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High Flux Isotope Reactor Quarterly Report April Through June 1987

B. L. Corbett
M. B. Farrar
E. M. Shirley

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Research Reactors Division

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT APRIL THROUGH JUNE 1987

B. L. Corbett, M. B. Farrar, and E. M. Shirley

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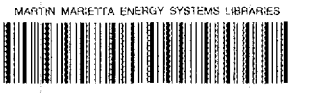

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HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
APRIL THROUGH JUNE 1987

SUMMARY

The end-of-cycle 287 shutdown was begun on November 14, 1986, and extended indefinitely to investigate the embrittlement of reactor vessel materials due to radiation damage. This shutdown was extended through the second quarter of 1987. Activities at the High Flux Isotope Reactor (HFIR) during the quarter have centered on maintenance, calibration, and modification of reactor systems. Also, eleven recommendations for changes proposed by the Brinkerhoff committee for the HFIR restart were addressed and action plans were developed to resolve these issues.

OPERATIONS

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

Table 1. HFIR basic operating data
(April 1 - June 30, 1987)

	This quarter	Last quarter	Year to date
Total energy, MWd	0	0	0
Time operated, h	0	0	0
Average operating power, MW	0	0	0
Time operating, %	0	0	0
Reactor availability, %	0	0	0
Reactor water radioactivity, cpm/ml (av)	8	45	
Pool water radioactivity,* cpm/ml (av)	39	52	

PROPOSED DESIGN CHANGES FOR THE HFIR RESTART

Embrittlement of the reactor pressure vessel has brought about the need for some new operational procedures and control features. The existing control and protective system is based on the premise that normal operating pressures are safe at system temperatures between 70°F

*Fluctuations in pool water activity are due to various maintenance activities in the pool area. During operation, pool water activity is approximately 100 cpm/ml.

and 200°F. With radiation induced embrittlement of the vessel, this is no longer the case. To assure vessel integrity, it is now necessary to maintain the vessel wall temperature above 85°F when the system pressure is above 300 psig. These numbers are based on hydrostatic proof testing of the vessel at approximately 900 psig and 85°F currently planned for next quarter. The development and analysis of new limiting conditions for operation to extend vessel life have been developed and are reported in ORNL/TM-10444, "Evaluation of High Flux Isotope Reactor Pressure Vessel Integrity Considering Radiation Embrittlement," by Cheverton, Merkle, and Nanstad. Operationally, the system must be revised to assure that if the vessel is pressurized, then the primary coolant inlet temperature will be kept at or above 85°F. In addition, the reactor pool temperature will be maintained above 90°F to reduce the stress on the vessel walls at normal operating conditions. Conversely, if the system should cool for whatever reason so that the reactor inlet temperature falls below 85°F or the pool temperature below 90°F, then the vessel must be depressurized to a pressure below 300 psig.

In addition to the cold pressurization limitations, a new maximum operating pressure and corresponding new maximum power level have been defined by ORNL/TM-10444 to allow a predictable life extension for the reactor vessel. This will require reliable means for preventing vessel pressure in excess of the newly defined maximum and readjustment of the reactor scram parameters for reduced power levels.

Designs are currently being developed to accommodate these new requirements. These designs, along with the procedures and administrative controls required to implement the new operating philosophy dictated by the embrittled vessel, must be in place prior to the resumption of routine operation of the HFIR.

HFIR MATERIALS INVENTORY

The status of the HFIR fuel and control-plate inventories on the last day of the quarter are indicated in Table 2. Only fuel assemblies which have undergone testing at the critical facility are included in this inventory.

SHUTDOWNS

The reactor remained shut down throughout the second quarter of 1987 while investigations into the embrittlement of the reactor vessel continued. Total downtime for the quarter was 2184 hours, all of which is designated as unscheduled (see Table 3 for further details).

LOW-POWER OPERATIONS

No Mode 2 or Mode 3 runs were performed during the second quarter.

Table 2. HFIR material inventories

Item	This quarter	Last quarter
New fuel assemblies placed in service	0	2
New fuel assemblies available for use at end of quarter (EOQ)	25	25
Spent fuel assemblies on hand at EOQ	12	12
Spent fuel assemblies shipped	0	1
New sets of control plates places in service	0	0
New sets of control plates available for use at EOQ	3	3
New control cylinders placed in service	0	0
New control cylinders available for use at EOQ	1	1

Table 3. Description of HFIR shutdowns

Date	Downtime, h	Remarks
--	2184.000	The scheduled end-of-cycle 287 shutdown, which began on November 14, 1986, was extended to investigate the embrittlement of the reactor vessel due to radiation damage. All downtime following the originally scheduled cycle 288 startup date was designated as unscheduled downtime. This shutdown continued through the entire second quarter of 1987.

PLANT MAINTENANCE

Maintenance and modifications of the various process systems are listed in Table 4.

Table 4. Process systems - maintenance and modifications

Date	Component	Remarks
		Primary system
4/20	Shroud flange	The shroud flange and a special shroud flange plug were installed in the reactor vessel to direct primary flow through the beam tube coolant channels.
4/24	Vessel studs	Temporary vessel head stud #72-22 was replaced with stud #43-0264-2-46.
4/29	Pony motor PU-1G	The battery breaker was repaired on pony motor PU-1G.
5/5	Heat exchangers	Seismic restraints were installed on the heat exchangers in cells 111 and 112.
5/12	Heat exchangers	Installation of new heat exchangers in cells 110 and 113 was completed.
5/12	Primary pump PU-1D	A new pump seal drain line was installed on PU-1D in cell 110.
5/13	Primary pumps PU-1A, 1B, and 1C	New pump seal drain lines were installed on primary pumps PU-1A, 1B, and 1C in heat exchanger cells 111, 112, and 113.
5/13	Primary cleanup pump PU-2B	Rebuilding of primary cleanup pump PU-2B was completed and it was reinstalled.
5/27	Primary cleanup prefilter FL-1B	A dye penetrant test was performed on the leaking inlet line to primary cleanup prefilter FL-1B. Repair action continues.
6/3	Equalizing valves HCV-583A and HCV-180A	Limit switches on pressure equalizing valves HCV-583A, cell 110 and HCV-180A, cell 113 were set.
6/4	Primary cooling pumps	The cooling water lines to primary pumps PU-1A, 1B, 1C, and 1D motor bearings were inspected.
6/9	Primary deaerator	Diaphragms were changed on the following valves: V-133, 1140, 141, 1440, 130, and 131.
6/12	Reactor vessel	The specimen holes which had been previously drilled in the vessel were rounded out.

Table 4. Continued

Date	Component	Remarks
		Secondary
4/9	Cathodic protection system	Quality Department completed the annual inspection of the cathodic protection system.
4/23	Secondary pump PU-14	Repairs were made on the discharge check valve for PU-14.
4/24	Secondary pump flume screens	New secondary pump flume screens were installed.
5/8	Secondary cooling tower	The band was replaced on the fan 4-D-1 stack.
5/19	Secondary pump PU-6A	The discharge check valve on secondary cooling pump PU-6A was inspected.
5/21	Secondary pump PU-6B	The discharge check valve on secondary cooling pump PU-6B was inspected.
5/26	Secondary pump PU-6C	The discharge check valve on secondary cooling pump PU-6C was inspected.
		Miscellaneous
4/2	Motorized work bridge	Seismic tiedowns were installed on the motorized work bridge.
4/3	Grating - cells 110 and 113	Gratings near the ladders in heat exchanger cells 110 and 113 were reinforced.
4/6	Unit chiller RE-1	Condenser heads were removed from the chiller to repair a tube leak.
4/7	Unit cooler cell 110	The unit cooler was replaced in heat exchanger cell 110.
4/9	No. 2 diesel generator	The air compressor on No. 2 diesel generator air starting system was replaced.
4/9	Nitric acid storage tank	The nitric acid storage tank was pumped to the acid truck. The lower sightglass isolation valve was replaced. The acid was pumped back to the tank on completion.

Table 4. Continued

Date	Component	Remarks
		Miscellaneous
4/13	Air compressor C-1A	A broken belt was replaced on air compressor C-1A.
4/13	No. 2 diesel	The relief valve was replaced on the No. 2 diesel air starting system.
4/14	Steam system	Steam valves were repaired at the caustic day tank.
4/14	Caustic day tank	A leak was repaired on the caustic day tank strainer.
4/15	Chiller RE-1	The secondary isolation valves were replaced on chiller RE-1.
4/16	Steam system	The upper 15-lb. steam reducer was replaced.
4/21	Air compressor C-1B	The heat sensor was replaced on air compressor C-1B.
4/28	Sulfuric acid storage tank	The sulfuric acid was pumped to a tanker and the tank was removed for inspection to locate a leak.
4/30	Reactor bay light dimmer switch	The reactor bay light dimmer switch was replaced.
5/5	Nuclear relay cabinets	Seismic restraints were installed on the nuclear relay cabinets in the auxiliary control room.
5/21	Nitric acid storage tank	The damaged sightglass was removed from the nitric acid storage tank.
5/28	Nitric acid and caustic storage tanks	Installation of bubbler-type level sensors was completed on the nitric acid and caustic storage tanks.
6/5	GPNAAF P-tube	The in-vessel and in-pool GPNAAF pneumatic tube installation in EF-3 facility was completed.
6/8	EF-3 anchor cap	Corrosion samples were collected from the EF-3 anchor cap and sent to the lab for analysis.

Table 4. Continued

Date	Component	Remarks
		Miscellaneous
6/10	Instrument battery charger B-2.	Repairs were completed on instrument battery charger B-2.
6/14	Chiller RE-1	Retubing of chiller RE-1 condenser was completed.
6/17	Instrument air dryer No. 1	The No. 1 air dryer valves were overhauled.

INSTRUMENTATION AND CONTROLS

Maintenance and modifications of the various instrumentation systems are listed in Table 5.

Table 5. Instrumentation - maintenance and modifications

Date	Component	Remarks
4/10	Calibration program	The primary pressure gauge at the transmitter rock and primary flow transmitter F-100-2B was calibrated.
4/16	Calibration program	The following instruments were calibrated: TM-310-A and -B, TC-310, TS-310-A, -B, -C, -D, and -E, and TS-310K.
4/24	Primary pH flow meter	The flow meter for pH-217 was rebuilt.
4/28	Calibration program	The following instruments were calibrated: LT-335 and PS-309.
4/30	Calibration program	The following instruments were calibrated: PI-915 and PI-916.
5/14	Calibration program	The pool cleanup flow meter FT-460 was calibrated.
6/1	Safety channel #1	Heat power calibration was performed on safety channel #1.

Table 5. Continued

Date	Component	Remarks
6/2	Safety channel #1	Channel #1 safety inlet and exit temperature probes were replaced, TS-100-1A and TS-100-1B respectively.
6/9	No. 2 safety heat power channel	The No. 2 safety heat power channel was calibrated.
6/10	Special building hot exhaust (SBHE) system	The pitot tube sensor in SBHE F1-913 was replaced with an annubar detector.
6/23	Calibration program	The following instruments were calibrated: LS-605A, LS-605B, and LI-605-2.
6/25	Secondary Delta-P transmitters	Secondary Delta-P transmitters were replaced in heat exchanger cells 110 and 113.
6/26	Calibration program	Demineralized water storage tank level indicator LI-605-2 and cell 113 primary Delta-P transmitter were calibrated.
6/29	Calibration program	The primary and secondary flow DP cells in heat exchanger cell 112 were calibrated.

SYSTEM SURVEILLANCE TESTS AND RESULTS

VESSEL HEAD STUDS

The accumulated number of tensioning cycles on the reactor vessel head studs is presented in Table 6. These studs were designed for a fatigue life of 40 cycles loading due to tensioning of the bolts and 730 full-pressure 6.9 MPa (1000-psig) cycles. Installation of new reactor vessel head studs was completed in June 1972. In November 1983, stud 72-1 was replaced by stud 73-9 because of a small anomaly discovered during previous ultrasonic inspections. These numbers in Table 6 represent the maximum cycles to which any stud has been exposed.

The annual ultrasonic inspection of all reactor vessel studs and nuts was completed on September 30, 1986. An indication was noted on stud 72-3 at a depth of 15 in. equal to 87% of the amplitude received from a 0.134-in. calibration notch. This depth corresponds to the point at which the center drilled holes intersect. A reinspection of this stud was scheduled for the following shutdown and was performed on October 24, 1986. This inspection confirmed the results of the previous inspection

in September. A more detailed inspection was deemed necessary; therefore, stud 72-3 was removed and replaced with a temporary stud (72-22). A detailed radiographic and ultrasonic inspection of the stud was performed. The radiographic examination revealed only a mismatch in the center drilled holes. The ultrasonic inspection results, however, were not consistent with the radiographic examination results so it was decided that a new stud should be placed in position 21 prior to restart. Temporary stud no. 72-22 was replaced with new stud no. 43-0264-2-46 on 4/24/87.

Table 6. Vessel head stud-tensioning cycles

	This quarter	Last quarter	Total to date
Head bolts tensioned	0	0	8*
10.3 MPa (1500 psig)	0	0	0
6.5 MPa (950 psig)	0	0	11
5.2 MPa (750 psig)	0	2	215
4.5 MPa (650 psig)	0	0	117

*Stud 43-0264-2-46 has been tensioned one time to date.

STACK FILTERS

Stack filtering systems in the SBHE and hot off-gas (HOG) systems were tested for particulate and iodine removal efficiencies. Results of the most recent tests are tabulated in Table 7.

Table 7. Particulate and iodine removal efficiencies

Filter bank	Elemental iodine				Filter position	Particulate retention			
	Last test		Previous test			Last test		Previous test	
	Date	Eff.,%	Date	Eff.,%		Date	Eff.,%	Date	Eff.,%
SBHE, west	4/16/87	99.932	10/22/86	99.967	South	3/31/87	99.99	9/22/86	99.99
					North	3/31/87	99.99	9/22/86	99.99
SBHE, center	4/22/87	99.963	10/24/86	99.992	South	3/31/87	99.99	9/22/86	99.99
					North	3/31/87	99.99	9/22/86	99.98
SBHE, east	4/14/87	99.924	10/16/86	99.950	South	3/31/87	99.99	9/22/86	99.99
					North	3/31/87	99.99	9/22/86	99.99
CHOG, West	4/23/87	99.998	11/13/86	99.988					
HOG, Center	5/1/87	99.997	11/4/86	99.992					
OHOG, east	4/29/87	99.897[a]	11/6/86	99.995					

[a]Below minimum acceptable efficiency.

SUMMARY OF SURVEILLANCE TESTS

Table 8 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 month or longer. Other surveillance requirements, which are not reported, are satisfied by the routine completion of daily and weekly check sheets, startup checklists, hourly data sheets, the operating logbooks, and miscellaneous quality assurance tests.

REVISIONS TO THE HFIR OPERATING MANUAL

There were no revisions to the HFIR Operating Manual during the quarter.

UNUSUAL OCCURRENCES

There were no unusual occurrence reports issued during the quarter.

REACTOR EXPERIMENTS

EXPERIMENT FACILITIES

Assignments of the various HFIR experiment facilities are tabulated in Table 9.

Table 8. Summary of Technical Specification surveillance tests

Test	Most recent test	Previous test	Previous test
Decennial tests			
Pressure boundary components	11/83	7/75	NA
Annual tests			
Count rate channel A calibration	10/28/86	3/11/86	2/6/85
Count rate channel B calibration	2/2/87	3/12/86	2/8/85
Count rate channel C calibration	2/11/87	3/13/86	2/19/85
Normal emergency systems	5/15/87	4/22/87	7/22/86
Poison injection system	8/14/86	8/16/85	10/29/84
Pressurizer pump high-pressure cutoff	2/27/87	2/6/86	2/22/85
Pressure relief valves	11/19/86	11/15/85	10/3/84
Reactor vessel head studs	9/30/86	11/18/85	10/4/84
Radiation block valve test	9/8/86	9/30/85	10/29/84

Table 8. Continued

Test	Most recent test	Previous test	Previous test
Annual tests			
Reactor bay in-leakage test	9/8/86	9/30/85	10/4/84
Reactor components	11/16/86	9/28/85	10/4/84
Safety channel A calibration	9/17/86	2/10/86	2/28/85
Safety channel B calibration	9/18/86	2/10/86	3/1/85
Safety channel C calibration	9/22/86	2/10/86	3/4/85
Servo channel A calibration	7/29/86	2/19/86	2/5/85
Servo channel B calibration	7/29/86	2/19/86	2/5/85
Servo channel C calibration	7/29/86	2/19/86	2/5/85
Speed of shim and regulating drives	1/29/87	11/20/85	11/19/84
Switchgear battery load test	5/27/87	5/12/86	5/8/85
Vessel material sample hole inspection	NA	NA	NA
Main pump low-pressure cutoff	11/14/86	10/25/86	9/29/86
Semiannual tests			
Pony motor battery E	4/28/87	9/8/86	5/11/86
Pony motor battery F	4/28/87	10/2/86	6/28/86
Pony motor battery G	4/28/87	10/25/86	7/11/86
Pony motor battery H	4/10/87	8/13/86	4/18/86
Radiation monitoring equipment	5/19/87	3/20/87	1/9/87
Monthly tests			
Cadmium nitrate tests	6/29/87	5/31/87	4/25/87
Diesel run test, No. 1	6/30/87	5/26/87	4/30/87
Diesel run test, No. 2	6/30/87	5/26/87	4/30/87

Table 9. Experiment facility assignments

Facility	Description	Sponsor
PTP-A1	Materials studies	Fusion Energy
PTP-A4	Materials studies	Fusion Energy
PTP-D1	Materials studies	Fusion Energy

Table 9. Continued

Facility	Description	Sponsor
PTP-D7	Materials studies	Fusion Energy
PTP-G4	Materials studies	Fusion Energy
PTP-G7	Materials studies	Fusion Energy
RB-1	Isotope production	Operations
RB-2	Isotope production	Operations
RB-3	Isotope production	Operations
RB-4	Isotope production	Operations
RB-5	Fuel studies	Engineering Technology
RB-6	Fuel studies	Engineering Technology
RB-7	Isotope production	Operations
RB-8	Isotope production	Operations
CR-1	Isotope production	Operations
CR-2	Isotope production	Operations
CR-3	Isotope production	Operations
CR-4	Isotope production	Operations
CR-5	Isotope production	Operations
CR-6	Isotope production	Operations
CR-7	Isotope production	Operations
CR-8	Isotope production	Operations
VXF-1	Isotope production	Operations
VXF-2	Isotope production	Operations
VXF-3	Isotope production	Operations
VXF-4	Isotope production	Operations
VXF-5	Isotope production	Operations
VXF-7	Pneumatic tube	Analytical Chemistry
VXF-8	Isotope production	Operations
VXF-9	Isotope production	Operations
VXF-10	Isotope production	Operations
VXF-11	Isotope production	Operations
VXF-12	Isotope production	Operations
VXF-13	Isotope production	Operations
VXF-14	Isotope production	Operations
VXF-15	Isotope production	Operations
VXF-16	Isotope production	Operations
VXF-17	Isotope production	Operations
VXF-18	Isotope production	Operations
VXF-19	Isotope production	Operations
VXF-20	Isotope production	Operations
VXF-21	Isotope production	Operations
VXF=22	Isotope production	Operations
HB-1	Neutron diffractometer	Solid State
HB-2	Neutron diffractometer	Chemistry
HB-3	Neutron diffractometer	Solid State
HB-4	Neutron diffractometer SANS Facility	Solid State

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