Safety-level channels calibration	3-6-86	11-22-85
Log-N channels calibration	3-4-86	11-20-85
ΔT channels calibration	3-6-86	8-21-85
Reactor water exit temperature channels calibration	3-6-86	8-21-85
Fission chamber channels calibration	3-4-86	11-23-85
Speed measurements of the shim-safety rod drive motors	3-6-86	11-26-85

Table 13. (Continued)

Test	Most recent	Previous
Annually (continued)		
Calibration of shim-safety rods	12-15-85	2-4-85
Reactivity assigned to the servo-control system	12-15-85	2-4-85
Semiannually		
Pressure drop measurements across NOG filters	3-30-86	12-29-85
Pressure drop measurements across POG filters	Out of service	
NOG filter system efficiency		
Elemental iodine test - east bank	12-5-85	6-20-85
Elemental iodine test - west bank	12-3-85	6-18-85
Dioctyl phthalate test - east bank	3-7-86	9-25-85
Dioctyl phthalate test - west bank	3-7-86	9-25-85
POG filter system efficiency	Out of service	
Containment closure system function test	3-4-86	11-21-85
Cell-ventilation filter system efficiency		
Elemental iodine measurements	12-10-85	8-15-85
Dioctyl phthalate measurements	3-7-86	9-26-85
Radiation monitoring equipment calibration	2-4-86	12-9-85
Stack radiation monitor calibration	10-8-85	6-28-85
Quarterly		
Primary coolant flow channels tested	3-6-86	11-26-85
^{16}N channels tested	3-6-86	11-22-85
North-facility flow channels tested	3-6-86	11-26-85

Table 13. (Continued)

Test	Most recent	Previous
Quarterly (continued)		
South-facility flow channels tested	3-6-86	11-26-85
Normal off-gas vacuum monitor tested	3-6-86	11-21-85
Pressurizable off-gas vacuum monitor tested	Out of service	
Building ventilation flow monitor tested	3-6-86	11-22-85
Manual scrams tested	3-6-86	11-26-85
Measurement of release time and time of flight for the shim-safety rods	3-6-86	11-26-85
Subcriticality with each shim-safety rod at its upper limit while all other shim-safety rods are fully inserted	3-6-86	11-3-85

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