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High Flux Isotope Reactor Quarterly Report April, May, and June of 1977

B. L. Corbett
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OAK RIDGE NATIONAL LABORATORY

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U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy \$4.00; Microfiche \$3.00

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Contract No. W-7405-eng-26

Operations Division

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
APRIL, MAY, AND JUNE OF 1977

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Date Published - September 1977

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SUMMARY

Routine reactor operation with four end-of-cycle shutdowns this quarter resulted in an on-stream time of 96.6%. The control plates were changed, and the No. 2 drive rod was replaced. Leaks have occurred in two primary heat exchangers, probably as a result of the 100 psi increase in system operating pressure. A brief electrical power outage (less than two seconds) was weathered without a reactor scram occurring--the control system worked as designed to maintain operation.

OPERATIONS

Basic operating data for the quarter are listed in Table 1.

Table 1. HFIR Basic Operating Data
(April 1, 1977 through June 30, 1977)

	This Quarter	Last Quarter	Year To Date
Total energy, MWd	8,782	8,455	17,237
Average power, MW/operating hr	99.9	99.4	99.7
Time operating, %	96.6	94.5	95.5
Reactor availability, %	96.7	95.1	95.9
Reactor water radioactivity, c/min (av) ml	286,000	356,000	
Pool water radioactivity, c/min (av) ml	49	49	

The starting and ending dates for cycles 145, 146, 147, and 148 are presented in Table 2.

Table 2. Cycles of Operation

Cycle No.	Date Started	Date Ended	Accumulated Power (MWd)
145	3-27-77	4-20-77	2329
146	4-20-77	5-13-77	2291
147	5-14-77	6-6-77	2265
148	6-6-77	6-29-77	2301

The status of the HFIR fuel and control-plate inventory is indicated in Table 3.

Table 3. HFIR Material Inventory

Item	This Quarter	Last Quarter
New fuel elements placed in service	3	4
New fuel elements available for use	47	45
Spent fuel elements on hand	15	13
Spent fuel elements shipped	2	1
New sets of shim plates placed in service	0	0
New sets of shim plates available for use	2	2

SHUTDOWNS

There were four end-of-cycle shutdowns this quarter for a total downtime of 74.151 hours. Table 4 gives further details of the shutdowns.

Table 4. Description of HFIR Shutdowns

Date	Downtime (hr)	Remarks
4-20-77	14.467	Fuel cycle 145 was completed at 5:54 a.m. A total power generation of 2329 MWd was obtained on fuel elements 141-0 and 141-I.

Table 4. (continued)

Date	Downtime (hr)	Remarks
5-13-77	18.7	Fuel cycle 146 was completed at 7:30 p.m. A total power generation of 2291 MWd was obtained on fuel elements 142-0 and 142-I. A two-hour delay was encountered while waiting for fuel delivery.
6-6-77	14.817	Fuel cycle 147 was terminated at 6:00 a.m. A total power generation of 2265 MWd was obtained on fuel elements 143-0 and 143-I.
6-29-77	26.167	Fuel cycle 148 was completed at 9:50 p.m. A total power generation of 2301 MWd was obtained on fuel elements 144-0 and 144-I. The shutdown was extended to change the outer control plates and the inner cylinder and to replace the No. 2 control plate drive rod.

OPERATIONAL NOTES AND SPECIAL TESTS

Normal Power Interruption

At ~8:00 a.m. on April 15, 1977, a momentary loss of the HFIR 13.8-kV preferred feeder occurred. An automatic transfer to the alternate feeder took place in less than 2 sec, but the brief outage caused all pump motors to stop. The reduction in primary coolant flow caused an automatic reactor power setback to ~15 MW. The 2400-V equipment was restarted with the "Auto Process Start" feature, and the reactor power was restored to 100 MW.

Since power to the facility was lost for less than 2 sec, the diesel-generators were not called upon to start. However, a faulty time delay relay caused the nuclear instrumentation and control plate drive power source to be transferred from transformer No. 7 to auxiliary transformer No. 7A. When normal power was restored, the automatic transfer of power from transformer No. 7A to No. 7 did not take place. A faulty time delay relay was later replaced in this control circuit and in the similar control circuit for transformers No. 6 and 6A. All other equipment operated properly during the brief power outage and the reactor did not scram.

Heat Exchanger Leaks

In March, 1977, the primary coolant operating pressure was increased from 650 psi to 750 psi. Since that time two primary heat exchangers have developed small leaks which required that one tube be plugged in each heat exchanger. A tube in a third heat exchanger is suspected of leaking slightly; this will be plugged if a leak can be verified. The tubes in which the leaks occurred are on the periphery of the tube bundle where they are subjected to the greatest stresses. All previous tube leaks have also occurred in these locations.

Before this year, the last heat exchanger tube leak occurred in 1972. The recent leaks were probably caused by the increase in primary coolant operating pressure.

Control Plate Bearing Test

Journal bearings have been undergoing in-reactor tests for over a year. Thus far their performance has been very good. The only discernible difference is an increase of 5-7% in the time-of-flight of the journal bearings over that of the ball bearings. For safety reasons only one set (four bearings mounted on one control plate) of journal bearings has been installed in the reactor at a time. No problems with "sticking" or failure-to-scrum have been encountered.

One set of journal bearings was run for six fuel cycles in the HFIR and then examined in a hot cell. Table 5 is a summary of the measurements made during this examination. A very minimal amount of wear had taken place and the bearings were still functional. This was very encouraging because the ball bearings show considerable wear after only four fuel cycles in the reactor.

Another set of journal bearings was run in the HFIR for six fuel cycles and was then examined underwater. Although it was not possible to measure dimensional changes, bearing wear appeared to be minimal. The bearings were all relatively "tight", turned freely, and had no flat or rough spots. This set of bearings will be reinstalled in the reactor for two additional fuel cycles.

Table 5. Dimensional Inspection Report of
Journal Bearings Removed from Control
Plate No. 9-3 after Six Fuel Cycles
in the HFIR

Bearing No.	75-9	75-10	75-11	75-12
Plate Location	U.R.	L.R.	U.L.	L.L.
Journal O.D. @ 0°	1.1796	1.1764	1.1797	1.1792
Journal O.D. @ 90°	1.1794	1.1759	1.1796	1.1774
"As Built"	1.1804	1.1805	1.1806	1.1805
Journal I.D. @ 0°	0.6615	0.6630	0.6625	0.6650
Journal I.D. @ 90°	0.6620	0.6630	0.6620	0.6650
"As Built"	0.6603	0.6610	0.6605	0.6603
Spacer Sleeve O.D. @ 0°	0.6525	0.6502	0.6537	0.6508
Spacer Sleeve I.D. @ 90°	0.6530	0.6484	0.6501	0.6499
"As Built"	0.6554	0.6556	0.6559	0.6558
Washer, Outer @ 0°	0.0420	0.0420	0.0430	0.0420
Washer, Outer @ 180°	0.0405	0.0420	0.0410	0.0430
"As Built"	0.0418	0.0420	0.0423	0.0427
Washer, Inner @ 0°	0.0425	0.0420	0.0420	0.0420
Washer, Inner @ 180°	0.0420	0.0420	0.0425	0.0425
"As Built"	0.0430	0.0420	0.0430	0.0427

PLANT MAINTENANCE

Maintenance and changes in the various process systems are listed in Table 6.

INSTRUMENTATION AND CONTROLS

Maintenance and changes in the various instrumentation systems are listed in Table 7.

Table 6. Process System - Maintenance and Changes

Date	Component	Remarks
Primary System		
4-4-77	Pressurizer pump	The magnetic clutch on pressurizer pump PU-4B was replaced because of bearing failure.
5-15-77	Pressurizer pump	The magnetic clutch on pressurizer pump PU-4B was replaced, again, because of bearing failure.
6-18-77	Pressurizer pump	The magnetic clutch on pressurizer pump PU-4B was replaced, again, because of bearing failure.
6-25-77	Primary pump	Primary pump PU-1B stopped each time the routine shunt test on its pony motor was performed. This caused a momentary power reduction to ~90 MW each time. A voltage sensing relay was replaced to correct the problem.
Miscellaneous		
5-9-77	Nitric acid pump	A new shaft was installed on the nitric acid pump after the pump failed due to a broken shaft.

Table 7. Instrumentation - Maintenance and Changes

Date	Component	Remarks
Miscellaneous		
4-20-77	Time delay relay	The SE time delay relays were replaced in the control circuits of transformers 7-7A and 6-6A because of improper performance.
5-14-77	Radiation block valve	The air diaphragm on the radiation block valve operator in Cell 112 was replaced due to failure.
6-20-77	Basin level control valve	A broken signal air line to the secondary basin level control valve was replaced.
6-30-77	Drive rod	The No. 2 control plate drive rod was replaced with a spare for routine servicing.

SYSTEM SURVEILLANCE TESTS AND RESULTS

Vessel Head Studs

The accumulated number of tensioning cycles on the reactor vessel head studs is presented in Table 8. These studs were designed for a fatigue life of 40 cycles loading due to tensioning of the bolts and 730 full-pressure (1000 psig) cycles. Installation of new reactor vessel head studs was completed in June, 1972. The numbers in Table 8 represent the maximum cycles to which any new stud has been exposed.

Table 8. Vessel Head Stud-Tensioning Cycles

Type Cycle	This Quarter	Last Quarter	Total To Date
Head bolts tensioned	0	0	6
1500 psig			0
950 psig	0	0	7
750 psig	3	2	5
650 psig	0	3	117

Stack Filters

Stack filtering systems in the special building hot exhaust (SBHE) and hot off-gas (HOG) systems were tested for iodine removal efficiency. Results of the most recent tests are tabulated in Table 9.

Table 9. Particulate and Iodine Removal Efficiency

Filter Bank	Methyl Iodide				Elemental Iodine				Filter Position	Particulate Retention			
	Last Test		Previous Test		Last Test		Previous Test			Last Test		Previous Test	
	Date	Eff., %	Date	Eff., %	Date	Eff., %	Date	Eff., %		Date	Eff., %	Date	Eff., %
SBHE, west	3-29-77	44	11-9-76	32.84	3-8-77	99.93	10-8-76	99.94	South	3-21-77	99.995	9-22-76	99.993
									North	3-21-77	99.996	9-22-76	99.996
SBHE, center	5-3-77	80	11-17-76	87	3-23-77	99.94	10-21-76	99.98	South	3-21-77	99.994	9-22-76	99.992
									North	3-30-77	99.996	9-22-76	99.972
SBHE, east	4-21-77	64	11-12-76	48	3-18-77	99.94	10-14-76	99.93	South	3-30-77	99.995	9-22-76	99.971
									North	3-21-77	99.990	9-22-76	99.992
H03, west	5-19-77	98	11-16-76	99	3-16-77	99.99	10-26-76	99.99					
H03, center	5-17-77	60	11-18-76	98	4-1-77	99.97	11-4-76	99.99					
H03, east	5-20-77	88	11-10-76	92	3-8-77	99.93	10-12-76	99.96					

REVISIONS TO THE HFIR OPERATING MANUAL

Revisions and additions to the HFIR operating manual which have been published this quarter are tabulated in Table 10.

Table 10. HFIR Manual Revisions

Date	Section No.	Subject	General Description
5-2-77	II-4, 6, 8, 10 & 11	Technical specification compliance	Miscellaneous additions and updating to conform with the HFIR technical specifications and set-point changes.

REACTOR EXPERIMENTS

Experimental Facilities

Usage of the various HFIR experiment facilities is tabulated in Table 11.

Table 11. Experiment Facility Usage

Facility	Description	Division
PTP-A1	Materials studies	Metals and Ceramics
PTP-A4	Materials studies	Metals and Ceramics
PTP-D1	Materials studies	Metals and Ceramics
PTP-D7	Materials studies	Metals and Ceramics
PTP-G4	Materials studies	Metals and Ceramics
PTP-G7	Materials studies	Metals and Ceramics
RB-1	Isotope production	Operations
RB-2	Isotope production	Operations
RB-3	Isotope production	Operations
RB-4	HFIR tensile specimens	Operations
RB-5	HTGR fuel irradiations	Engineering Technology
RB-6	Isotope production	Operations

Table 11. (continued)

Facility	Description	Division
RB-7	HTGR fuel irradiations	Engineering Technology
RB-8	Isotope production	Operations
CR-1	Isotope production	Operations
CR-2	Isotope production	Operations
CR-3	Californium production	Chemical Technology
CR-4	Californium production	Chemical Technology
CR-5	Isotope production	Operations
CR-6	Isotope production	Operations
CR-7	Isotope production	Operations
CR-8	Isotope production	Operations
VXF-1	HFIR corrosion specimen	Operations
VXF-7	Pneumatic tube	Analytical Chemistry
VXF-13	HTGR fuel irradiations	Engineering Technology
EF-2	Noise analysis studies	Instrumentation and Controls and Operations
HB-1	Neutron diffractometer	Solid State
HB-2	Neutron diffractometer	Chemistry
HB-3	Neutron diffractometer	Solid State
HB-4	Neutron diffractometer	Solid State

HFIR Target Loading

A description of the HFIR target loading for each of the operating cycles this quarter is presented in Figures 1, 2, 3 and 4.

<u>TARGET TYPE</u>	<u>NUMBER</u>
PLUTONIUM (Pu)	-
CURIUM (Cm)	<u>27</u>
STAINLESS STEEL (SST)	-
GRAPHITE (C)	-
ALUMINUM (Al)	<u>3</u>
HYDRAULIC TUBE (HT)	<u>1</u>

Fig. 1. HFIR Target Loading for Cycle 145 - March 27, 1977

<u>TARGET TYPE</u>	<u>NUMBER</u>
PLUTONIUM (Pu)	<u>—</u>
CURIUM (Cm)	<u>28</u>
STAINLESS STEEL (SST)	<u>—</u>
GRAPHITE (C)	<u>—</u>
ALUMINUM (Al)	<u>2</u>
HYDRAULIC TUBE (HT)	<u>1</u>

Fig. 2. HFIR Target Loading for Cycle 146 - April 20, 1977

<u>TARGET TYPE</u>	<u>NUMBER</u>
PLUTONIUM (Pu)	<u>-</u>
CURIUM (Cm)	<u>28</u>
STAINLESS STEEL (SST)	<u>-</u>
GRAPHITE (C)	<u>-</u>
ALUMINUM (AI)	<u>2</u>
HYDRAULIC TUBE (HT)	<u>1</u>

Fig. 3. HFIR Target Loading for Cycle 147 - May 14, 1977

<u>TARGET TYPE</u>	<u>NUMBER</u>
PLUTONIUM (Pu)	<u>—</u>
CURIUM (Cm)	<u>27</u>
STAINLESS STEEL (SST)	<u>—</u>
GRAPHITE (C)	<u>—</u>
ALUMINUM (AI)	<u>3</u>
HYDRAULIC TUBE (HT)	<u>1</u>

Fig. 4. HFIR Target Loading for Cycle 148 - June 6, 1977

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