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High Flux Isotope Reactor Quarterly Report July Through September 1985

B. L. Corbett
M. B. Farrar
K. S. Belitz

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Operations Division

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
JULY THROUGH SEPTEMBER 1985

B. L. Corbett, M. B. Farrar, and K. S. Belitz

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Operations Division

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
JULY THROUGH SEPTEMBER 1985

SUMMARY

Three routine cycles of operation were completed during the third quarter. Eight scheduled shutdowns, however, resulted in an on-stream percentage of 70.5%. This low percentage on-stream time is attributed primarily to the replacement of the Cell 111 primary heat exchanger during the end-of-cycle-268 shutdown and the replacement of control plates, control cylinder, extension tubes, and shock-absorber tubes during the end-of-cycle-270 shutdown. Ten low-power (<90-MW) runs were performed during the quarter.

OPERATIONS

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

Table 1. HFIR basic operating data
(July 1 - September 30, 1985)

	This quarter	Last quarter	Year to date
Total energy, MWd	6447	7704	22,639
Time operated, h	1555.75	1857.918	5453.069
Average power, MW/operating h	99.5	99.5	99.6
Time operating, %	70.5	85.1	83.2
Reactor availability, %	72.5	85.1	83.9
Reactor water radioactivity, cpm/ml (av)	251,686	260,584	
Pool water radioactivity cpm/ml (av)	198	72	

The starting and ending dates for Cycles 268, 269, and 270 are presented in Table 2.

Table 2. Cycles of operation

Cycle No.	Fuel assembly	Date started	Date ended	Accumulated power (MWd)
268	267	7/1/85	7/23/85	2249
269	268	8/10/85*	9/3/85	2083
270	270	9/5/85	9/26/85	2101

*Full-power operation with a complete core loading was begun on this date. Low-power tests and a heat exchanger performance evaluation were performed prior to this, using fuel assembly 268.

The status of the HFIR fuel and control-plate inventories on the last day of the quarter are indicated in Table 3.

Table 3. HFIR material inventories

Item	This quarter	Last quarter
New fuel assemblies placed in service	3	3
New fuel assemblies available for use at end of quarter	15	13
Spent fuel assemblies on hand	12	12
Spent fuel assemblies shipped	3	6
New sets of control plates placed in service	0	0
New sets of control plates available for use	4	4

SHUTDOWNS

There were three end-of-cycle shutdowns. In all, there was a total of eight scheduled shutdowns for a total downtime of 652.25 hours. There were no unscheduled shutdowns during the quarter. Table 4 gives further details.

Table 4. Description of HFIR shutdowns

Date	Downtime, h	Remarks
		Scheduled
7/1	4.867	A continuation of the end-of-cycle-267 shutdown. Total downtime for the end of cycle 267 was 30.367 hours.
7/23	253.317	End of Cycle No. 268. The total energy accumulated on fuel assembly 267 during this cycle was 2249 MWd. The installation of a new primary heat exchanger was performed during this shutdown. Seven one-hour, Mode-3, 100-kW flux measurement runs were performed during this shutdown. See Table 5 for details of low-power runs during the end-of-cycle-268 shutdown.
8/3	10.933	Following a one-hour, Mode-1, 10-MW flux measurement run, accumulating approximately 0.5 MWd on fuel assembly 268, the reactor was shut down to rearrange flux dosimetry units in the core. See Table 5 for details of low-power runs during the end-of-cycle-268 shutdown.
8/3	144.917	Following a one-hour, Mode-1, 10-MW flux measurement run, accumulating approximately 0.5 MWd on fuel assembly 268, the reactor was shut down to complete the installation of the primary heat exchanger in Cell 111. See Table 5 for details of low-power runs during the end-of-cycle-268 shutdown.
8/10	10.300	Following the completion of a Mode-1, 60-MW heat exchanger performance test run, accumulating 1 MWd on fuel assembly 268, the reactor was shut down to work experiments for cycle 269. See Table 5 for details of low-power runs during the end-of-cycle 268 exercises.
8/13	88.333	The reactor was shut down during cycle 269 to allow for the installation of HRB-17 and -18 in RB-5 and -7 positions. The reactor building HVAC chiller was also repaired during this shutdown.

Table 4. (Continued)

Date	Downtime, h	Remarks
9/3	27.617	End of cycle 269. The energy accumulated on fuel assembly 268 during this cycle was 2081 MWd. The total energy accumulated on fuel assembly 268 during cycle 269 and the low-power runs is 2083 MWd.
9/26	111.966	End of cycle 270. The total energy accumulated on fuel assembly 270 during this cycle was 2101 MWd. During this shutdown, the control plates, control cylinder, extension tubes, and shock-absorber assemblies were replaced.

LOW-POWER OPERATIONS

During the course of the end-of-cycle-268 shutdown, ten low-power (<90 MW) runs were performed on the reactor. Seven Mode-3, 100-kW runs and two Mode-1, 10-MW runs were performed to determine the effects of hafnium-sleeved RB experiment positions on beam tube fluxes and in-core experiment facility fluxes. A 10- to 60-MW new heat exchanger performance evaluation was also performed. A summary of low-power operation during this quarter is given in Table 5.

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 5. Summary of low-power (<90 MW) operations

Date	Time operated, h	Power level	Remarks
7/29	0.417	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 267 and an all-beryllium loading in the RB experiment positions to determine the feasibility of using a "spent" fuel element for low-power flux measurement runs. It was determined that the excess reactivity available in fuel assembly 267 was not sufficient to attain criticality with neutron absorbers placed in the RB experiment positions. A power level of 100-kW was attained at 0900, and the reactor was shut down at 0925.
7/31	0.500	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268 and an all-beryllium loading in the RB experiment positions. This run was used to obtain base-case flux measurements at the beam tubes to be used in evaluating the effects of hafnium sleeves in the RB experiment positions on the beam fluxes. A power level of 100-kW was attained at 1740, and the reactor was shut down at 2127.
7/31	0.700	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268. The RB experiment positions were loaded with seven iridium samples. This run was used to obtain "normal load" base-case measurements at the beam tubes to be used in evaluating the effects of hafnium sleeves in the RB experiment positions on the beam fluxes. A power level of 100 kW was attained at 2045, and the reactor was shut down at 2127.

Table 5. (Continued)

Date	Time operated, h	Power level	Remarks
8/1	0.817	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268. The RB experiment loading included one hafnium experiment placed in RB-3 and seven iridium samples located in other RB positions. A power level of 100-kW was attained at 1036, and the reactor was shut down at 1125.
8/1	0.633	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268. The RB loading included one hafnium experiment in RB-5 and six iridium samples located in other RB positions. A power level of 100-kW was attained at 1320, and the reactor was shut down at 1358.
8/1	0.567	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268. The RB loading included one hafnium experiment in RB-7 and six iridium samples located in other RB positions. A power level of 100 kW was attained at 1528 and the reactor was shut down at 1612.
8/1	0.983	100 kW	A Mode-3, 100-kW run was performed using fuel assembly 268. The RB loading included one hafnium experiment in RB-1 and six iridium samples located in other RB positions. A power level of 100 kW was attained at 1757, and the reactor was shut down at 1856.

Table 5. (continued)

Date	Time operated, h	Power level	Remarks
8/3	1.000	10 MW	A Mode-1, 10-MW run was performed using fuel assembly 268. The RB loading included aluminum dosimetry units in RB-1 and RB-5. Also, five iridium samples were located in other RB positions. A power level of 10-MW was attained at 0919, and the reactor was shut down at 1019.
8/3	1.000	10 MW	A Mode-1, 10-MW run was performed using fuel assembly 268. The RB loading included one hafnium experiment in RB-1 and one aluminum dosimetry unit in RB-7. Also, five iridium samples were located in other RB positions. A power level of 10-MW was attained at 2115, and the reactor was shut down at 2215.
8/10	1.833	10 to 60 MW	A Mode-1, heat exchanger performance evaluation run was performed. Heat removal and vibration data were gathered from the new Cell 111 heat exchanger at power levels from 10 to 60 MW. The reactor was brought critical at 10 MW at 2310 and was shut down from 60 MW at 2400.

Table 6. Process systems - maintenance and changes

Date	Component	Remarks
		Primary system
7/23-8/10	Primary heat exchanger 1C	The heat exchanger was removed and replaced with a new exchanger.
8/12	Radiation block valve	The Cell 111 radiation block valve solenoid was replaced.
8/15	Radiation block valve	The Cell 110 radiation block valve air solenoid was replaced.
8/16	TS-100-3B	A repair was attempted on a TS-100-3B flange leak.
8/16	Primary relief valve	A leak was repaired on a flange.
8/16	Cleanup pump PU-2B	A piece of valve diaphragm material was removed from the suction line.
8/20	Cell 112 heat exchanger	Leaks were repaired in tube 11 in row 1 and tube 3 in row 5.
9/11	Pressurizer pump PU-4B	The motor seals and bearings were replaced, and the magnetic clutch was rebuilt.
9/26	PU-1C pump switch	The "pump on" indication in the control room was repaired.
		Secondary system
8/14	Secondary screens	The holding brackets for the screens were repaired.
8/19	Secondary acid pumps	The service piping to the pumps was replaced.
8/29	Manual acid valve	The manual acid feed valve was replaced.
9/4	Cooling	P&E personnel inspected the secondary cooling tower structure.

Table 6. (continued)

Date	Component	Remarks
		Miscellaneous
7/15	Air compressor C-1A	The motor was reworked.
7/19	SBHE charcoal filters	The west bank of SBHE charcoal filters was topped off with additional charcoal, following a failure of a routine QD test.
7/24	WRCC No. 1 fission chamber	The fission chamber drive gear box was rebuilt and replaced.
7/30	SBHE charcoal filters	The charcoal in the east bank of SBHE filters was topped off after it failed a scheduled iodine retention test.
7/31	FFED rotating shield	The limit-switches and motor wiring for the channel No. 3 FFED rotating shield were replaced.
8/6	SBHE charcoal filters	The charcoal in the west filters was replaced after topping them off failed to increase their efficiency.
8/12	HRB-17 and -18 experiments	The experiments were installed in the reactor.
8/12	Chiller unit, RE-1	The chiller compressor and oil pump were overhauled.
8/19	SBHE charcoal filters	The charcoal in the east SBHE was replaced.
8/22	HVAC units	The heating and cooling coils were replaced in AC-9 and AC-14.
8/26	Control room instrument cabinets	Electricians sealed the conduit holes in the floor with fireproof material.
9/5	Air compressors	The cooling water solenoids were replaced on C-1C and C-3.

Table 6. (continued)

Date	Component	Remarks
		Miscellaneous
9/16	Air compressor C-1B	A faulty coolant solenoid and broken exhaust valves were replaced.
9/17	Poison injection system	One pound of cadmium nitrate was added to adjust the specific gravity.
9/18	Backflow preventer	The backflow preventer on the first floor north was repaired.
9/25	Ph-334 controller	The sample-line flow meter was replaced.
9/27	Electrical wiring	The electrical wiring in the heat exchanger cells and pipe tunnel was inspected for radiation damage.

Table 7. Instrumentation - maintenance and changes

Date	Component	Remarks
7/9	Safety channel No. 1	Calibrated all nuclear recorders.
7/10	Safety channel No. 2	Calibrated all nuclear recorders.
7/10	PU-1F low-current sensor	The PU-1F low-current sensor was calibrated.
7/11	Safety channel No. 3	Calibrated all nuclear recorders.
7/24	FT-300	Secondary flow transmitter was recalibrated.
7/24	TI-1040	The multipoint temperature indicator was recalibrated.

Table 7. (continued)

Date	Component	Remarks
7/25	Safety channel No. 3	The safety channel No. 3 inlet and exit temperature probes were replaced with calibrated probes and the calibration of the channels Nos. 1 and 2 probes was checked against them.
7/26	Safety flow square root extractors	Safety flow square root extractors, FM-100-1A, FM-100-2A, and FM-100-3A were calibrated.
7/26	Safety flow repeaters	Safety flow current repeaters FX-100-1, FX-100-2, and FX-100-3 were calibrated.
7/29	Safety full-flow transmitters	All three transmitters were calibrated.
7/29	Safety low-low-flow transmitters	All three transmitters were calibrated.
8/5	Digital primary-pressure indicator	The indicator/transmitter was calibrated.
8/13	Primary heat exchanger	New shell ΔP gauges were installed on Cells 110, 111, and 113.
8/15	PDI-302	A plugged line was replaced.
8/19	Digital power readout	The digital power readout unit was replaced.
8/19	HFIR computer	A heat-damaged chip board in the computer was replaced.
9/30	Seat-switch relay	A faulty contact was found on the No. 2 control rod seat-switch relay. It was rewired to spare contacts.
9/30	No. 1 servo channel	The No. 1 servo failed to respond properly on startup and was diagnosed as a bad motor.

SYSTEM SURVEILLANCE TESTS AND RESULTS

VESSEL HEAD STUDS

The accumulated number of tensioning cycles on the reactor vessel head studs is presented in Table 7. 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. The numbers in Table 8 represent the maximum cycles to which any stud has been exposed.

Table 8. 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)	15	7	189
4.5 MPa (650 psig)	0	0	117

STACK FILTERS

Stack filtering systems in the special building hot exhaust (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 9.

SUMMARY OF SURVEILLANCE TESTS

Table 10 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.

Table 9. 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	7/10/85	99.681[a]	1/15/85[b]	99.91	South	9/25/85	99.99	3/26/85	99.99
	7/27/85	99.512[a,c]			North	9/25/85	99.99	3/26/85	99.99
	8/9/85	99.926							
SBHE, center	7/11/85	99.935	2/5/85[b]	99.95	South	9/25/85	99.99	3/26/85	99.99
					North	9/25/85	99.99	3/26/85	99.99
SBHE, east	7/25/85	98.87[a,c]	2/7/85[b]	99.91	South	9/25/85	99.99	3/26/85	99.99
	7/26/85	98.88[a,c]			North	9/25/85	99.99	3/26/85	99.93[a,d]
	8/6/85	99.77[a,c]						4/19/85	99.99
	9/10/85	99.94							
HOG, west	8/9/85	99.926	2/15/85	99.95					
HOG, center	9/17/85	99.99	2/20/85	99.99					
HOG, east	9/24/85	99.88[a]	2/28/85	99.99					

[a]Below minimum acceptable efficiency. Note: See Table 6 for details of filter maintenance.

[b]The period between this test and the previous test exceeds the 8-month limit imposed on semi-annual tests. This constitutes a Technical Specification violation.

[c]The East and West banks of filters were retested following the failure of both banks. The reactor was already shutdown for the replacement of the primary heat exchanger. The west bank charcoal filters were replaced and were tested satisfactorily prior to the completion of the shutdown.

[d]The East bank of SBHE filters was removed from service for the replacement of HEPA filters. The North bank of HEPA filters was replaced and tested on 4/19/85.

Table 10. Summary of 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	2/6/85	3/20/84	9/20/83
Count rate channel B calibration	2/8/85	3/22/84	9/20/83
Count rate channel C calibration	2/19/85	3/27/84	9/20/83
Normal emergency systems	5/29/85	10/4/84	7/5/84
Poison injection system	8/6/85	10/29/84	12/8/83
Pressurizer pump high-pressure cutoff	2/22/85	3/6/84	8/9/83
Pressure relief valves	10/3/84	1/6/84	10/24/83
Pressure-vessel head studs	10/4/84	10/1/83	2/22/83
Radiation block valve test	9/30/85	10/29/84	12/12/83
Reactor bay in-leakage test	9/30/85	10/28/84	12/12/83
Reactor components	9/28/85	10/4/84	12/12/83
Safety channel A calibration	2/28/85	3/11/84	7/19/83
Safety channel B calibration	3/1/85	3/11/84	7/20/83
Safety channel C calibration	3/4 85	3/11/84	7/21/83
Servo channel A calibration	2/5/85	2/9/84	6/8/83
Servo channel B calibration	2/5/85	2/9/84	6/8/83
Servo channel C calibration	2/5/85	2/9/84	6/8/83
Speed of shim and regulating drives	11/19/84	12/20/83	2/22/83
Switchgear battery load test	5/8/85	4/30/84	5/5/83
Semiannual tests			
Main pump low-pressure cutoff	6/30/85	2/24/85	7/5/84
Pony motor battery E	10/22/85	5/28/85	2/1/85
Pony motor battery F	8/13/85	6/17/85	2/24/85
Pony motor battery G	9/26/85	6/30/85	12/28/84
Pony motor battery H	9/4/85	6/30/85	1/9/85
Radiation monitoring equipment	7/16/85	5/14/85	1/16/85
Monthly tests			
Cadmium nitrate tests	9/22/85	8/31/85	7/28/85
Diesel run test, No. 1	9/24/85	8/13/85	7/29/85
Diesel run test, No. 2	9/24/85	8/13/85	7/29/85

REVISIONS TO THE HFIR OPERATING MANUAL

There were no HFIR Operating Manual revisions this quarter.

UNUSUAL OCCURRENCES

There were no unusual occurrence reports issued this quarter.

REACTOR EXPERIMENTS

EXPERIMENT FACILITIES

Assignments of the various HFIR experiment facilities are tablulated in Table 11.

HFIR TARGET LOADING

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

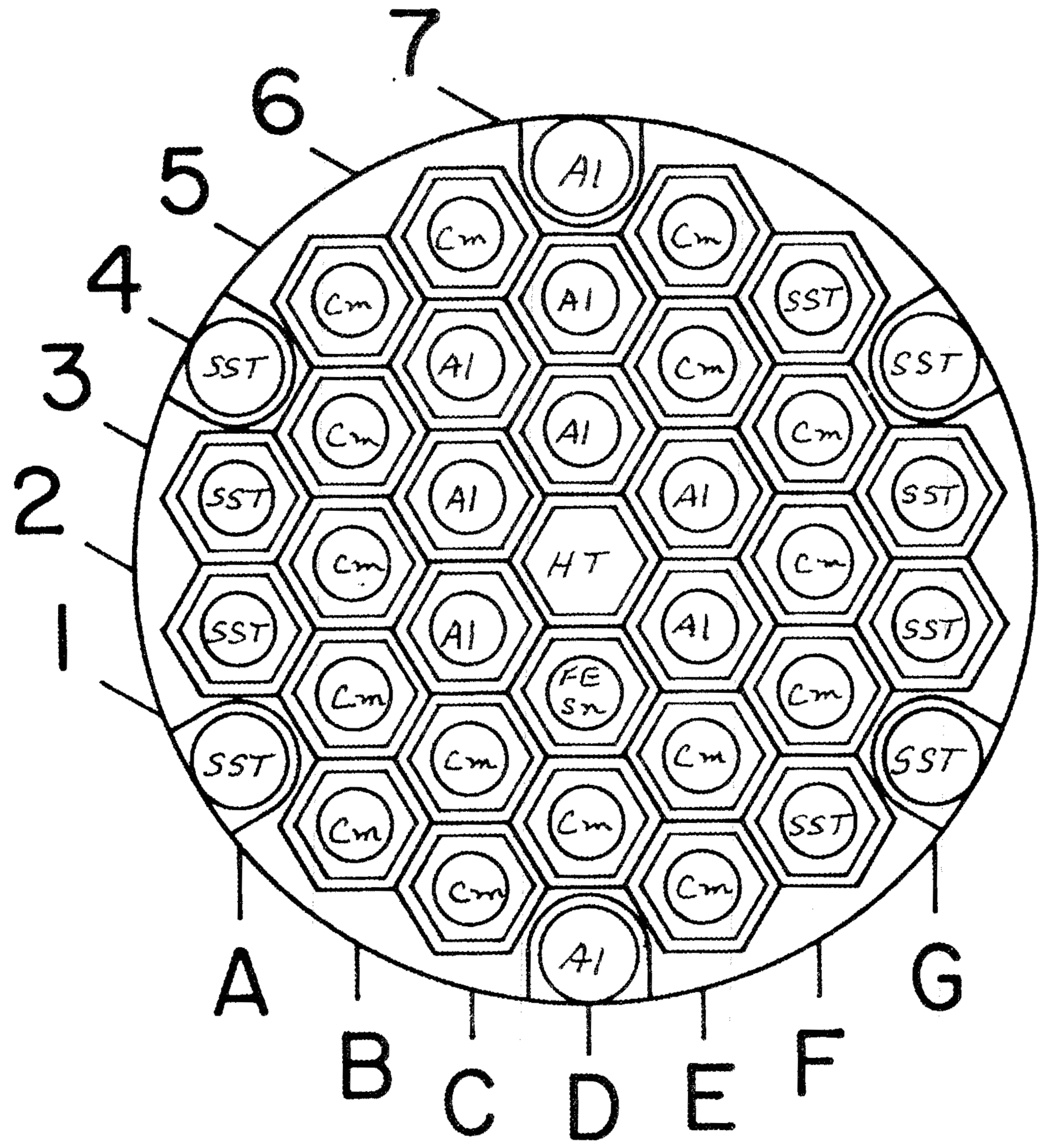
Table 11. Experiment facility assignments

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
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	HFIR corrosion specimen	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

HFIR TARGET LOADING

CYCLE NO. 268 DATE July 1, 1985

ORNL Dwg. 85-17786



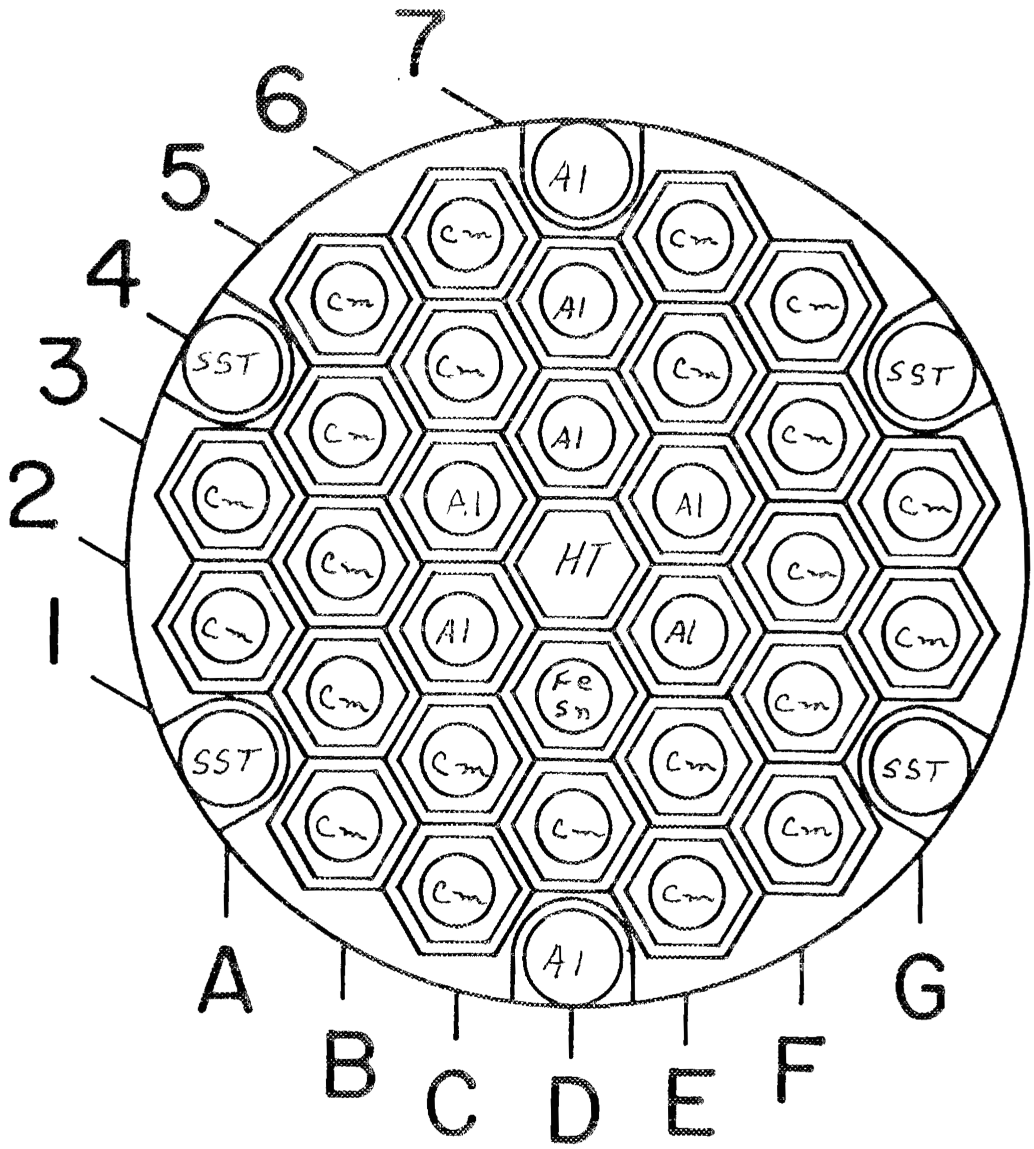
TARGET TYPE	NUMBER
PLUTONIUM (Pu)	
CURIUM (Cm)	16
COBALT (Co)	
TIN (Sn)	1
NICKEL (Ni)	
STAINLESS STEEL (SST)	6
GRAPHITE (C)	
ALUMINUM (Al)	7
HYDRAULIC TUBE (HT)	1

Fig. 1.

HFIR TARGET LOADING

CYCLE NO. 269 DATE 8/12/85

ORNL Dwg. 85-17787



TARGET TYPE	NUMBER
PLUTONIUM (Pu)	
CURIUM (Cm)	23
COBALT (Co)	
TIN (Sn)	1
NICKEL (Ni)	
STAINLESS STEEL (SST)	4
GRAPHITE (C)	
ALUMINUM (Al)	6
HYDRAULIC TUBE (HT)	1

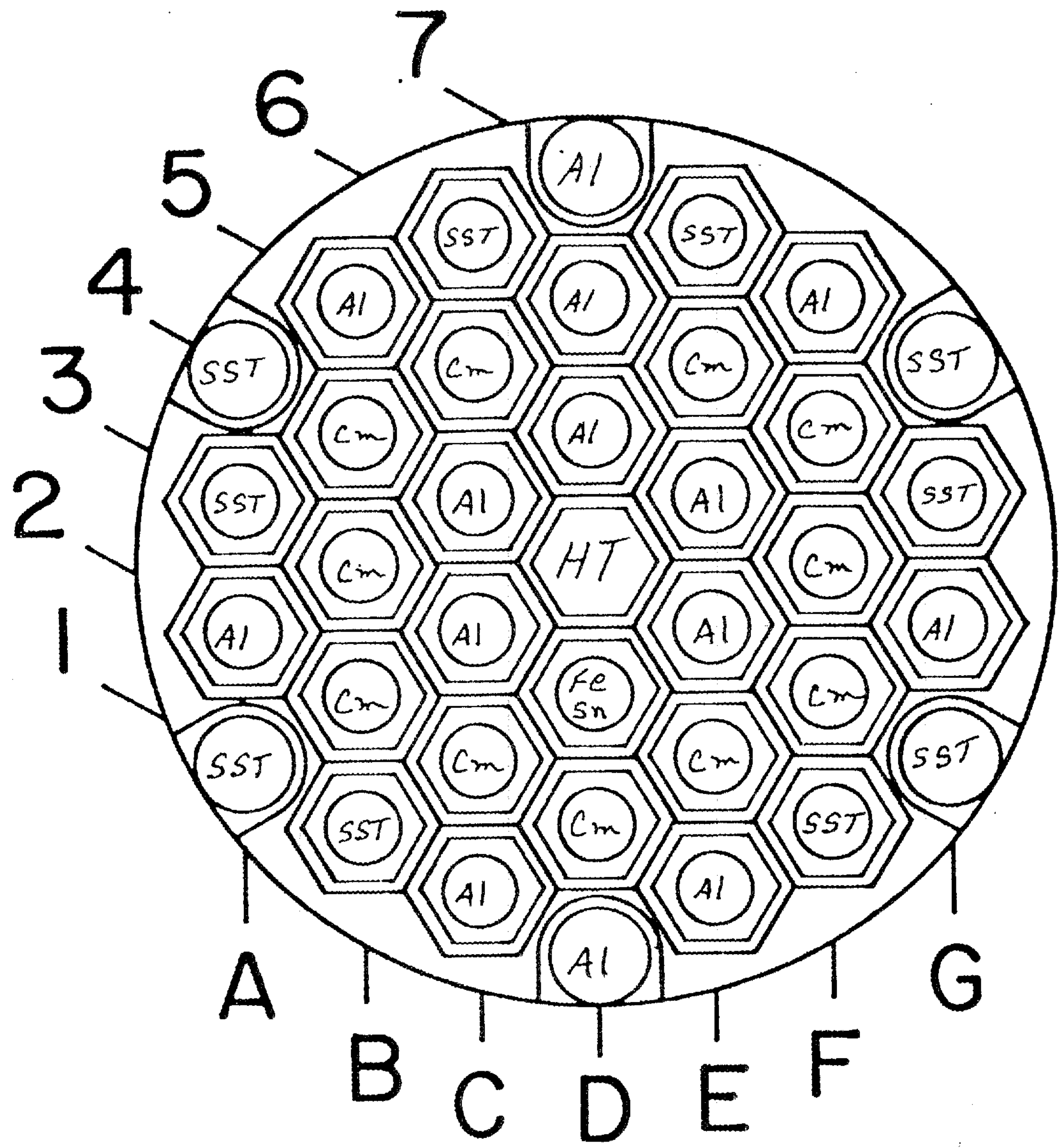
Fig. 2.

HFIR TARGET LOADING

CYCLE NO. 270

DATE 9/4/85

ORNL Dwg. 85-17788



TARGET TYPE	NUMBER
PLUTONIUM (Pu)	
CURIUM (Cm)	11
COBALT (Co)	
TIN (Sn)	1
NICKEL (Ni)	
STAINLESS STEEL (SST)	6
GRAPHITE (C)	
ALUMINUM (Al)	12
HYDRAULIC TUBE (HT)	1

Fig. 3.

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