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High Flux Isotope Reactor Quarterly Report July Through September 1987

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Research Reactors Division

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT JULY THROUGH SEPTEMBER 1987

B. L. Corbett, M. B. Farrar, and C. H. Helton

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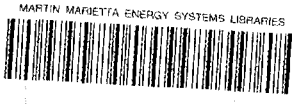

CONTENTS

LIST OF TABLES

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
JULY THROUGH SEPTEMBER 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 third quarter of 1987. Activities at the High Flux Isotope Reactor (HFIR) during the quarter have centered on maintenance, calibration, and modification of reactor systems. A hydrostatic pressure test of the HFIR primary coolant system was performed on August 4, 1987, to evaluate the integrity of the pressure vessel and to develop a basis for future reactor operations at 85 MW with 468 psig system pressure.

A work stoppage declared in June by the Atomic Trades and Labor Council was continued throughout the quarter. Routine surveillance of the reactor facility was continued by qualified monthly personnel. Some maintenance and modification work was also continued by qualified craft supervisors.

OPERATIONS

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

Table 1. HFIR basic operating data
(July 1 - September 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)	34	8	
Pool water radioactivity,* cpm/ml (av)	90	39	

*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.

IMPLEMENTATION OF SYSTEM DESIGN CHANGES AND INSTRUMENT MODIFICATIONS FOR THE HFIR RESTART PER HFIR CHANGE REQUEST HFIR-83-3, MAY 20, 1987

Preparations are being made for the resumption of HFIR operations at a maximum of 85 MW at 468 psig primary system pressure. Preparations include development and installation of systems to shut the reactor down prior to a cold shock of the vessel, maintain the vessel wall at operating temperatures following a scram, reduce primary system pressure to preclude pressurized cold shock of the vessel, and heat the HFIR coolant systems to operating temperatures prior to startup. Also, new operating parameters, safety-related documentation, personnel qualification programs, and enhanced management systems are being developed.

HFIR VESSEL HYDROSTATIC PROOF TEST

Radiation embrittlement of the HFIR vessel has increased the chances of a sharp crack-like defect (flaw) propagating through the vessel wall. The tendency for a flaw to propagate is evaluated using linear elastic fracture mechanics (LEFM), for which the governing parameters are the size and orientation of the flaw, the stress level, and the fracture toughness of the material. The uncertainties associated with flaws and fracture toughness are large and are accommodated in the portion of the ASME Code pertaining to PWR pressure vessels by the application of large safety factors. Evaluation of the HFIR vessel in accordance with criteria adapted from the Code results in noncompliance for some operating conditions. Some noncompliance is considered to be acceptable because the calculated probability of failure of the vessel is very small, and because the consequences of failure are much less than for a commercial power reactor. However, establishing an acceptable degree of noncompliance is difficult. An alternative is to perform a hydrostatic proof test on the vessel, and this approach is being taken.

A hydrotest was conducted on the HFIR vessel on August 4, 1987, at a vessel temperature of 85°F and a maximum pressure of 900 psig. There were no indications during the test of flaw propagation, and thorough post-test evaluation of all recorded data and a check of instrument sensitivity confirmed that there was no propagation of flaws. This test was planned and conducted by Oak Ridge National Laboratory with the assistance of acoustic-emission-monitoring specialists from Pacific Northwest Laboratories (PNL). The test was witnessed by DOE/EH/HQ and DOE/ORO personnel as well as Oak Ridge National Laboratory management.

The above hydrotest conditions correspond to a desired vessel life extension 10 EFPY, provided the HFIR is operated in accordance with the conditions recommended in ORNL/TM-10444. Based on the Oak Ridge National Laboratory's determination of hydrotest conditions, no additional hydrotesting is required during the 10-EFPY life extension. However, a DOE/EH/HQ HFIR review committee recommended testing at 1-EFPY intervals for further assurance of safe operation; and this will be done, although subsequent testing can be at a lower pressure.

HFIR MATERIALS INVENTORIES

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 through the third quarter of 1987 while process systems and instrument modifications continued. Total downtime for the quarter was 2208 hours, all of which are designated as unscheduled (see Table 3 for further details).

LOW-POWER OPERATIONS

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

Table 2. HFIR material inventories

Item	This quarter	Last quarter
New fuel assemblies placed in service	0	0
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	0
New sets of control plates placed 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
--	2208.000	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 and develop system modifications to allow for continued operations. All downtime following the originally scheduled cycle 288 startup date was designated as unscheduled downtime. This shutdown continued through the entire third 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
7/21	Primary heat exchangers	The 9-in. primary heat exchanger nozzle flange studs in cells 110 and 113 were replaced with 10-in. studs.
7/23	Primary heat exchangers	The east seismic restraint was installed on cell 113 heat exchanger. All four heat exchangers are now equipped with two seismic restraints.
7/24	Primary heat exchangers	The shell side of cells 110 and 113 newly installed heat exchangers were satisfactorily leak-tested.
7/29	Reactor pressure vessel	The installation of acoustic emission monitor fixtures and video surveillance equipment on the outside of the reactor vessel and beam tube nozzles was completed in preparation for the vessel hydrostatic test.

Table 4. Continued

Date	Component	Remarks
		Primary System
7/30	Acoustic monitoring devices	The reactor vessel acoustic monitoring equipment was tested satisfactorily.
7/30	Primary cooling system	The primary cooling system was pressurized to 100 psig for venting and leak checks.
7/31	Primary cooling system	The primary cooling system was pressurized to 400 psig in 50 psig increments to filter pump noise from the acoustic emission equipment and to test and calibrate acoustic emission equipment in preparation for the reactor vessel acoustic hydrostatic test.
7/31	Hydraulic flow monitoring	Four small leaks were repaired on the hydraulic flow monitoring lines outside the reactor vessel.
8/1	Primary cooling system	A preliminary reactor vessel hydrostatic proof test was completed up to 750 psig per procedure prepared by B. L. Corbett and R. D. Cheverton.
8/2	Rod drive seal	An external high-pressure seal water leak was repaired at an autoclave fitting to No. 3 rod drive seal housing.
8/4	Reactor vessel and primary cooling system	A satisfactory hydrostatic test was performed on the reactor vessel and primary system to a pressure of 900 psi. All acoustic measurements obtained during the test were satisfactory.
8/5	Primary system pressure letdown valves	Instrumentation & Controls (I&C) personnel conducted an operational test of all four primary letdown control valves.
8/5	Primary system relief valve rupture disk monitoring	A small leak from an autoclave fitting in the rupture disk leak monitoring line was repaired.
8/26	Reactor vessel quick-opening hatch	The alignment lugs were removed from the quick-opening hatch for weld repairs.

Table 4. Continued

Date	Component	Remarks
		Primary System
8/27	Reactor vessel quick-opening hatch	The alignment lugs were reinstalled on the quick-opening hatch after weld repairs were completed.
9/16	Reactor vessel head studs	Quality Department personnel performed a satisfactory ultrasonic test of the reactor vessel head studs.
9/21	PU-11 emergency pressurizer pump	Corrective maintenance of PU-11 emergency pressurizer pump revealed a broken pump shaft. A new low-head pump is to be installed to comply with the new primary system design changes.
9/23	No. 2 drive seal housing	No. 2 drive rod seal housing was replaced.
9/25	No. 2 drive rod components	No. 2 drive rod seal housing seals, secondary O-ring seal, and flat gasket were replaced. Also, a new drive rod and refurbished gear box were installed. The shim motor, lead screw, and position indicators were installed.
9/28	No. 2 drive rod components	No. 2 drive rod magnet was installed and coupled to the drive rod, and the limit switches were set.
		Miscellaneous
7/7	Plant demineralizer	The new plant demineralized water storage tank level control valve LCV-605 was installed.
7/14	Rod drive components	No. 3 magnet, lead screw, and drive rod gear box were installed.
7/15	Rod drive switches	The No. 3 drive rod limit, clutch, and seat switches were set.
7/21	13.8-kV electrical service	The 13.8-kV electrical service was returned to normal after extensive line maintenance.
		The 13.8-kV preferred feeder breaker No. 294 was reinstalled and tested.

Table 4. Continued

Date	Component	Remarks
		Miscellaneous
7/28	Diesel generator No. 2	A faulty coil was replaced in No. 2 diesel generator fuel rack solenoid.
7/30	Diesel generator No. 2	A routine inspection of No. 2 diesel generator was completed.
8/6	Plant demineralizer	A cylinder of the north plant demineralizer bank ruptured and was replaced by the Continental Water Systems Company.
8/6	Instrument air system	The solenoid valves in the cooling water supply line to the head of C-1A and -1B instrument air compressors were repaired.
8/10	Instrument air system	The instrument air system pressure relief valves were tested by the Quality Department.
8/12	No. 2 diesel air receiver	Quality Department personnel tested the pressure relief valves and inspected the inside of No. 2 diesel starting air receiver.
8/14	No. 2 diesel fuel rack solenoid	No. 2 diesel fuel rack solenoid was replaced due to a ground fault.
8/19	pH and resistance portable meters	New portable pH and resistance meters were provided to replace the old ones at the sample sinks.
8/20	Hot off-gas (HOG) fan FN-6 shaft bearings	Faulty pillow block shaft bearings were replaced on HOG fan FN-6.
8/21	Primary clean-up pump PU-2B	A leak from primary clean-up pump PU-2B impeller housing drain valve was repaired.
8/28	Hydraulic flow sensing lines	The hydraulic flow sensing lines, which were removed from the transmitters for the reactor vessel hydrostatic test, were reconnected.
9/1	Backflow preventers	Quality Department personnel completed programmed inspection of the backflow preventers.

Table 4. Continued

Date	Component	Remarks
		Miscellaneous
9/2	C-1B instrument air compressor	The piston rings, valves, and head gasket were replaced in C-1B air compressor.
9/3	Poison injection system	The annual poison injection system valve operation test was performed satisfactorily.
9/6	Electrical system No. 1 480-V switchgear	A ground fault in a welding receptable on MCC-B was repaired.
9/8	Electrical system	The safety instruments auto-transfer power feeder switches were tested.
9/10	Building dynamic containment	The annual reactor bay in-leakage test was completed satisfactorily.
9/15	Heat exchanger cells and pipe tunnel	EQE personnel inspected the four heat exchanger cells and pipe tunnel as a part of a seismic evaluation of the HFIR.
9/18	Control rod drive gear box	A spare control rod drive gear box was refurbished.
9/29	Rod drive gear box No. 5	Plant and Equipment (P&E) personnel began rebuilding rod drive gear box No. 5.

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
7/7	Calibration program	Primary pressure transmitter PT-104 was calibrated.
7/9	Calibration program	Primary inlet and exit temperature recorders TR-100-1A, -2A, and -3A and TR-100-1B, -2B, and -3B were calibrated. Primary system pressure indicator PI-104 was calibrated.
7/10	Calibration program	Primary inlet and exit temperature transmitters TE-100-1A, -2A, -3A, -1B, -2B, and -3B were calibrated.
7/13	Calibration program	Pool clean-up system inlet flow gauge FI-460A was calibrated.
7/15	Calibration program	Reactor bay delta-P transmitter PDI-300 was calibrated.
7/16	Calibration program	The following instruments were calibrated: 1. PWD flow recorder FR-707 2. Secondary tower blowdown recorder FR-708 3. Secondary flow indicator FI-300 4. Primary pressure recorder controller PRC-127
7/17	Calibration program	Primary head tank level transmitter LT-214A was calibrated.
7/23	Calibration program	The pressure gauges on the delta-P cells for HB-1,-2, -3, and -4 were zeroed.
8/10	Calibration program	Secondary flow transmitters PDT-302 and FT-300 were calibrated.
8/21	Calibration program	The following instruments were calibrated: radiation recorder RR-1000, radiation monitors RE-252, -257, and -326, and pH recorder ApHR-1010.
8/25	Calibration program	The following instruments were calibrated: pool surge tank level indicator LI-428, primary storage tank level indicator LI-429, pool clean-up flow indicators FIT-426 and -460, primary clean-up system flow transmitters FT-216 and -258, and flow sensor FS-216.

Table 5. Continued

Date	Component	Remarks
8/26	Calibration program	The following flow transmitters were calibrated: reactor pool cooling flow indicator FI-425, clean pool coolant flow indicator FI-468, and critical pool coolant flow indicator FI-441.
8/28	Calibration program	Pool and primary underground storage tank level transmitters LT-428 and -429 were calibrated.
9/1	Instrument power inverters	The instrument battery static inverters were adjusted.
9/18	Safety and servo nuclear tests	I&C personnel completed the annual nuclear checks for safety and servo channels 1, 2, and 3 per procedure HFR-1201 and -1202.
9/21	No. 1 WRCC	I&C personnel performed tests on No. 1 wide-range counting channel.
9/22	No. 2 WRCC	I&C personnel performed tests on No. 2 wide-range counting channel.
9/23	No. 3 WRCC	I&C personnel performed tests on No. 3 wide-range counting channel.
9/28	Nuclear instruments	I&C personnel began modifications to nuclear instruments per I&C modifications and design change request HFIR-87-3 (May 20, 1987) for HFIR restart.

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. In April 1987, stud 72-3 was replaced with stud 43-0264-2-46 because of an anomaly discovered by ultrasonic and

radiographic examination. 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 16, 1987.

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)	1	0	217
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 special building hot exhaust (SBHE) and 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	10/7/86	99.967	South	9/24/87	99.99	3/31/87	99.99
					North	9/24/87	99.99	3/31/87	99.99
SBHE, center	4/22/87	99.963	10/24/86	99.992	South	9/24/87	99.99	3/31/87	99.99
					North	9/24/87	99.99	3/31/87	99.98
SBHE, east	4/14/87	99.924	10/16/86	99.950	South	9/24/87	99.99	3/11/87	99.99
					North	9/24/87	99.99	3/11/87	99.99
CHOG, west	4/23/87	99.997	11/13/86	99.998					
HOG, center	5/11/87	99.997	11/4/87	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	9/21/87	10/28/86	3/11/86
Count rate channel B calibration	9/22/87	2/2/87	3/12/86
Count rate channel C calibration	9/23/87	2/11/87	3/13/86
Normal emergency systems	9/8/87	7/22/86	11/20/85
Poison injection system	9/3/87	8/14/86	8/16/85
Pressurizer pump high-pressure cutoff	2/17/87	2/6/86	2/22/85
Pressure relief valves	11/19/86	11/15/85	10/3/84
Reactor vessel head studs	9/16/87	9/30/86	11/18/85
Radiation block valve test	9/16/87	9/8/86	9/30/85

Table 8. Continued

Test	Most recent test	Previous test	Previous test
Annual tests			
Reactor bay in-leakage test	9/10/87	9/8/86	9/30/85
Reactor components	11/16/86	9/28/85	10/4/84
Safety channel A calibration	9/18/87	9/17/86	2/10/86
Safety channel B calibration	9/18/87	9/18/86	2/10/86
Safety channel C calibration	9/18/87	9/22/86	2/16/86
Servo channel A calibration	9/18/87	7/29/86	2/19/86
Servo channel B calibration	9/18/87	7/29/86	2/19/86
Servo channel C calibration	9/18/87	7/29/86	2/19/86
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	9/23/87	5/9/87	1/9/87
Monthly tests			
Cadmium nitrate tests	9/27/87	8/30/87	7/26/87
Diesel run test, No. 1	9/30/87	8/26/87	7/17/87
Diesel run test, No. 2	9/30/87	8/26/87	7/17/87

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
PTP-D7	Materials studies	Fusion Energy

Table 9. Continued

Facility	Description	Sponsor
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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