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HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT
JANUARY, FEBRUARY, AND MARCH OF 1966

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SUMMARY

During this quarter the HFIR operated at an appreciable power level for the first time. As operating experience accumulated and confidence in the machine developed, the power level was gradually increased to 20 Mw. However, as the excessive downtime and unscheduled shutdowns indicate, the reactor was still in a "shakedown" and testing phase. Numerous minor, but aggravating, problems occurred. These problems and their solutions are discussed in the various categories of this report.

OPERATIONS

During this quarter the HFIR attained an appreciable power level for the first time. A power level of 2.6 Mw was reached on January 26, 1966. Power was gradually raised from this level to 20 Mw--the highest power attained this quarter. Operating data for the quarter are listed in Table 1.

Table 1. HFIR Basic Operating Data
(January 1 through March 31, 1966)

	This Quarter	Year To Date
Total energy, Mwd	668.8	668.8
Average power, Mw/operating hr	17.1	17.1
Time operating, %	43.5	43.5
Reactor water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	37,590	37,590
Pool water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	67	67
Reactor water resis- tivity, ohm-cm (av)	1.40×10^6	1.40×10^6
Pool water resis- tivity, ohm-cm (av)	1.41×10^6	1.41×10^6

Figure 1 is a plot of the symmetric plate position (at xenon equilibrium) versus accumulated megawatt days on the first production core. The reactor was operated at power levels between 12 and 20 Mw during this period.

SHUTDOWNS

A summary of the HFIR shutdowns for the quarter is given in Table 2. Table 3 and Table 4 give further details of the scheduled and unscheduled shutdowns respectively. Only shutdowns from an accountable power level are included. Before January 29, 1966, all shutdowns were considered part of the HFIR post-neutron experiments and are not included in the tabulation.

Fig. 1. Symmetric Plate Position vs Accumulated Megawatt Days --
First Production Core.

Table 2. Summary of HFIR Shutdowns

Reason	Number	Downtime (hr)
Scheduled		
Training and Maintenance	27	545.935
Unscheduled		
Equipment failure	5	0.916
Instrument failure	7	10.867
Debugging	10	1.968
Human error	1	0.167
Shim plate drop	1	0.233
Unknown	1	2.500
TOTAL	25	16.650

Table 3. HFIR Scheduled Shutdowns

Date	Duration (hr)	Remarks
2-2-66	2.582	The reactor was shut down so that maintenance personnel could enter the pipe tunnel to locate the cause of electronic noise in the channel 1 heat-power system. The source of the noise was not definitely determined; however, it is thought to have originated from a leaking valve in the hot-water-injection system.
2-16-66	0.634	The reactor was shut down to check the operation of the safety and servo heat-power instrumentation during startup conditions.
2-18-66	7.984	The reactor was shut down for the following maintenance work: (1) to change the setpoints on all three safety heat power permissives from 8 Mw to 5 Mw, (2) to change the calibration resistors in the servo afterheat computer, (3) to change the startup permissive circuits to one-out-of-three 30-sec-period withdraw inhibit instead of the previous two-out-of-three 20-sec-period inhibit, and (4) to reverse the polarity of the servo motor velocity meters so that they would agree in direction with the "raise-lower" demand push buttons. During the shutdown, the No. 1 fission chamber failed due to a high-voltage-to-ground short in the preamplifier and had to be replaced before startup.

Table 3. (Continued)

Date	Duration (hr)	Remarks
2-24-66	1.5	The reactor was shut down to investigate the failure to open of the discharge valve on primary pump PU-1B. The valve stuck in the closed position and would not open either manually or with the electric motor operator. After the valve packing was loosened, the valve operated freely. No further maintenance is scheduled.
2-27-66	425.084	The reactor was shut down for a scheduled maintenance period.
3-18-66	22.467	The reactor was shut down for replacement of the No. 2 fission chamber. The chamber was removed while the reactor was at 20 Mw so that the radiation level could be monitored. Direct β - γ radiation through the open fission chamber thimble was 200 mR/hr. No thermal or fast neutrons were detected.
3-23-66	3.700	Nine shutdowns were made to check the automatic startup of the reactor and to correct minor defects.
3-24-66	2.084	Nine shutdowns were made for operator training.
3-24-66	1.033	During the training shutdowns mentioned above, it was discovered that the No. 5 rod inhibit feature during a scram in two-out-of-three channels did not, in fact, inhibit withdrawal if the rod was in motion when the scram occurred. The reactor was shut down until this deficiency could be corrected. To correct the situation, the inhibit coincidence relay matrix was removed from the two-phase motor wiring and placed instead in the withdraw relay contactor circuit.
3-28-66	0.117	The reactor was shut down to demonstrate the reactor-control-system operation. This shutdown was utilized as a training shutdown and startup.
3-28-66	78.750	The reactor was shut down for an extended period for maintenance purposes; the principle item was the removal and calibration of the servo system thermal bulbs.
	545.935	TOTAL

Table 4. HFIR Unscheduled Shutdowns

Date	Duration (hr)	Remarks
1-29-66	0.333	A scram was received from channels 1 and 2 heat-power trips when a primary pump was started. Starting the pump caused the reactor inlet water temperature to decrease. Since the exit water temperature remained the same momentarily, a false, high-heat-power signal was generated. (Starting and stopping the pumps was part of the HFIR post-neutron startup tests.)
1-29-66	0.517	A scram was received from channel 1 heat-power trip and channel 2 rate trip when the secondary flow control valve, FCV-377, was opened too quickly. A "cold slug" caused the heat-power trip (as above). The channel 2 rate trip was apparently the result of a noisy module.
1-29-66	0.183	A scram was received from all three heat-power trips when the inlet water temperature controller was changed from 90°F to 120°F. When the set-point was raised, flow control valve FCV-377A closed automatically. This valve opened too rapidly when the inlet water temperature reached 120°F. The result was another "cold slug" and a reactor heat-power scram.
1-29-66	7.633	Channel 1 failed (in a scram condition) due to a shorted dc-to-ac inverter power lead. While this channel was out of service, a false trip signal came through the No. 2 faulty fuel element detector and scrammed the reactor. The reactor remained down until the inverter could be repaired.
1-30-66	0.083	The cooling tower bypass valve in the secondary system was opened to prevent ice formation in the tower, and the secondary water temperature increased sharply. It was necessary to shut down the secondary system pump to close the bypass valve. A scram was received from high inlet temperature on channel 2 and high heat power on channel 3 when the pump was shut down.
1-31-66	0.167	A scram was received from channel 1 high inlet temperature. The secondary water system temperature was lowered too much by the manual operation of the cooling tower fans. As the secondary water temperature decreased, flow control valve FCV-377A closed automatically. When the primary system temperature started to increase, FCV-377A did not open fast enough and a scram resulted.

Table 4. (Continued)

Date	Duration (hr)	Remarks
2-3-66	0.167	A reactor scram was received from high heat power on channel 1 and 2 when the hot-water-injection system was valved out of service. There apparently had been excessive bleed flow from the hot-water-injection system to the inlet temperature sensors. This caused incorrect heat-power indications (lower than the actual heat power). When the sensors cooled, the indicated heat power exceeded the trip levels.
2-4-66	1.584	Channel 1 was out of service for maintenance (in a scram condition) when a false trip signal was received from the channel 2 faulty fuel element detector. The false trip signal was apparently caused by electronic noise in the No. 2 faulty fuel element detector (FFED) channel.
2-4-66	0.167	A reactor scram was received from high heat power on all three channels when a main secondary pump was started. The secondary system had been operating on the shutdown pump, PU-14. An increase in the secondary temperature necessitated a higher flow rate. When the large pump was started, secondary flow to the primary heat exchangers increased significantly. This "cold slugged" the heat power instrumentation and resulted in a reactor scram.
2-8-66	0.950	The No. 1 channel was out of service (in scram condition) for recorder calibration when a false trip signal occurred in channel 2 faulty fuel element detector. The FFED trip was caused by electrical noise in the amplifier.
2-24-66	0.167	A shutdown occurred when one safety channel was tripped using the OR-gate lock and a "test" button on another channel was pushed.
2-24-66	0.150	While the No. 3 channel was out of service (in scram condition) for maintenance, the inlet-temperature control setpoint was raised from 100°F to 120°F. This caused a momentary decrease in heat power indication and resulted in operation of the flux reset mechanism. While the reset mechanism was operating, a flux spike from 14 Mw to ~35 Mw occurred in channel 1 and a scram resulted.
2-24-66	0.117	Operation of the secondary flow control valve, FCV-377A, was being checked while the reactor was operating at 16 Mw. In switching from the "manual" mode

Table 4. (Continued)

Date	Duration (hr)	Remarks
		to "automatic", the valve closed momentarily and then reopened. This resulted in a "cold slug" and a scram due to high heat-power trips on all channels.
3-17-66	0.250	The reactor was scrammed when a spurious flux/flow trip signal was received on channel 3 while channel 1 was out of service for maintenance.
3-18-66	0.233	A heat-power scram was received from all three channels. In attempting to locate the cause of numerous low instrument air pressure alarms, both air dryers were valved into service. Shortly after this was done, one of the air dryer valves failed to operate and bled pressure from the air receiver. This loss of air pressure caused the secondary flow control valve, FCV-377, to open. This "cold slugged" the reactor and resulted in a high heat power scram.
3-22-66	0.167	The reactor was scrammed when a spurious trip signal was received on channel 1 faulty fuel element detector while the channel 2 low pressure trip was being routinely tested.
3-22-66	0.133	The reactor was scrammed when channels 2 and 3 heat power trips were received during a routine safety system test. Leaky valves in the hot-water injection system caused the heat-power signals to increase to the trip points.
3-22-66	0.233	The reactor was scrammed when channels 1 and 3 flux/flow trips were received during a flow test. Primary pump 1C shut down unexpectedly from a vibration caused by a throttled exit valve. This caused a momentary increase in the flux/flow signal.
3-22-66	0.150	An attempt was made to start the main primary pump motors while operating at 10 Mw on three pony motors. To prevent a false heat power scram (caused by a near instantaneous flow increase while the relatively large ΔT signal remained momentarily constant), the discharge valve on one of the circulating pumps was closed before starting its ac motor. Although this prevented a heat power scram, a scram was received from the channels 1 and 3 flux/flow trip. The flux/flow scram was attributed to poor flow signal calibration at low flow rates.

Table 4. (Continued)

Date	Duration (hr)	Remarks
3-23-66	0.134	A heat power scram was received while attempting to return to 20 Mw as quickly as possible after a scheduled shutdown. The unscheduled scram resulted from the action of secondary flow control valve, FCV-377A. The valve opened too quickly and "cold slugged" the reactor. This caused a false high-heat-power indication and a reactor scram.
3-24-66	0.150	A scram was received from transient heat-power signal increases caused by the action of secondary flow control valve FCV-377A. The conditions which caused the scram were similar to those experienced on March 23, 1966.
3-25-66	0.133	The reactor was scrammed when a spurious trip signal was received from channel 3 high inlet temperature while channel 1 was out of service (tripped) for maintenance.
3-25-66	2.500	The reactor was scrammed from an unknown source. No annunciator or module latch lights appeared to identify the source of the trip.
3-26-66	0.233	The reactor was shut down when the No. 3 shim-safety plate dropped. Channel 3 heat power was being tested at the time the plate dropped. The cause was not discovered, since no unusual annunciator or latch lights were actuated. This is the first case of a single shim-safety plate drop at the HFIR.
3-28-66	0.117	The reactor was scrammed from high-heat-power trips on all channels while an attempt was being made to return to 20 Mw as quickly as possible following a scheduled shutdown. Insufficient time was spent at N_L to let the servo system reset gains reach equilibrium.
	16.650	TOTAL

INSTRUMENTATION AND CONTROLS MAINTENANCE AND CHANGES

Control Changes

Several changes were made this quarter in the reactor controls. During the initial period of power operation, certain deficiencies were uncovered. Improvements in the system were made as operating experience provided additional insight into control interactions. The changes to the reactor control circuits are outlined below.

The control plate asymmetry detection circuit was installed and tested. The system was placed in service with the following alarms and setbacks present in the reactor controls.

<u>Condition</u>	<u>Alarm (in.)</u>	<u>Setback (in.)</u>
Two plates unbalanced in excess of	0.6	1.2
No. 5 cylinder unbalanced with any plate in excess of	1.7	2.3

After a few automatic startups in mode 1, the intermittent timer was bypassed to permit continuous rod withdrawal. This change has allowed faster and more orderly startups. The period inhibit and reverse are still effective to control the startup rate.

During the initial reactor startups, the response of the +20-sec-period inhibit was not fast enough to prevent an overshoot to the +5-sec-period reverse. Two changes were made to eliminate this undesirable condition. First, the inhibit was changed to a +30-sec period. Second, instead of requiring two channels to detect a +30-sec period to inhibit rod withdrawal, a requirement of only one channel was established.

Making the transition from start to the run mode was difficult during the early startups. The $1.1 N_L$ reset flux reverse from the safety system was being obtained before the servo systems were indicating a power high enough to start automatic control. This problem was attacked in two phases:

1. The safety system thermohms and the servo thermobulbs were recalibrated and the safety system resistance to current converters were modified. These changes provided closer agreement between the heat power instrumentation for the two systems.

2. The $1.1 N_L$ reverse in start was increased to $1.5 N_L$. The 8-Mw requirement to enter run was lowered to 5 Mw. This widened the power range to permit a more orderly attainment of the run mode.

The "water systems" startup permissive for mode 1 operation was modified to require only one main secondary pump operating. This change will be in effect for the duration of 20-Mw operation.

A new permissive was added to the control circuitry for the rod drive electrical motors. The permissive allows the drive units to be inserted while in the "test" mode. The ability to operate the drive units in this manner is beneficial during shutdowns, when limit switches are adjusted.

Wide Range Counting Channels

The period smoothing time constant in each of the three channels was changed from 3 sec to 1 sec to improve the response time of the reverse and control rod inhibit functions. However, this change increased the fluxuations of the period display on the recorders.

The fission chamber assembly for channel 2 failed three times during the quarter. Each failure was attributed to the chamber voltage being shorted to ground. The chamber cabling was being damaged in the thimble during operation, causing the grounded condition. Tests are being conducted to determine the cause of the damage.

Safety Channels

During mode 3 operation, numerous rate trips were received in channel 1. Primary water flow through the reactor vessel caused vibration of the ionization chamber. The chamber was replaced, but the same variations in the flux signal occurred causing rate trips. For modes 1 and 2, the vibration-induced oscillations were insignificant, as compared to the less sensitive rate trip settings in these modes.

On January 7, trips were received in channel 2 because of a corroded terminal connection on one of the battery cells. The terminal was cleaned to eliminate the trips. A routine maintenance schedule to clean all battery terminals was established.

The reset flux signals did not return to their original reading after the safety tests were performed on each channel. To decrease these deviations, the reset gain deadband for each safety and servo channel was reduced from 1 Mw to 200 kw.

The faulty fuel element amplifiers were replaced in each channel to increase the sensitivity at 20-Mw operation. Each channel was sensitized to read 50% at 20 Mw and to scram at 75% of scale.

The hot-water-injection system check valves leaked excessively, causing variations in the heat power signals. A procedure was established to keep the block valves for each thermohm closed during the interval between tests of the safety system.

During a scram in two-out-of-three channels, the No. 5 rod withdraw inhibit feature did not function when the rod was in motion as the scram occurred. The inhibit matrix was changed to include both phases of the two-phase rod-drive motor. Previously, the inhibit matrix was in one phase only, allowing the motor to continue operating by the other phase.

Servo Channels

The polarity of the servo motor velocity indicators was reversed so that it would agree in direction with the "raise-lower" demand push buttons.

Oscillations occurred in each one of the servo systems as displayed by the velocity indicators during the quarter. Each time the other two channels responded to compensate for the oscillations and regulate the power at a constant level. Since the oscillations have been of such short duration, difficulty has been encountered in determining the source of trouble.

Control Plate Drives

The air motor for control plate 4 leaked air excessively and was replaced.

On March 26, during 20-Mw operation, the No. 3 plate dropped. Safety channel 3 was in a trip condition because the routine safety tests were being conducted. Oscillations were observed in the magnet current amplifiers for channel 1. It was suspected that the current

momentarily dropped low enough to cause the plate to drop. This was the first single-plate drop experienced.

The individual plates were dropped and timed on eleven occasions during the quarter. Acceptable results were obtained each time. Typical times from the withdraw limits are as follows:

<u>Plate No.</u>	<u>Release Time (msec)</u>	<u>Response Time (msec)</u>	<u>Time of Flight (msec)</u>
3/3 Scram - No Flow			
1	9.5	25	326
2	10.3	26	324
3	9.8	27	330
4	9.4	26	319
3/3 Scram - 15,800 gpm Flow			
1	10.2	26	279
2	9.6	25	279
3	9.7	26	282
4	9.7	26	285

Radiation Monitoring Channels

A high-level-radiation detection channel was installed in the control room with the detector located in the reactor bay. A recorder was provided in the control room to indicate radiation levels from 100 mr/hr to 10^5 r/hr. An annunciation is received if the level exceeds 5 r/hr.

Dual range amplifiers were installed in the two poolside onitrons to replace the single-range type. The two ranges are 0-25 mr and 0-125 mr with alarms at 7.5 and 40 mr. The higher range permits annunciation of higher radiation levels, such as those encountered during shutdowns and fuel transfers.

The ^{16}N monitoring system cycling valves leaked excessively and were replaced with spares. The original valves will be reinstalled after repairs are made.

Process Instrumentation

An operational test was made on all the process instrumentation prior to the power escalation to 20 Mw. This provided assurance that all process systems were operating properly.

The alarm switches for the secondary-fan-control circuitry were overloaded electrically. Relays were installed in the circuit with the switches to eliminate the overload condition.

The piping arrangements for the pH and conductivity sensing elements in the various water systems were inadequate to provide reliable information. Modifications are being made to correct the problem.

PROCESS SYSTEMS

Maintenance and changes in the various process systems are listed in Table 5.

Table 5. Process Systems, Maintenance and Changes

Date	Component	Remarks
Primary System		
1-24-66	Pressurizer pump 4A	The outboard bearing on 4A pressurizer pump was replaced.
3-9-66	Vessel and exit water line	Short sections of pipe and blank flanges were installed on the vessel RH-1 nozzle and the exit water line. These were installed for future use with the hydraulic rabbit facility.
3-30-66	Pressure-relief valve	The pressure-relief valve, PSV-155, on the discharge of the auxiliary pressurizer pump was adjusted to relieve at 750 psig.
Secondary System		
1-13-66	Control valve FCV-377	The valve operator was removed for a bench check of linkage.
1-21-66	Bypass valve FCV-377A	Installed 10-in. bypass valve FCV-377A around 36-in. valve FCV-377 for better control.
2-9-66	Fan 4A-1 gearbox	An oil leak was discovered at the sight-glass of the cooling tower fan 4A-1 gearbox. A new sight-glass will be installed.

Table 5. (Continued)

Date	Component	Remarks
2-10-66	Fan 4B-1 gearbox	Cooling tower fan 4B-1 gearbox was re-installed after being repaired by the vendor.
3-21-66	Pump flume screens	The pump flume screens were inspected. Large holes were found in the two, center, fine-mesh screens apparently caused by corrosion. All four fine-mesh screens are being replaced with galvanized wire.
3-29-66	Tower riser valves	The worm gear bearings in the riser valves for tower cells A and B were replaced. These valves had become very difficult to operate.

Ventilation Systems

2-10-66	CHOG fan FN-3 OHOG fan FN-5	The 27-in.-diam impellers for CHOG fan FN-3 and OHOG fan FN-5 were replaced by new 30 5/8-in.-diam impellers supplied by the vendor. A brief test of each fan showed it to be operating satisfactorily, providing a maximum suction pressure of -49-in. H ₂ O.
2-17-66	CHOG fan FN-4 OHOG fan FN-6	The 27-in.-diam impellers for CHOG fan FN-4 and OHOG fan FN-6 were replaced by new 30 5/8-in.-diam impellers supplied by the vendor. A brief test of each fan showed it to be operating satisfactorily, providing a maximum suction pressure of -49-in. H ₂ O.
2-28-66	New SBHE fan	Blanks isolating the new SBHE fan were removed. Operational tests indicate that the fan is performing properly.
3-3-66	SBHE and HOG filter pit sumps	Liquid-level sensors and alarms were installed in the drainage sumps at the SBHE and HOG filter pits.

Miscellaneous

1-6-66	Reactor components	Removed components, cleaned threads, and sprayed with Lubribond "A", a molybdenum disulfide lubricant (see Appendixes A and B).
1-11-66	Plant demineralizer	Removed and repaired internal piping which had been damaged. Added additional piping supports inside the demineralizer.

Table 5. (Continued)

Date	Component	Remarks
1-21-66	Air compressors	Air compressor ClB was inspected because of excessive noise. A broken feather valve in the lower exhaust port was found; pieces of the broken valve had damaged the carbon piston. The broken piston and feather valve were replaced.
2-14-66	Intermediate-level waste (ILW) sump	A local sump-level alarm (bell) and two indicating lights were installed at the ILW sump pit. The alarm will sound and a red light will come on when the sump level is low. A green light, indicating a satisfactory sump level, will normally be on.
2-16-66	Diversion valves	The process waste drain (PWD) to ILW diversion valves, which are operated remotely from the control room, did not work properly. Investigation showed corroded and dirty contacts on the relays and limit switches. These were cleaned and proper operation was restored.
2-18-66	Air compressors	A defective low-oil-pressure switch in air compressor ClA was replaced.
2-22-66	Diversion valves	The PWD to ILW diversion valves again failed to operate properly. The normally open auxiliary contact on the reversing starter for FCV-701 was stuck in the closed position. After these contacts were replaced, the system operated properly.
3-9-66	Poison injection system	A nipple and valve were installed on the suction line of the pressurizer pumps. Additional fabrication of this system can continue with the reactor operating.
3-24-66	Air compressors	The main air compressor loading and unloading pressure switches were reset to load and unload at 65 and 75 psig, respectively. The "standby start" setpoint was adjusted from 53 to 60 psi.
3-28-66	Instrument air dryer	A faulty automatic valve on instrument air dryer AD-2 was repaired and the unit was placed in service. The faulty valve had a scored shaft which was corrected by polishing.

Table 5. (Continued)

Date	Component	Remarks
3-31-66	Air compressors	The emergency air compressor automatic start and alarm switch settings were readjusted from 47 to 43 psig. This change was made to insure startup of the standby compressor before the emergency compressor.

FUEL

The status of the HFIR fuel target and control plate inventory is indicated in Table 6.

Table 6. HFTR Material Inventory

Item	No.
New fuel elements placed in service	1
New fuel elements available for use	5
New sets of shim plates placed in service	1
New sets of shim plates available for use	2
New plutonium target rods ready for use	31

EXPERIMENT FACILITIES

The only experiment facilities utilized at the HFIR this quarter were two of the beam tubes, HB-2 and HB-3. Scientists from Argonne National Laboratory and ORNL collaborated to measure the neutron spectrum emanating from the cold, clean reactor as the power was gradually increased.

OPERATIONAL NOTES AND SPECIAL TESTS

Building-Radiation Levels

A complete building-radiation survey was made when the reactor power level reached 20 Mw. The radiation at all the normally occupied areas of the facility was well below the daily tolerance level. These measurements indicate that the shielding will be more than adequate at 100 Mw.

Areas which are normally not entered during reactor operation were also surveyed to determine the radiation levels present. In the pipe tunnel a reading of 10 r/hr was observed ~18 in. from the exit water line midway of the east-west pipe tunnel. Less than 5 mrem/hr of fast neutrons were present. The maximum radiation level observed in the heat exchanger cells was 10 r/hr while the cell entrances did not exceed 100 mr/hr.

Stuck Fuel Element

After the reactor was shut down on February 27, 1966, the outer fuel element could not be removed from the fuel grid. As much as 800 lbs force was used while attempting to free the element, but without success. It was finally necessary to remove the element and fuel grid from the reactor as a unit.

A special tool was fabricated to separate the fuel element from the grid. About 5,000-lbs force was required to separate the components. An underwater inspection of the fuel element seating surface revealed nothing unusual; however, many small nicks were noted on the mating surface of the fuel grid. These nicks did not appear to be very deep and were spaced randomly around the outer rim of the mating surface. Their source has not been determined.

An evaluation of the "sticking" problem is under way. The clearance between the outer fuel element and the fuel grid will be increased on a few elements. Meanwhile the fuel element and fuel grid, which stuck together, were reinserted into the reactor and are being used for an additional operational period.

Oxidation of Fuel Elements

Recent experience at the HFIR has shown that if relatively clean aluminum components are put into the reactor and run at low temperatures (100-120°F) a voluminous, loosely adherent type of oxide is formed. This oxide is capable of cementing adjacent components. If an adherent, high-temperature oxide coating which forms at 90-100°C is already on the aluminum surfaces when they are put in the reactor, the low-temperature oxide does not form and many problems are avoided. Therefore, a small facility

was designed and installed to "oxidize" new fuel elements before they are placed in the reactor. Experiments have shown that treatment in 90-95°C water for 72 hours is sufficient to form the high temperature oxide, so all new fuel elements are "boiled" for 72 hours (in a critically safe container) before they are inserted into the reactor.

¹⁶N Thermocouple Probe

During an inspection of the reactor vessel while the fuel elements and fuel grid were removed, a bent ¹⁶N thermocouple probe was discovered in the No. 4 position. The thermocouple probe, which extends 7/8 in. above the 1.050-in.-diam pipe that houses both the probe and the water-sample inlet, was bent at an angle of approximately 45°. No leaks developed at the bottom head of the reactor vessel where the thermocouple leads enter the subpile room, so it was decided not to attempt to straighten the probe.

No definite conclusion has been reached as to how the probe was bent; however, it is probable the damage occurred while the outer fuel element and grid were being removed as a unit since a hook was placed beneath the grid to assure that it would not drop off the element during removal.

Hydraulic Tests

Hydraulic tests were performed to determine the effect on flow rate of leaving a plug out of the permanent beryllium. The following results were obtained with three pumps operating:

<u>Condition</u>	<u>Flow (gpm)</u>	<u>Temperature (°F)</u>
All plugs in	15,850	120
V-5 (1.58 in.) plug out	16,400	101
V-4 (1.58 in.) plug out	16,200	110

With a 2.83-in.-diam plug removed, the flow recorder went off scale (>17,000 gpm) with three circulating pumps in operation. The following data were taken with two pumps operating:

<u>Condition</u>	<u>Flow (gpm)</u>	<u>Temperature (°F)</u>
All plugs in	13,860	112
V-6 (2.83 in.) plug out	14,875	100

DEMINERALIZER SYSTEMS

Operation of the HFIR demineralizers is summarized in Table 7. All systems performed well. The only trouble occurred in the monobed of the plant demineralizer when it began leaking resin at the interface outlet piping. After removing the resin, an inspection revealed the internal interface piping was bent and broken. The piping was repaired and reinforced with better braces, and the unit was returned to service.

Table 7. Demineralizer Data: January 1 - March 31, 1966

Column	Run No.	Starting Date	Termination Date	Throughput Gallons	Specific Resistance		pH		Gross Activity (Counts/min/ml)	
					ohms	cm	Influent	Effluent	Influent	Effluent
					Influent	Effluent				
Pool System										
Cation	1	1-26-66		15,632,958	1.42x10 ⁶		6.1		70	
Anion	1	1-24-66		15,632,958		1.65x10 ⁶		6.1		8
Reactor System										
East Cation	1	1-26-66		8,984,970	1.43x10 ⁶		6.1		37,590	
East Anion	1	1-26-66		8,984,970		1.57x10 ⁶		6.1		153
Plant Demineralizer										
Monobed	72	12-21-65	1-5-66	20,720						
Monobed	73	1-5-66	1-13-66	23,920						
Monobed	74	1-13-66	1-14-66	23,140						
Monobed	75	1-14-66	1-16-66	27,680						
Monobed	76	1-16-66	1-16-66	24,250						
Monobed	77	1-16-66	1-19-66	27,640						
Monobed	78	1-19-66	1-27-66	25,600						
Monobed	79	1-27-66	1-29-66	24,010						
Monobed	80	1-29-66	1-30-66	29,850						
Monobed	81	1-30-66	2-2-66	31,590						
Monobed	82	2-2-66	2-13-66	24,800						
Monobed	83	2-13-66	2-20-66	26,300						
Monobed	84	2-20-66	3-1-66	30,420						
Monobed	85	3-1-66	3-12-66	31,310						
Monobed	86	3-12-66	3-14-66	25,880						
Monobed	87	3-14-66	3-23-66	26,100						
Monobed	88	3-23-66	3-30-66	22,920						
Monobed	89	3-30-66								

APPENDIX A

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

January 6, 1966

To: HFIR File

A meeting was held January 5, 1966 by the HFIR Project to discuss the problems of galling of various stainless steel bolts. The Project decided that all bolts fastening the following reactor components will be removed, lubricated with Lubri-Bond "A" and reinstalled:

<u>Component</u>	<u>Number of Bolts</u>
Clamp ring	24
Fuel grid	2
4 Control plate ball latch actuator	4
Inner control cylinder locknut	2
Upper tracks	4
Lower tracks	3
Fuel grid support	4
4 Shock absorbers	8
Shroud flange	20
Shroud flange bolt assembly	2
4 Outer shroud coolant nozzles	8
11 Coolant water nozzles	22

The procedure for the use and application of Lubri-Bond "A" is as follows:

1. Shake well before using.
2. Clean part to remove all dust, dirt, sand, oil grease or water, etc.
3. Keep nozzle of spray bomb approximately 10 inches from part. Spray thin coat of Lubri-Bond evenly over area to be lubricated. Too thick a coat is not only wasteful, but will also decrease the efficiency of the coating.
4. Allow "LUBRI-BOND" to dry thoroughly. Parts are ready for assembly within 30 minutes. Allow 6 hours additional drying time before use.
5. Shake spray bomb periodically while using to prevent sedimentation.
6. Spray on male threads only.
7. Do not use on aluminum.

HFIR File

January 6, 1966

8. Do not store in sunshine or permit contents to exceed 100°F.
9. Do not use near fire or flame.
10. Avoid prolonged or repeated breathing of vapors or contact with skin.

The use of lubricants on bolted joints inside the reactor vessel is contrary to the established practice. However, it was the consensus that the best combinations of materials are now being used and the application of a lubricant is the only alternative except for a long range development program.

R. V. McCord.

RVMc:ecm

Distribution: A. L. Boch
C. D. Cagle
W. R. Casto
R. D. Cheverton
W. G. Cobb
T. E. Cole
B. L. Corbett
J. A. Cox
R. M. Hill, Jr.
J. D. Hutchins
J. R. McGuffey

APPENDIX B

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

January 14, 1966

To: HFIR File

In addition to the components listed in my memorandum of January 6, 1966, the following components were also lubricated with Lubri-Bond "A":

<u>Component</u>	<u>Number of Bolts</u>
Beryllium plug access bolts in shroud flange	8
Inner shroud hold down clamps	8
Inner control rod bearing	2
Outer shroud strainers	8
Outer shroud pressure monitor flange	2

R. V. McCord

RVMc:ecn

Distribution: A. L. Boch
C. D. Cagle
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