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Oak Ridge Research Reactor Quarterly Report October, November, and December 1985

T. P. Hamrick
M. K. Ford

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Operations Division
Reactor Operations Section

OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT OCTOBER, NOVEMBER, AND DECEMBER 1985

T. P. Hamrick
M. K. Ford

SPONSOR: J. H. Swanks
Operations Division

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OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT
OCTOBER, NOVEMBER, AND DECEMBER 1985

SUMMARY

The ORR operated at an average power level of 29.65 MW for 65.5% of the time during October, November, and December of 1985.

The reactor was shut down on fourteen occasions, three of which were unscheduled. Reactor downtime needed for refueling and checks was normal. The reactor remained available for operation 73.3% of the time.

Maintenance activities, both mechanical and instrument, were essentially routine in nature with the exception of one Instrumentation and Controls Change memorandum.

Special tests completed during the quarter for the RERTR program included: (1) shim rod calibrations, (2) an isothermal temperature coefficient of reactivity measurement, (3) reactivity measurements of ORR experiments under various conditions, (4) gamma heating measurements in core positions E-3 and E-5, and (5) a flux run at N_L.

In-service inspections completed during the quarter involved the QD inspection of the ORR reactor vessel pool window.

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-86-7365

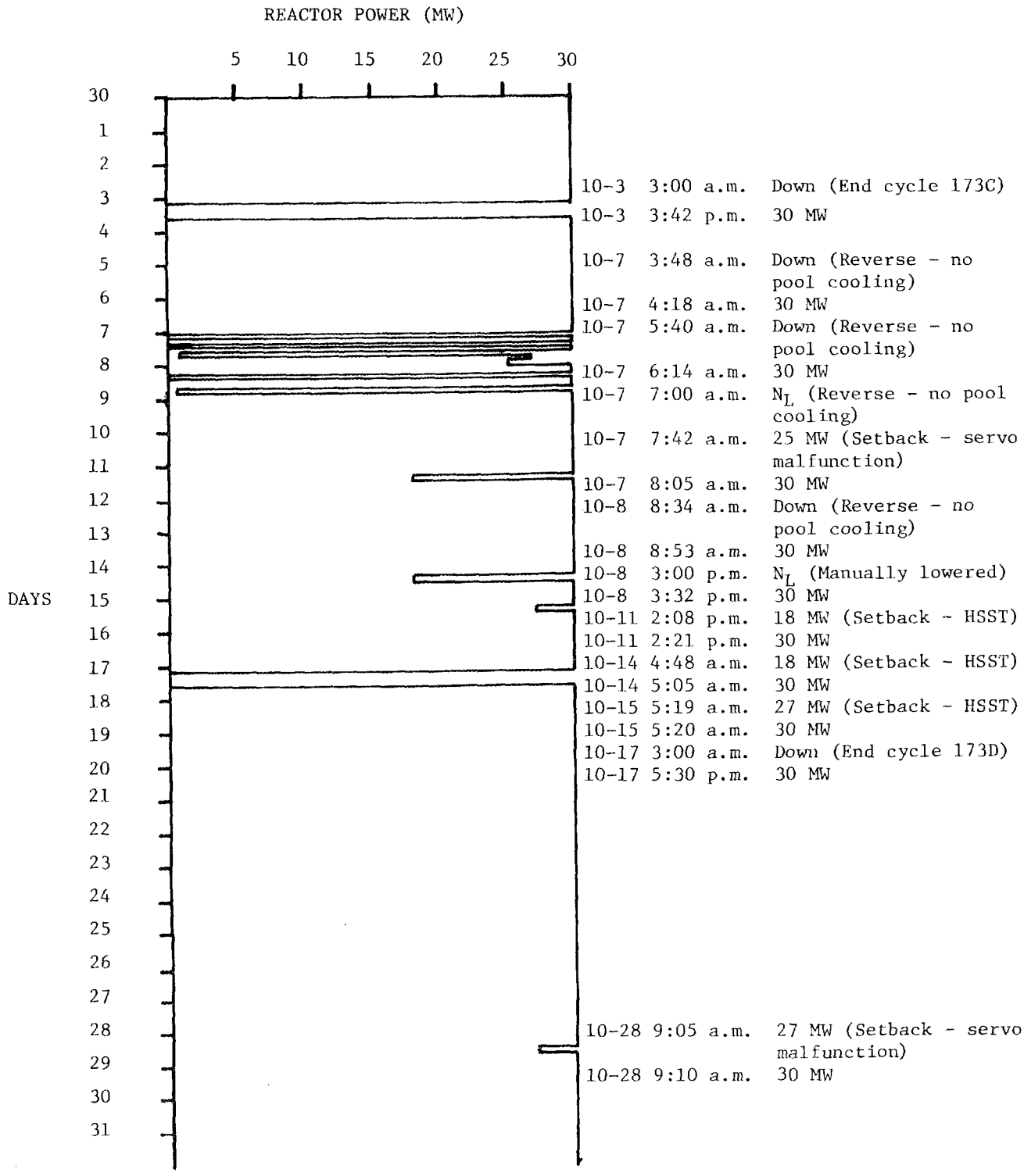

Fig. 1. Reactor power history - October 1985.

ORNL/DWG-86-7366

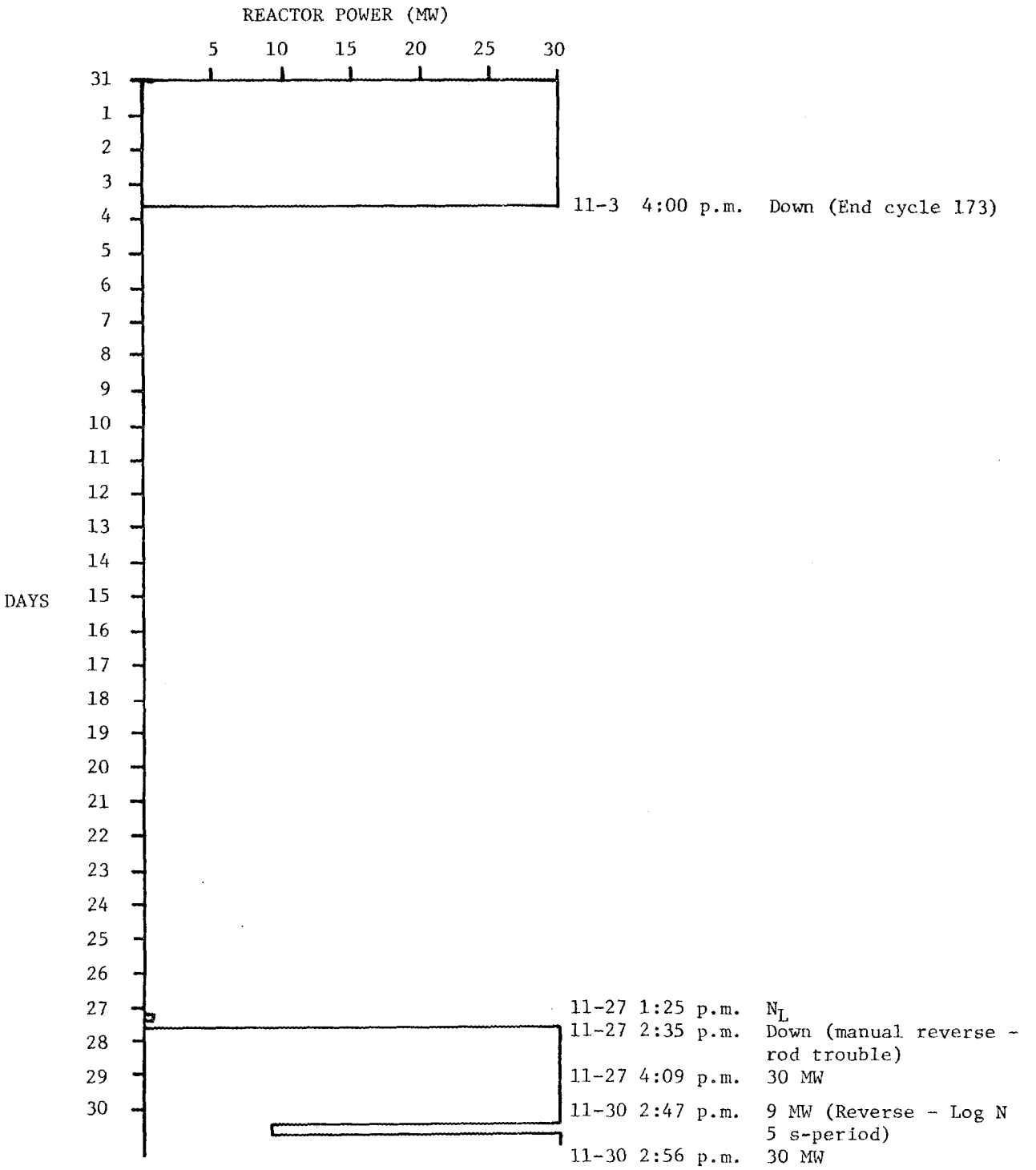

Fig. 2. Reactor power history - November 1985.

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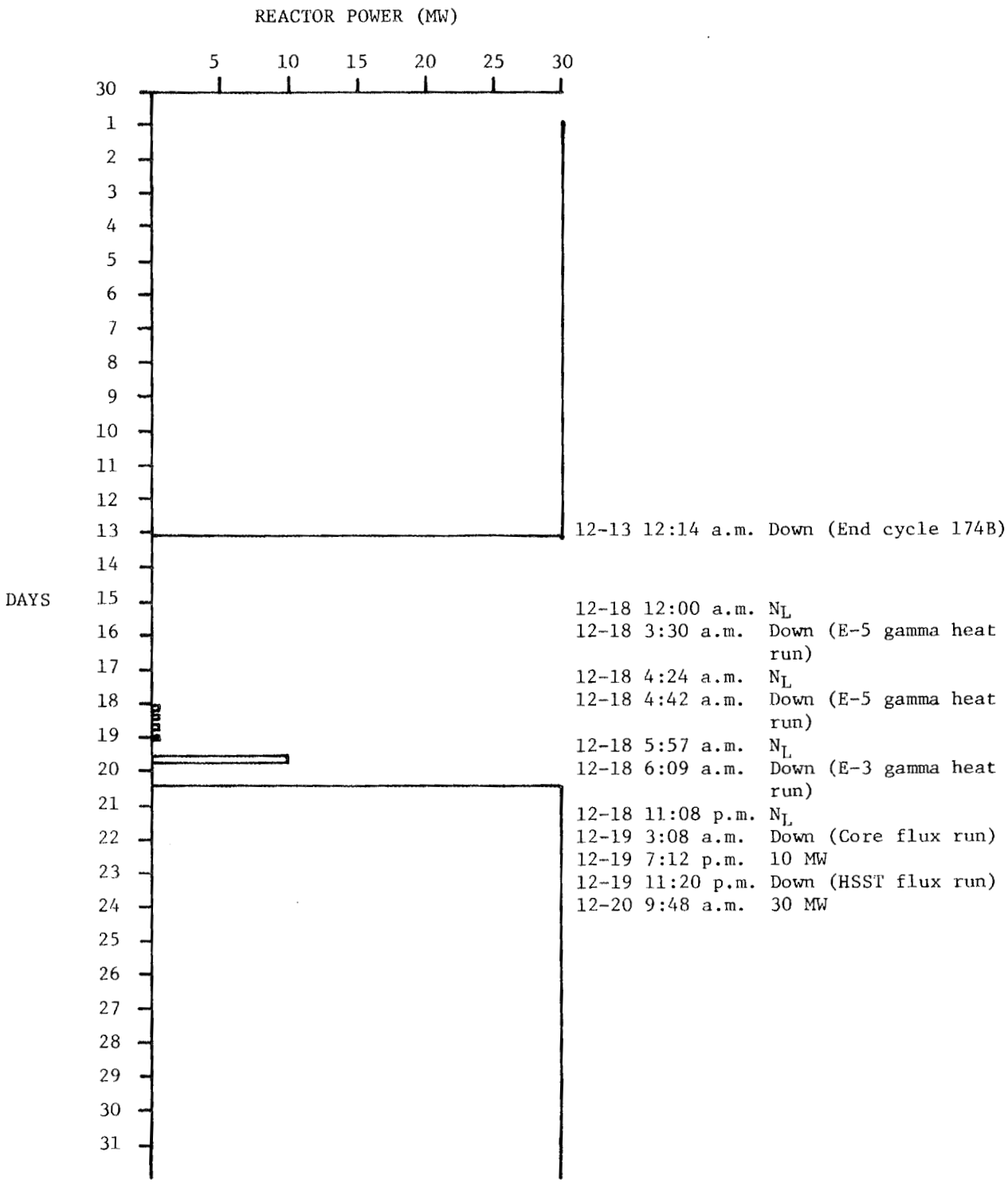

Fig. 3. Reactor power history - December 1985.

Table 1. Basic operating data
(October-December 1985)

	This quarter	Last quarter	Calendar Year 1985	Calendar Year 1984
Total energy, MWd	1,787.6	2,125.6	8,198.5	8,966.7
Average power, MW	29.7	29.9	29.8	29.7
Time operating, %	65.5[a]	76.1	75.3	82.6
Availability, %	73.3[a]	80.8	80.0	89.2
Reactor water radioactivity, cpm/ml (av)	33,900	27,800	30,250	34,509
Pool water radioactivity, cpm/ml (av)	1,180	910	953	973
Reactor water resistivity, ohm-cm (av)	1,182,000	1,569,000	1,497,500	1,377,175
Pool water resistivity, ohm-cm (av)	963,000	1,065,000	1,052,750	1,131,825
Fuel elements depleted	13	32	80	69
Average burnup of fuel elements depleted, %	47.7	46.0	46.0	45.0
Shim-safety rods depleted	2	1	8	8
Average burnup of shim-safety rods depleted, %	77.5	81.4	77.2	83.0
Radioisotope samples	0	0	0	0
Research samples	6	12	25	28

[a]Lower than normal due to additional downtime needed for maintenance.

Table 2. Cycles of operation

Cycle No.	Date begun	Date ended	Accumulated energy (MWd)
173	August 23, 1985	November 3, 1985	976.5[a]
174	November 27, 1985	In progress	811.1

[a]MWd this quarter

FUEL USAGE AND INVENTORY

Thirty-one spent fuel elements and three spent shim-safety rods were shipped for chemical separation. Thirteen fuel elements and two shim-safety rods were declared spent during the quarter. Fifteen new elements were received from the vendor, and sixteen fuel elements and two shim-safety rods were placed in service this quarter.

Other details of fuel usage and inventory may be found in Tables 1 and 3.

Table 3. Fuel status

	This quarter	Last quarter	Calendar Year 1985	Calendar Year 1984
Depleted fuel elements transferred for chemical recovery	31	17	75	88
Average percent burnup of fuel elements transferred	46.9	44.1	45.3	44.6
New elements start of quarter	142	132	--	--
New elements received	15	25	72	139
New elements placed in service	16	15	57	67
New elements end of quarter	141	142	--	--
Special or test elements	21	21	21	21
Depleted shim-safety rod elements transferred for chemical recovery	3	0	7	10
Average percent burnup of shim-safety rods transferred	73.3	--	78.4	82.8
New shim-safety rod elements start of quarter	12	13	--	--
New shim-safety rod elements received	0	1	1	14
New shim-safety rod elements placed in service	2	2	8	8
New shim-safety rod elements end of quarter	10	12	--	--

SHUTDOWNS AND POWER REDUCTIONS

Reactor downtime (power level $<N_L$) totaled approximately 762 hours. A summary of the shutdowns is given in Table 4, and details of each 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	573.417
Regular, refueling and experiment	3	145.050
Special, gamma measurements and flux runs	5	41.000
Special, instrument maintenance	2	2.483
Subtotal:	11	761.950
Unscheduled		
Instrument failure, reactor	3	0.299
Subtotal:	3	0.299
TOTAL:	14	762.249

Table 5. Scheduled shutdowns, details

Date	Duration (h)	End cycle	Remarks
10-3-85	11.783	173C	The reactor was refueled and iridium was worked
10-17-85	13.500	173D	The reactor was refueled, iridium was worked, and the HSST capsules were rotated
11-3-85	573.417	173	The shutdown activities included: (1) refueling; (2) installation of a new solid-state reactor safety system; (3) replacement of the seal housings on Nos. 1, 3, and 5 rod drives; (4) replacement of No. 4 rod drive; and (5) installation of a new basin drain line at 3103
11-27-85	0.500	--	The reactor was manually reversed to replace No. 4 rod selsyn motor
12-12-85	119.767	174B*	The reactor was refueled and iridium was worked. The HSST carriage assembly was modified, and new capsules were installed
12-18-85	0.900	--	Completed gamma measurements in core position E-5
12-18-85	1.250	--	Completed gamma measurements with ion chamber in E-5
12-18-85	16.983	--	Completed gamma measurements in core position E-3
12-19-85	13.700	--	Completed a four-hour flux map of the core
12-19-85	1.983	--	Completed a run for I&C to make adjustments on servo
12-19-85	8.167	--	Completed a 10-MW flux run for HSST

*Cycle 174A was loaded but never used.

Table 6. Unscheduled shutdowns, details

Date	Duration (h)	End cycle	Remarks
10-7-85	0.133	--	A reverse was received due to a false "No Pool Cooling Pump" alarm
10-7-85	0.033	--	A reverse was received due to a false "No Pool Cooling Pump" alarm
10-8-85	0.133	--	A reverse was received due to a false "No Pool Cooling Pump" alarm

Table 7. Reductions in power not resulting in shutdowns

Date	Source of signal	Type of signal	Lowest power (MW)	Comments
10-7-85	Servo	Setback	25	A setback to 25 MW was received due to a malfunction of the servo system
10-7-85	Servo	Setback	25	A setback to 25 MW was received due to a malfunction of the servo system
10-11-85	HSST experiment	Setback	18	A setback to 18 MW occurred when the HSST computer failed
10-14-85	HSST experiment	Setback	18	A setback to 18 MW was received when the HSST computer failed
10-15-85	HSST experiment	Setback	27	A momentary setback to 27 MW was received while retracting HSST
10-28-85	Servo system	Setback	27	While troubleshooting the servo flux recorder the signal leads were accidentally grounded, initiating a setback to 27 MW
11-30-85	Log N period	Reverse	9	A reverse to 9 MW was received when the No. 2 log N period recorder spiked to 5 s
12-21-85	Servo system	Insert error	28	The servo stuck on an insert error, reducing power momentarily to 28 MW

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 is indicated in Table 11.

EXPERIMENT FACILITIES, GASEOUS WASTE FILTERS, AND CORE CHANGES

Experiment facility usage is given in Table 12. Table 13 summarizes the results of efficiency tests of the various gaseous-waste filters. The core configuraitons used during the quarter are shown in Figs. 4, 5, 6, and 7.

Table 8. Maintenance and changes, instrumentation and controls

Date	Component	Trouble or change	Reason or maintenance
10-3-85	Magnet amplifier	Amplifier failed	Magnet amplifier 6B was replaced
10-8-85	Pool cooling flow channel	False reverse signals	The set point was reset to 450 gpm
10-9-85	Servo control system	Erratic	The servo flux monitor recorder amplifier was replaced
11-4-85 thru 11-26-85	Safety system	Upgrading	A new reactor protection system was installed
11-26-85	Pool cooling flow channel	Flow transmitter signal	A new electronic pool flow transmitter was installed
11-27-85	Servo power supply	Erratic	The internal power supply was replaced
12-2-85	No. 2 Log N channel	Noisy operation	The No. 2 Log N amplifier was replaced
12-4-85	No. 2 Log N channel	Noisy operation	The No. 2 Log N amplifier was replaced
12-13-85	N-16 channel	Chart drive	The N-16 channel chart drive was replaced
12-18-85	No. 2 count rate channel	Erratic	The count rate meter was replaced
12-18-85	Servo control system	Erratic	The flux signal conditioner was modified and reinstalled

Table 9. Instrumentation and controls design change memorandums

Change memo number	Title of change	Reason for change	General description of change
ORR-133	Reactor Protection System upgrade	To replace obsolete and difficult-to-maintain vacuum tube electronics with solid state	A new safety system consisting of three channels of neutron flux information, three channels of reactor period information (derived from the same ionization chamber as neutron flux), an electronically upgraded N-16 channel in the slow scram circuitry, fast trip comparators, and test modules for the gamma, N-16, and neutron channels was installed this quarter. The new system (two-out-of-three coincidence for both neutron current and reactor period) replaced the previous safety system (one-out-of-three coincidence for neutron current) Some improvements were made in the slow scram circuitry to improve signal reliability and remove unreliable backset recorder switches Also, the gamma and N-16 channels were upgraded by removing the gamma channel from the slow scram circuit (superceded by measurements related to heat power) and switching from backset switches to fast-trip comparators in the N-16 channel

Table 9. (Continued)

Change memo number	Title of change	Reason for change	General description of change
ORR-133 (continued)			Signal conditioning was provided for each channel by neutron flux input instrumentation consisting of a non-compensated ion chamber, period safety module, neutron current amplifier, an ion chamber high-voltage supply, a test module, and five comparators. The neutron current amplifier and period safety module outputs are the power level and reactor period signals, respectively. These outputs become the inputs to the comparators. The flux level trip point has two separate gain settings (as in the existing system), depending on whether the primary coolant pumps are running. Two independent flow signals and one manual signal activate switching relays which change the value of the neutron current amplifier feedback resistance by a factor of 45 and, therefore, provide scram trip points of 45 MW or 1.0 MW. The flux amplifiers also provide minor adjustments of 20% in sensitivity (screwdriver adjustments) The comparators provide the discrimination point for each signal of the various parameters. These relay outputs are combined logically to provide the desired protective or auxiliary action. The period trip comparator is bypassed in the new system above significant heat power levels to prevent unnecessary noise

Table 9. (Continued)

Change memo number	Title of change	Reason for change	General description of change
ORR-133 (continue)			The neutron current and period comparator outputs are combined in OR circuits. The coincidence circuit requires that at least two-out-of-three inputs to the OR circuits be in the tripped state before the output switches to the tripped state. Each of the six coincidence circuits drives a magnet switch from the output of the OR gate The magnet control system installed provides each control rod with a separate set of electronics Transistorized switching circuits, referred to as magnet switches, are provided for each rod. The dc power for all six magnet switches is supplied from a single magnet power supply and provides 32 V dc at up to 5 A. The magnet power supply is powered by 115-V ac primary through the slow scram bus. The bus is essentially unchanged but controls power to the single magnet power supply which, in turn, controls power to all six magnet switches Channel power supplies installed are regulated ±15-V supplies for all instrument and logic circuits. "Dirty" loads are 32-V supplies, one per channel, identical to the magnet supply

Table 9. (Continued)

Change memo number	Title of change	Reason for change	General description of change
ORR-133 (continued)			Setback and reverse logic for the new system is provided from additional neutron current level comparators, eliminating recorder backset switches. A two-out-of-three coincidence signal arrangement is provided for each of the three required set points. The coincidence matrices are composed of slave relays controlled by the comparator relay contacts. Single channel trips are indicated by lights on the comparators and no longer produce a setback or reverse. This provides protection against single channel failure and allows safety channel on-line testing The new system contains an undervoltage or no-continuity channel trip for each of the three channels plus a magnet drawer trip. The channel trips for undervoltage or no continuity are annunciated. They are also indicated along with the magnet drawer trip in the same vertical panel. This indication supercedes the safety trouble circuitry from the previous protection system

Table 10. Process systems, maintenance and changes

Date	Component	Remarks
	Reactor primary cooling system	
11-13-85	No. 1 primary pump exit check valve	The valve was rebuilt
	Reactor secondary cooling system	
11-12-85	Cooling tower	A new basin drain line was installed
	Pool primary cooling system	
11-11-85	Cooling pump	An exit pressure gauge was installed on the pump
	Pool secondary cooling system	
10-17-85	Tower basin	The make-up float valve was replaced
11-22-85	Tower fan	The fan motor was replaced
11-26-85	Cooling pump	The pump was removed, rebuilt, and reinstalled

Table 11. Mechanical system, maintenance and changes

Date	Component	Remarks
11-4-85	Shim-safety rod drive assembly No. 1	New engagement and seal housing assemblies were installed
11-5-85	Shim-safety rod drive assembly No. 4	New engagement and seal housing assemblies were installed
11-6-85	Shim-safety rod drive assembly No. 5	New engagement and seal housing assemblies were installed
11-7-85	Shim-safety rod drive assembly No. 3	A complete shim-safety rod drive replacement (excluding the shock absorber assembly) was completed
11-8-85	Shim-safety rod drive assembly No. 3	Miter gears were rebuilt on selsyn position indicator assembly
11-27-85	Shim-safety rod drive assembly No. 4	The No. 4 rod-drive selsyn motor was determined inoperable and replaced

Table 12. 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	9-5-85	12-13-85	Material test (HSST-5, Nos. 11 and 12)	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 13. 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	9-26-85	DOP	99.994
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	9-26-85	DOP	99.997
CWS	North	3-11-80	9-26-85	DOP	99.998
		Normal off-gas			
CWS	West[b]	8-14-85	9-26-85	DOP	99.996
Charcoal	West[b]	8-14-85	12-3-85	Elemental iodine	99.968
CWS	East	5-1-85	9-26-85	DOP	99.995
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 173-C, D

	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	Xe	Be
C	Be	F	MFE 7J E	F	F	F	MFE 6J E	F	Be
D	Be	F	F	SR	F	SR	F	F	Be
E	Be	F	HFED E	F	Ir	F	Ir	F	Be
F	Be	Be	F	SR	F	SR	F	Be	Be
G	Be	Be	Be	Be	Be	Be	Be	Be	Be

Lattice component	Number
Fuel (F)	27
Shim-safety rod (SR)	6
Beryllium (Be)	24
Experiment (E)	3
Xenon (Xe)	1
Iridium (Ir)	2

Fig. 4. Lattice configuration - October 1-17, 1985.

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Lattice loading

For fuel cycles 173-E

	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	Xe	Be
C	Be	F	MFE 7J E	F	F	F	MFE 6J E	F	Be
D	Be	F	F	SR	F	SR	F	F	Be
E	Be	F	Al	F	Ir	F	Ir	F	Be
F	Be	Be	F	SR	F	SR	F	Be	Be
G	Be	Be	Be	Be	Be	Be	Be	Be	Be

Lattice component	Number
Fuel (F)	27
Shim-safety rod (SR)	6
Beryllium (Be)	24
Experiment (E)	2
Xenon (Xe)	1
Iridium (Ir)	2
Aluminum (Al)	1

Fig. 5. Lattice configuration - October 17-November 3, 1985.

ORNL/DWG-86-7370

Lattice loading

For fuel cycles 174-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	Xe	Be
C	Be	F	MFE 7J E	F	F	F	MFE 6J E	F	Be
D	Be	F	F	SR	F	SR	F	F	Be
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)	22
Experiment (E)	3
Xenon (Xe)	1
Iridium (Ir)	2
Europium (Eu)	2

Fig. 6. Lattice configuration - November 27-December 13, 1985.

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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	Xe	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)	18
Experiment (E)	3
Xenon (Xe)	1
Iridium (Ir)	2
Europium (Eu)	6

Fig. 7. Lattice configuration - December 20-31, 1985.

IN-SERVICE INSPECTION

QD VISUAL INSPECTION OF ORR POOL WINDOW (By J. E. Batey and W. M. Collins)

The ORR pool window was visually inspected on November 11, 1985. The welds and the window centerline (horizontal and vertical) were examined. Corrosion, pitting, and suspect areas were compared with results recorded on video tape of the 1984 inspection. No change was detected.

SUMMARY OF SURVEILLANCE TESTS

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 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 14. 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	11-22-85	8-19-85
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	11-3-85	1-20-85
Annually		
Safety-level channels calibration	11-22-85	8-19-85
Log-N channels calibration	11-20-85	8-19-85
ΔT channels calibration	8-21-85	7-26-84
Reactor water exit temperature channels calibration	8-21-85	7-26-84
Fission chamber channels calibration	11-23-85	8-21-85
Speed measurements of the shim-safety rod drive motors	11-26-85	8-21-85

Table 14. (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	12-29-85	9-29-85
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	9-25-85	6-20-85
Dioctyl phthalate test - west bank	9-25-85	3-13-85
POG filter system efficiency	Out of service	
Containment closure system function test	11-21-85	8-15-85
Cell-ventilation filter system efficiency		
Elemental iodine measurements	12-10-85	8-15-85
Dioctyl phthalate measurements	9-26-85	3-13-85
Radiation monitoring equipment calibration	12-9-85	9-12-85
Stack radiation monitor calibration	10-8-85	6-28-85
Quarterly		
Primary coolant flow channels tested	11-26-85	8-21-85
^{16}N channels tested	11-22-85	8-19-85
North-facility flow channels tested	11-26-85	8-21-85

Table 14. (Continued)

Test	Most recent	Previous
Quarterly (continued)		
South-facility flow channels tested	11-26-85	8-21-85
Normal off-gas vacuum monitor tested	11-21-85	8-21-85
Pressurizable off-gas vacuum monitor tested	Out of service	
Building ventilation flow monitor tested	11-22-85	8-21-85
Manual scrams tested	11-26-85	8-21-85
Measurement of release time and time of flight for the shim-safety rods	11-26-85	8-21-85
Subcriticality with each shim-safety rod at its upper limit while all other shim-safety rods are fully inserted	11-3-85	8-21-85

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