UNIVERSITY OF MISSOURI

Research Reactor Facility

Research Park
Columbia, Missouri 65211
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September 28, 1981

Director of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Docket 50-186
University of Missouri
Research Reactor
License R-103

Subject: Annual Report as required by
Technical Specification 6.1.h(4).

Dear Sir:

Enclosed are the additional twelve copies of the reactor operations annual report for the University of Missouri Research Reactor as mentioned in my letter of August 28, 1981.

Sincerely,

J. C. McKibben
Reactor Manager

JCMK:vs

Enclosures

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UNIVERSITY OF MISSOURI

Annual Report 1980-81

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RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS

ANNUAL REPORT

August, 1981

Compiled by the Reactor Staff

Submitted by

J. C. McKibben
Reactor Manager

Reviewed and Approved

D. M. Alger
Associate Director

TABLE OF CONTENTS

SECTION I

REACTOR OPERATIONS SUMMARY

The following table and discussion summarize reactor operations in the period 1 July 1980 to 30 June 1981.

Date	Full Power Hours	MWD	Full Power Percent* Of Total Time	Full Power Percent* Of Schedule
July 80	704.9	293.54	94.74	106.1
Aug 80	697.9	290.95	93.80	105.1
Sep 80	675.9	281.06	93.88	105.1
Oct 80	707.7	308.97	95.12	106.5
Nov 80	655.2	273.18	91.00	101.9
Dec 80	683.1	284.72	91.81	102.8
Jan 81	704.5	293.61	94.69	106.1
Feb 81	597.4	248.31	88.90	99.6
Mar 81	700.1	291.77	94.10	105.4
Apr 81	619.1	258.30	85.99	96.3
May 81	692.9	288.83	93.13	104.3
June 81	620.2	258.70	86.14	96.6
Total For Year	8,058.9	3,371.94	92.00	103.3

*MURR is scheduled to average at least 150 hours per week at 10MW. Total time is the number of hours in a month or year.

JULY 1980

The reactor operated continuously during July, with the following exceptions: two maintenance shutdowns on July 14 and 28; nine scheduled shutdowns for flux trap sample changes; and five unscheduled shutdowns.

The reactor was shutdown due to loss of facility electrical power on July 2 and July 3. The loss of electrical power was verified by the city power plant in both instances.

A reflector differential pressure scram occurred on July 6 and again on July 8. Each time the breaker for pool pump P508B had tripped. When the breaker was thoroughly checked on the maintenance shutdown on July 14, the electrician found a poor connection between the breaker contact and starting relay. This caused overheating in the breaker assembly and tripping of the breaker's thermal overloads.

A rod not in contact with magnet rod run-in occurred July 14, when control rod mechanism "D" was bumped during a silicon sample handling evolution.

Major maintenance items for July included repairs to the silicon sample unloader, the pool pump breaker (P508B) and the particulate off-gas recorder.

AUGUST 1980

The reactor operated continuously during August with the following exceptions: one maintenance shutdown on August 25; a maintenance period following the unscheduled shutdown on August 3; nine scheduled shutdowns for flux trap sample changes; and five unscheduled shutdowns.

The reactor was shutdown by manual rod run-in on August 3 when an improper valve line-up resulted in sending water not meeting primary grade specifications to the primary hold-up tank (T-300). In accordance with technical specifications, T-300 must contain greater than 2000 gallons of primary grade make-up water to operate in Mode I. This occurrence was reported to the Nuclear Regulatory Commission in a letter dated August 29, 1980.

When the primary systems were being shutdown following the manual rod run-in on August 3, the primary inlet isolation valve (V507B) failed to shut when operated remotely. The valve was then shut by disconnecting the tubing to the solenoid valve and manually venting off the air pressure. The failure of the isolation valve to shut was due to the installation of an improper (oversized) lower seal on the solenoid control valve actuating piston, preventing the valve from venting properly. This incident was reported to the Nuclear Regulatory Commission in a letter dater August 29, 1980.

On August 4, a reactor startup was terminated by a manual rod run-in when the source range indication became erratic. The source range detector was replaced and no further problems were experienced with the source range.

Two scrams occurred on August 5, both due to temporary losses of electrical power to the facility. The power losses were verified by the University Power Plant.

The reactor was shutdown by manual scram on August 21, when Reactor Services notified the Control Room that the wrong sample had been removed from flux trap tube "B" during the previous sample changeout. This error resulted in tube "B" holder being 1" short of samples and spacers. This occurrence was reported to the Nuclear Regulatory Commission in a letter dated September 18, 1980.

Major maintenance items for August included removal of the Nuclepore irradiator case, the rebuilding of three-way valves for V507A, V527C and V526, and replacement of the source range detector.

SEPTEMBER 1980

The reactor operated continuously during September, with the following exceptions: two maintenance shutdowns on September 8 and 22; nine scheduled shutdowns and three unscheduled shutdowns.

A reactor scram occurred September 16 when the facility lost electrical power. The power outage was verified by the city power plant.

A power level interlock scram occurred September 22 when the motor-to-pump coupling failed on primary pump, P501A. The Machine Shop repaired and aligned P501A and the reactor returned to normal operation.

The reactor was shutdown by rod run-in on September 30, when the Rod Run-In Trip Actuator Amplifier (TAA) failed. The electronics technicians replaced the TAA and associated relays, 1K8 and 1K9. The rod run-in circuitry was tested and the reactor returned to normal operation.

Major maintenance items for September included the calibration of nuclear instrument channels 2 and 4, the repair of P501A and the rod run-in trip actuator amplifier.

OCTOBER 1980

The reactor operated continuously during October with the following exceptions: two maintenance shutdowns on October 6 and 20; eight scheduled shutdowns and one unscheduled shutdown on October 23.

The unscheduled shutdown was due to the failure of 529G, a solenoid which supplies operating air to the pool system isolation valve (V509). The failure of this solenoid caused V509 to shut, causing a power level interlock scram. After replacing the solenoid, V509 was tested and found to operate satisfactorily.

A reactor operations inspection was conducted by NRC Region III inspectors K. Ridgeway and K. Connaughton from October 8 to October 10; no items of noncompliance were found.

A letter dated October 20 was sent to the Nuclear Regulatory Commission detailing the events of September 22, 1980. While performing a semi-annual compliance check on the reactor coolant high temperature scram unit 980A, the meter relay trip unit failed to activate in response to a scram signal. The relay unit was replaced and the compliance check completed satisfactorily.

Major maintenance items for October included the alignment of P501A and the removal of the Nuclepore irradiator case from containment to an anti-contamination room outside the truck entry door.

NOVEMBER 1980

The reactor operated continuously during November, with the following exceptions: four maintenance shutdowns on November 3, 10, 16 and 23, eight scheduled shutdowns and two unscheduled shutdowns.

A reactor loop high temperature scram occurred November 6, after a reactor startup following a scheduled shutdown for flux trap sample change. Secondary pumps P-2 and P-3 were found to be air-bound, resulting in low secondary flow. The pumps were vented, secondary flow restored and the reactor returned to normal operation.

A reactor scram occurred November 18, when the facility lost electrical power. The power outage was confirmed by the power plant.

Major maintenance for November consisted of two spent fuel shipments, preparations for a third fuel shipment, repair work on the Nuclepore irradiator case and the inspection of offset mechanism "D".

DECEMBER 1980

The reactor operated continuously during December with the following exceptions: three maintenance shutdowns on December 1, 15 and 29; eight scheduled shutdowns and two unscheduled shutdowns.

A rod not in contact with magnet rod run-in occurred December 7, when control rod "A" mechanism was bumped while handling a silicon sample.

On December 17, a reactor loop high temperature scram occurred when the bulb which actuates the photoelectric cell in meter relay 980B (HX 503B) burned out. The bulb was replaced and the scram function of the meter relay was tested and found to meet compliance check specifications.

Major maintenance items for December included a spent fuel shipment, the replacement of DI-200 bed "M" with new bed "P", and the changeout of the offset mechanism for rod "B".

JANUARY 1981

The reactor operated continuously during January, with the following exceptions: two maintenance shutdowns on January 9 and 15; ten scheduled shutdowns; four power reductions to work on the Nuclepore irradiator case; one power reduction to enter the thermal column to remove a stuck radiography sample and one unscheduled shutdown on January 28.

The unscheduled shutdown was an intermediate range channel 3 short period rod run-in. The short period signal was due to electronic drift in the instrument. The high voltage power supply and voltage regulator were replaced and the reactor returned to operation.

Major maintenance activities in January consisted of the replacement of a line bearing in primary pump P501A and continued work on the Nuclepore irradiator case. The Nuclepore case was returned to service in January following an extended outage. Operational data and effluent analysis indicated that the new equipment was functioning very well.

On January 9 and 10, for a period of 20 hours, 40 minutes, the reactor was operated with low air flow through the stack radiation monitor due to the associated air bl..r being secured. This blower had been inadvertently left secured by Electronic Shop personnel after performing a calibr tion of the iodine instrument during a reactor start-up check. This incident was reported to the Nuclear Regulatory Commission in a letter dated February 5, 1981. The addition of a "blower on" light in the control room to prevent a reoccurrence of this problem was completed March 23, 1981.

FEBRUARY 1981

The rea-tor operated continuously during February with the following exceptions: two maintenance shutdowns on February 9 and 23; eleven scheduled shutdowns and six unscheduled shutdowns.

Two unscheduled shutdowns occurred on February 10. The first was caused by a short period scram from the failure of intermediate range detector channel 3. The detector was replaced and a reactor startup was begun. During this startup, a rod not in contact with magnet rod run-in occurred when rod "D" dropped from its magnet. Rod "D" was inspected and debris was removed from the magnet seating surface.

On February 13, during a hot startup, a channel 3 short period scram occurred. Channel 3 failed with meter indication upscale. The drywell for channel 3 was found to be leaking at the support bracket on the refuel bridge. After the drywell was repaired by the Machine Shop, channel 3 detector was reinstalled and a reactor startup was commenced [illegible]ring this startup, the reactor was manually scrammed when the reactor operator noticed a negative period on channel 3 while pulling control rods while still subcritical. This was caused by reversal of leads when channel 3 detector was reconnected to the channel 3 drawer. The drawer connections were made properly, a front panel check was performed and the reactor returned to operation. This incident was reported to the Nuclear Regulatory Commission in a letter dated March 13, 1981.

During 10 MW operations on February 14, the regulating blade shifted out of automatic control resulting in a power reduction to about 2.5 MW's. Power was controlled at this point in manual control until the regulating blade circuitry could be inspected. No abnormalities were discovered and the reactor returned to normal operation in automatic control.

While shutdown for regularly scheduled maintenance on February 23, the actuator for one of the reactor convective cooling loop isolation valves was found to no longer be capable of moving the valve to the fully open or shut seats. The parallel isolation valve functioned properly and s[illegible]y analysis assumes only one of the parallel valves will function. The valve was rebuilt and tested satisfactorily. This was reported to the Nuclear Regulatory Commission in a letter dated March 17, 1981.

Also on February 23, one of the air charging valves for the containment leak check system was found open. This valve is on a 3/4" line leading directly from the facility basement to the containment building. A valve line-up was conducted and a pipe plug installed in the line. This was reported to the Nuclear Regulatory Commission in a letter dated March 17.

A rod not in contact with magnet rod run-in occurred on February 24 when rod "D" fell off its magnet while shimming control blades. The rod "D" drive mechanism was pulled and the magnet and anvil were inspected and aligned.

Major activities in February included a reactor operator license examination on February 9, research into a secondary-to-primary calorimetric power indication mismatch (found to be due to secondary flow transmitter being out of calibration), emergency repair of channel 3 drywell and repair of reactor convective valve V546B.

MARCH 1981

The reactor operated continuously during March, with the following exceptions: two maintenance shutdowns on March 9 and 23 and nine scheduled shutdowns. There were no unscheduled shutdowns in March.

Major maintenance in March included the replacement of offset mechanism "D" (Modification Package 81-6); the installation of a poly bushing in offset "B" (Modification Package 81-5); and the addition of a "motor on" light in the control room to monitor the off gas system blower (Modification Package 81-3).

APRIL 1981

The reactor operated continuously in April with the following exceptions: three maintenance shutdowns on April 6, 20, 27; nine scheduled shutdowns and eleven unscheduled shutdowns.

The reactor was shutdown by manual rod run-in on April 3 to replace a failed bearing on the inner airlock door.

During a normal reactor startup on April 6, the failure of channel 6 nuclear instrument detector to respond sufficiently to power level changes resulted in a manual rod run-in. The channel 6 detector was replaced and the reactor returned to operation.

Two scrams due to loss of facility electrical power occurred in April (April 9 and April 16). Both electrical power losses were verified by the University Power Plant.

The reactor was shutdown by manual rod run-in on April 11, when a reactor loop high temperature alarm was received. The cold leg temperature indicated 172° on the chart recorder, but the digital indication from the same unit was normal and a separate cold leg recorder also indicated normal temperature. The reactor was returned to operation with no further problem of this nature.

Later, on April 11, the reactor was shutdown by manual rod run-in when one of two operators had to leave the facility, resulting in only one licensed operator available. A second licensed operator was called in and operation resumed.

There were two manual scrams and one manual rod run-in to repair fire main leaks. This water source is required by technical specifications for reactor operation. These shutdowns occurred twice on April 12 and once April 18.

The reactor was shutdown by manual scram on April 16 to replace the drive sprocket on the outer airlock door.

The reactor was shutdown by manual scram on April 25 when a loud explosion was heard on the beamport floor. The reactor was returned to normal operations after investigating the problem and discovering an air dryer unit supplying control air to the Nuclepore experiment exploded due to overpressure. The control air system for the Nuclepore has no effect on reactor operations.

Major maintenance items for April included work on the fire main system, the replacement of channel 6 nuclear instrument detector and two reactor test procedures - RTP-4 (Control Rod Calibration) and RTP-17A (Flux Trap Sample Reactivity Determination).

During compliance check 22 (Primary Pressure Switch 944 A/B and Pressure Transmitter 943) conducted April 20, the meter relay unit for pressure transmitter 943 failed to provide a scram. The meter relay unit was replaced, the compliance check completed and the reactor started up upon completion of scheduled maintenance. This incident was reported to the Nuclear Regulatory Commission in a letter dated May 18, 1981.

All similar meter relay units used in the protection system were bench tested and verified operable on the April 27 maintenance day.

MAY 1981

The reactor operated continuously during May with the following exceptions: nine scheduled shutdowns for flux trap sample changes; two shutdowns for maintenance days on May 4 and May 18; and four unscheduled shutdowns.

Two shutdowns by rod not in contact with magnet rod run-in occurred in May, one May 4 and another on May 5. Both were due to rod "D" disengaging from its magnet. In both cases, the cause of the rod drop was due to misalignment of the upper housing.

Two unscheduled shutdowns occurred due to loss of facility electrical power. These occurred on May 18 and May 23. Both power interruptions were verified by the University Power Plant.

Major maintenance items for May included completion of the building leak rate check, the replacement of P-4 check valve in the secondary-to-air-conditioning units' piping, and the dumping of DI-200 resin bed "N".

Two NRC inspections took place in May. NRC Region III Inspector G. Christoffer performed a safeguards inspection on May 5 and 6 and NRC Region III Inspector Ken Ridgway completed a routine inspection extending from May 18 to May 22.

JUNE 1981

The reactor operated continuously during June with the following exceptions: four maintenance shutdowns on June 1, 8, 15 and 29; eight scheduled shutdowns and seven unscheduled shutdowns.

A rod not in contact with magnet rod run-in occurred June 3 when rod "D" dropped from its magnet. Moisture was found in the pins of rod "D" power connector. After drying the connector, the reactor was returned to operation.

The reactor was shut down on three separate occasions by manual rod run-in to work on the personnel airlock doors. On June 5, the shutdown was due to the airlock door gasket coming out of its seat. The other shutdowns, on June 16 and 18, were due to failures in the electrical control relays for the open-close sequence of the airlock doors.

The reactor was shutdown by manual rod run-in due to fluctuations in indications provided by channel 3. The channel 3 detector, cables and connectors were replaced and the reactor returned to operation.

On June 9, the reactor was shutdown by a high power scram channel 4 during a reactor startup. The scram was caused by a static charge buildup in the wide range selector switch and was not due to actual high power on channel 4.

A rod not in contact with magnet rod run-in occurred June 16 when rod "C" dropped from its magnet. The upper housing was realigned and the reactor returned to operation.

Major maintenance items included the installation of offset #5 in rod "C" position, the installation of a new channel 3 detector and the installation of a new section of pipe in the fire main emergency pool fill line.

SECTION II

OPERATING PROCEDURE CHANGES

As required by the MURR Technical Specifications, the Reactor Manager reviews and approves the Standard Operating and Emergency Procedures (SOP). Ten revisions have been made to the SOP during the past year. The revisions are contained in this section with the part of each page that was revised marked on the right side of the page by a vertical black line.

REVISION NO. 1

8/05/80

SOP/VIII-11	Revised 8/80
SOP/VIII-12	Revised 8/80

water and biological fluids will be doubly encapsulated with the secondary encapsulation being a high density polyethylene rabbit.

3. Powder samples will be sealed in a polyethylene vial and irradiated in a high density polyethylene rabbit. Boron and boron compounds in powder form will be sealed in high density polyethylene within the rabbit.
4. A metal liner such as cadmium sheet may be used in the rabbit providing it is in one piece and covers at least 80 percent of the rabbit's interior surface. The experimenter shall take measures to insure that the heat generated by the metal can be dissipated and will not cause damage to the sample or rabbit.
5. The experimenter shall insure that the sample is adequately secured in the rabbit (by polyethylene packing, etc.) so that the motion within the rabbit is minimized.

C. Material which may be irradiated in the p-tube system includes water, plant and animal tissue and fluids, bone, air filters, soils, rocks, soil extracts, coal, paper, meteorites, fibers, dried paint, safe insulation and glass. Pure elements, alloys and compounds not exempted in D below may also be irradiated subject to the activity limitations in A.

D. Unless it is specifically authorized in the experimenter's RUR, the following materials will not be irradiated in the p-tube system:

1. Natural uranium;
2. Special nuclear materials as defined in Title 10, Part 70, Paragraph 70.4m of the Federal Code of Regulations (i.e., plutonium, uranium-233 or uranium enriched in isotope 233 or 235);

3. Pure elements: Li, Na, K, Rb, Cs, Ca, Sr, Ba, Hg, Os, H, O, F, Ne, Ar, Kr, Xe, and P;
4. Compounds: NH_4NO_3, CaC_2, CaO, perchlorates, permanganates, Na_2O, and Na_2O_2;
5. Materials which chemically react with water to produce undesirable quantities of heat and pressure;
6. Any explosive, flammable, combustible, or toxic materials.

E. The controlling factor for determining the weight and time limits of a sample to be irradiated in the p-tube is the activity limitation of section A. If the activity limits do not further restrict a sample's size, the following weight limits shall apply:

1. For irradiation times up to 30 minutes, the maximum weight of irradiated materials in one rabbit will be 2 grams with three exceptions:
   a. A maximum of 10 grams of water or dried feces;
   b. Only 1 mg of chemical compounds in solution;
   c. A maximum of 10 grams of boron, BC, or BN in the form of powder. The experimenter shall take measures to insure the heat generated can be dissipated without causing damage to the rabbit or sample.
2. For irradiation times of 30 minutes to 1 hour, the maximum weight of irradiated materials in one rabbit will be 1 gram with two exceptions:
   a. A maximum of 10 grams of water or dried feces;
   b. Only 500 μg of chemical compounds in solution.

The weight limits above do not include the weight of the rabbit, polyethylene vial, or packing, or the candmium (or other metal) shields.

The maximum irradiation time for most samples will be one hour at power levels $\leq$5 MW and 30 minutes for power levels $>$5 MW. Hair, fibers, paint, air filters and flux monitors may be irradiated for a maximum of 4 hours at power levels $\leq$5 MW and 2 hours at power levels $>$5 MW. The following additional limitations shall apply for irradiations $>$ 10 minutes:

1. Primary encapsulation will be heat-sealed high-density polyethylene vials (Holland vials).

REVISION NO. 2

8/25/80

SOP/I-14	Revised 8/80
SOP/III-6	Revised 8/80
SOP/VII-40	Revised 8/80
SOP/VIII-19	Revised 8/80
SOP/VIII-20	Revised 8/80

Table IV

Values of Trip Settings for Alarm, Run-In and Scram Conditions

		Scram	Run-In	Alarm	Units
1.	Short Period	9	11	----	sec
2.	Low Count Rate	---	---	<1.0	cps
3.	High Power	120	115	---	% full power
4.	RC Inlet Temp	152	---	148	°F
5.	RC Outlet Temp	173	---	165	°F
6.	RC System Low Flow 5 MW Operation	1675	---	1750	gpm
	RC System Low Flow 10 MW Operation	[2]1675	---	[2]1750	gpm
7.	Heat Exchanger Low ΔP (DPS 928A/B)	[4]1675	---	---	gpm
8.	Rx System Low Press Switch PS 944A/B	[3]61	---	---	psig
9.	Core Low ΔP, 5 MW	[4]1650	---	---	gpm
	Core Low ΔP, 10 MW	[4]3300	---	---	gpm
10.	Low Pressurizer Level	14 below ℄	---	10-13 below ℄	inch
11.	Hi Pressurizer Wtr Level	---	---	12-15 above ℄	inch
12.	Low Pressurizer Press	61	---	64	psig
13.	Hi Pressurizer Press	79	---	76	psig
14.	Pool Low Flow, 5 MW	440	---	480	gpm
	Pool Low Flow, 10 MW	[2]440	---	[2]480	gpm
15.	Pool Loop Hi Temp	---	---	115	°F
16.	Low Pri Denim Flow	---	---	< 42.5	gpm
17.	Low Pool Demin Flow	---	---	< 42.5	gpm
18.	Bldg Air Plenum Hi Activity	1.0	---	---	mr/hr

[1]Deleted

[2]For 10 MW operation, Alarm and Scram Received from Either Loop

[3]Pressurizer Pressure with normal system flow

[4]ΔP corresponding to this flow value

E. Set function switch to "operate". Verify that "drawer inoperative" lamp is extinguished.

F. Verify that power level trip indicators are extinguished.

G. Set function switch to "standby". Verify that power level trip indicators are extinguished, that "drawer inoperative" light (DS16A) is energized, and that a nuclear instrument anomaly annunciation occurs.

H. Set function switch to "zero". Verify that both percent power meters (on the console and instrument cubicle) and the recorder indicate 0 ± 2%. Verify that a downscale light is received on the drawer and that a downscale alarm is received on the annunciator.

I. Set function switch to 110%. Verify that the console percent power meter and the recorder indicate 110% ± 2% and the drawer meter indicates 110% ± 5%.

J. Set function switch to 75%. Verify that the console percent power meter and the recorder indicate 75% ± 2% and the drawer meter indicates 75% ± 5%.

K. Set function switch to 10%. Verify that the console percent power meter and the recorder indicate 10% ± 2% and that the drawer meter indicates 10% ± 5%.

L. Place function switch in "cal" position. Rotate reset switch to left or right to clear rod run-in and scram trips. Reset annunciator board. Using the potentiometer provided on the front of the drawer, apply an input current equivalent to the desired trip point for rod run-in (114% ± 1%). Verify that rod run-in light (DS17A) is energized and that Channels 4-5-6 High Power Rod Run-In annunciation occurs.

M. Apply an input current equivalent to the desired trip point for scram (120% ± 1%). Verify that scram light (DS16B) is energized and that Channels 4-5-6 high power scram annunciation occurs.

Note: Rinse only long enough to obtain an increase in resistance. If it stops, repeat VII.4.8.10; varying the flow rate may also help the rinse requirement. Use minimum DCW for rinse.

D. Let the water run to waste until the purity instrument shows a minimum resistivity of 500K ohms.

E. Close all valves, then open the outlet valve on F301.

F. The demineralizer is now ready for use.

G. Log regeneration complete.

VII.4.8.13 Providing DI Water to T300

DI water may be sent to T300 with or without the use of the reverse osmosis unit as a DI300 makeup supply. Due to the fact that DCW, after passing through the R.O. Unit, is much more pure than raw DCW, the R.O. Unit is normally utilized to prolong the life of the DI300 resin regeneration. However, there are provisions for bypassing the R.O. Unit when sending DI-300 water directly to DI200. (See VII.4.8.13a, b and c.)

VII.4.8.13a Providing DI Water to T300 with Reverse Osmosis Makeup

1. Check shut valve 7 and open RO-8.
2. Open T300 supply valve (Reach Rod).
3. Open isolation valve for auto valve.
4. Turn on conductivity meter and place auto valve in auto.

   CAUTION: Auto valve should be open, if not or if reading is near set point, place normal, bypass switch to bypass. (This is so the R.O. Unit will not cycle on and off as the auto valve opens and closes. When the reading on the conductivity meter is low so the valves do not cycle, place normal, bypass switch to normal.)
5. Place R.O. Unit in operate mode and push start/reset switch. (Pressure should come up to 180-200 psig.)

C. Report to the control room the material contained in the sample, the expected activity and dose rate, and the approximate time the rabbit can remain in the reactor without creating any hazard.

VIII.3.5.3 Rabbit Stuck in Tube

Any time all or any part of the rabbit fails to return to the dispatch station, notify the control room immediately about the problem, stating the material contained in the sample, the weight of the sample, the expected activity and dose rate, the approximate time the rabbit can remain in the reactor without creating any hazard or melting.

A. After the control room is aware of the problem, press the emergency return switch. Observe the rabbit in reactor light (CL-4) and check with the control room to see if the operators heard the rabbit leave the reflector region.

Note: CL-4 is not a true indication of rabbit location. It simply indicates the electronic control signal to the unit. Hearing the rabbit depart the reflector is the only sure way to know it has left.

If the rabbit was heard to depart the reflector region, check the connecting station to see if the rabbit was returned there.

B. Check the station lineup, verify the circuit selector switch (CB-1) is selected to the proper station as indicated by CL-2 or CL-3.

C. Depress the reset switch (CB-3).

D. Depress the dispatch button (CB-4) while observing CL-4.

E. Repeat steps A through D several times as directed by the control room.

F. If the attempts fail, go to the connecting station, line it up for service and repeat steps A through D.

G. If these procedures have failed, follow up action will be handled by reactor operations and Health Physics personnel.

Note: If the rabbit is stuck outside the reactor it may be found by searching the guide tubes with a radiation monitor.

If the rabbit is stuck in the reflector, the reactor must be shutdown and the p-tube removed.

VIII.3.5.4 Wet Rabbit

If the outside of the rabbit is wet when it is returned from the reactor, notify the control room immediately.

VIII.3.6 Emergency Return of Rabbit with Malfunctioning P-Tube Control Box

Dispatch and return of the rabbit is controlled by solenoids in cabiret located by the seal trench. All solenoids in use are labeled by letters in the solenoid cabinet. Procedure to be followed in case of a failure at the local station is as follows:

A. Remove cover to solenoid cabinet.
B. Turn solenoid power switch off. (This deenergizes all solenoids.)
(NOTE: This closes off all tubes which will result in a high concentration of Ar^{41} if the reactor is operating.)

REVISION NO. 3

9/30/80

SOP/I-7	Revised 9/80
SOP/I-8	Revised 9/80
SOP/I-8b	Revised 9/80
SOP/II-1	Revised 9/80
SOP/II-2	Revised 9/80
SOP/II-3	Revised 9/80
SOP/II-4	Revised 9/80

Table II

ECP	Acceptable Limits
11" - 16"	± 0.40"
16" - 22"	± 0.70"
22" - 26"	± 1.25"

H. Instrumentation

Minimum nuclear instrumentation for startups shall be one source channel, two intermediate range channels each with period trip, two power channels each with flux trips, and one wide range channel with high flux trip.

I. Use of the Public Address System

Immediately prior to actual movement of the control rods, an announcement will be made over the public address system that a reactor startup has been commenced. A second announcement will be made when the desired power level is obtained. If during the startup the determination is made that power will be held constant at any level for a period of greater than five minutes an additional announcement will be made to inform building personnel.

J. Health Physics Monitoring of Reactor Experiments During a Reactor Startup

When a change is made to a beamport or other reactor experiment which could lead to significant alterations in area radiation levels as reactor power is increased, a Health Physics Technician will be assigned to continuously monitor that experiment throughout the startup. Direct communications will be maintained between the Control Room and the Health Physics Technician. The Control Room will inform the Health Physics Technician at the following power levels

1. During a Normal Reactor Startup
    a. When the reactor reaches criticality.
    b. When reactor power reaches 50 KWs.

c. When reactor power reaches 5 MWs. (2.5 MWs if operating in Mode II)

d. When reactor power reaches 10 MWs. (5 MWs if operating in Mode II)

2. During a Reactor Hot Startup

a. When the reactor reaches criticality.

b. When reactor power reaches 5 MWs. (2.5 MWs if operating in Mode II)

c. When Reactor power reaches 10 MWs.

If direct communications are lost or if one of the above reports is not acknowledged, reactor power will be maintained at a steady level until the problem is corrected. The Health Physics Technician will make his final report to the Control Room after a complete survey is conducted at the desired power level.

I.4.4 Normal Operation

A. Normal power level will be 9.90 to 10.00 MW as indicated by the total power meter.

B. The control room shall be occupied by at least one licensed operator during steady state operation of the reactor and a second licensed operator will be in the Facility Building and at a location where communication with the control room can be maintained.

C. Prior to assuming control of the reactor, the oncoming operator will read the control room log book and shall be briefed on current operation.

D. During shift operation, the shift supervisor for the new shift will review the log book and be briefed on current operations by the crew he is to relieve. Upon completion of the log book review, the shift supervisor will note the same in the log book.

E. A complete set of Nuclear data will be taken once an hour during steady state operation.

F. A complete set of Process data will be taken every two (2) hours during steady state operation.

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Section II
Reactor Operating Procedures

II.1 Routine Reactor Operation

II.1.1 Procedure for Reactor Startup

For full power, closed pressure vessel operation, the reactor will be brought to its scheduled operating power level according to the procedure outlined below.

A. Take a complete set of full power process data.

B. Obtain from the Shift Supervisor an estimate of the critical banked control blade position.

C. Take a complete set of nuclear data on the Startup Nuclear Data Sheet.

D. Complete the applicable startup checksheet required by Section I (I.4.3.F).

E. Obtain from the Shift Supervisor permission to commence a reactor startup.

F. Announce via the public address system that a normal reactor startup has been commenced.

G. Withdraw the four control blades in gang, stopping to take a set of startup nuclear data at five-inch increments. Indicate in the console log book that startup has commenced.

H. When the blades have reached a position within 2 inches of the estimated critical position, discontinue pulling in gang and take a set of startup nuclear data.

I. Continue the startup, withdrawing only one blade at a time until the reactor power level is increasing on <u>no less than</u> a 30-second period.

J. At the point where the reactor is indeed critical and on a positive period, a console log entry shall be made stating that fact.

K. Bring the reactor critical at a steady state power level of approximately 50 KW unless a lower power level is desired for tests, calibration runs, etc. The lowest steady state power level reached and any ensuing steady state power will be logged on the Startup Nuclear Data Sheet for a record of reactor operating time.

L. Withdraw the fission chamber to full out.

M. Verify that all nuclear instrumentation is responding normally.

N. Take a complete set of nuclear data on the Startup Nuclear Data Sheet. Indicate on this sheet the critical control and reg. blade positions and the primary and pool temperatures.

O. Continue the startup, withdrawing only one blade at a time until the reactor power is increasing at no less than a 30 second period. At power levels greater than 100 KW, maintain the control blades such that the maximum difference in position between any two blades always remains less than 1 inch.

P. As the reactor power level approaches 1 MW, increase the period until a stable period remains that is no less than 100 seconds for all power increases greater than 1 MW.

Q. Bring the reactor critical at a steady state power level of 2.5 MW if in 5 MW mode of operation or 5.0 MW if in 10 MW mode of operation. At this power level:

   1. Verify that the nuclear instrumentation is in essential agreement with the actual power level which can be read out directly from the digital calorimetric meter. Note the actual power level in the operations console log book. In the case of the calorimetric meter being out of commission during a startup, the power level may be determined by manual calculation.

   2. Note the time of arrival and departure from this power level on the Nuclear Startup Data Sheet.

R. Continue the reactor power increase by withdrawing only one control blade at a time, maintaining the reactor period at no less than 100 seconds.

S. As the scheduled power level is reached, adjust the control blades until the reactor is critical at the desired steady state power in either the manual or automatic control mode.

T. Switch IRM recorder from fast to slow speed and secure the SRM recorder and scaler.

U. After the temperatures stabilize, take a complete set of nuclear and process data.

V. Announce to experimenters the reactor power level, schedule and note arrival in the log book.

II.1.2 Procedure for Hot Startup

A hot startup shall only be made by a senior reactor operator, or a licensed reactor operator under the direct supervision of a senior reactor operator. Gang control of the rod drives may be used for the entire approach to critical and to override Xenon buildup if required.

A. Take a set of startup nuclear data.

B. Obtain an estimate of the critical banked control blade position from the shift supervisor.

C. Obtain permission from the shift supervisor to commence a reactor startup.

D. Announce via the public address system that a hot reactor startup has been commenced.

E. Withdraw the four (4) control blades in gang, stopping to take a set of startup nuclear data at five inch increments. Insure the stable period is no less than 30 seconds.

F. At 50 KW or when channel 1 indication is greater than 10^{+5}, withdraw the fission chamber to full out position.

G. Continue the startup, insuring that the maximum difference in position between any two (2) blades always remains less than one (1) inch.

H. Stabilize reactor power at a power level of 2.5 MW in Mode II or 5 MW in Mode 1. At this power level:

1. Verify that the nuclear instrumentation is in essential agreement with the actual power level which can be read out directly from the digital calorimetric meter. Note the actual power level and the time of arrival in the console log book.

2. Note the critical rod heights, power level, primary and pool temperatures, and arrival/departure times on the Startup Nuclear Data Sheet.

I. Continue the reactor startup by withdrawing only one control blade at a time, maintaining the reactor period at no less than 100 seconds.

J. As the scheduled power level is reached, stabilize power in either manual or automatic control and complete the following:

1. Switch the IRM recorder to slow speed and secure the SRM recorder and scaler.
2. Note the time of arrival in the console log book and in the Start-up Nuclear Data Sheet.
3. Take a complete set of nuclear and process data as soon as the temperatures stabilize enough to get a representative ΔT on the primary and pool.
4. Announce to experimenters the reactor power level.

II.1.3 Assuming Automatic Reactor Control

A. Conditions to be met prior to "auto" operation.

Prior to assuming automatic control for reactor operation, the following conditions must be met:

1. The period as indicated by both IRM-2 and IRM-3 must indicate not less than 35 seconds.
2. The WRM selector switch must be in the 5 KW red scale position or above.
3. The power trace pointer (black) on the WRM recorder must be reading greater than the auto control prohibits set point (red).
4. The reg blade position must be greater than 60% withdrawn, such that 60% annunciator alarm is energized.

B. Procedure

To place the reactor into the automatic control mode:

1. Set the low level trip (red pointer) in the wide range recorder so that the auto-control prohibit trip is at 75% of the desired operating power.
2. Using the power schedule switch (1S9), bring the setpoint indicator to approximately 3% below a desired power level of >1000 watts as would be indicated on the black scale of the wide range monitor.

REVISION NO. 4

12/19/80

SOP/II-9	Revised 12/80
SOP/II-10a	Revised 12/80
SOP/II-11	Revised 12/80

B. Depress the manual rod run-in button on the control console. Enter the time of shutdown in the log book.

C. Follow the reactor power decrease by changing the range selector switch so as to keep channel WRM-4 on scale.

D. Complete the Reactor Shutdown Checksheet.

E. Ascertain that the reactor system is secured and enter same in log book.

II.2.1 Fuel Handling Procedure

A. All fuel transfers will be authorized by the Reactor Manager or his designated representative.

B. If a fuel assembly is determined by the Shift Supervisor to be damaged, authorization must be obtained from the Reactor Manager prior to loading that element in the reactor.

C. The Special Nuclear Materials Custodian (Reactor Physicist) shall provide a step by step fuel movement procedure anytime fuel is handled.

D. Fuel, new or irradiated, shall only be handled one element at a time.

E. The reactor will be shutdown prior to handling fuel in the reactor. Fuel may be handled in the weir area while the reactor is operating.

F. Containment integrity is required anytime irradiated fuel is being handled.

G. Health Physics coverage shall be necessary when the pool is below normal operating level, inspecting irradiated fuel, shipping irradiated fuel and handling suspected ruptured irradiated fuel.

H. One senior reactor operator and one reactor operator must be present to handle fuel. Only a senior reactor operator, a reactor operator, or a reactor operator trainee under the <u>direct</u> supervision of a senior reactor operator may handle fuel. The senior operator is in charge of the fuel handling evolution and is responsible for the proper conduct of the evolution.

the element by pushing down and turning until it floats off. Failing to release the element in this manner may result in accidentally lifting and leaving the element a few inches off of its seated position without realizing it.

II.2.2 Procedure for Handling Fuel in or out of the Core

A. Obtain a fuel handling sequence from the Reactor Physicist.

B. Inspect the fuel handling tool.

C. Place the bridge ARMS to upscale position.

D. Insure the pool is at the normal operating level or pump the pool to refuel level as necessary.

E. Remove the pressure vessel head.

F. Turn on the Source Range Monitor Scaler and Chart Recorder. Drive in the fission chamber to ≈ 1000 counts.

G. Attach a fuel element to the handling tool.

H. The operator handling the fuel element tool shall verify that the element is fully latched and verbally report this to the supervising Senior Reactor Operator.

NOTE: A positive latch is achieved only when the red plunger on the air-handling tool is fully retracted and flush with the cylinder. Any protrusion of the plunger means the fuel element is not latched.

I. Remove and visually identify the fuel element and place it in the position specified on the loading sheet.

J. Verify the element is seated in its new position. If in the reactor, utilize board and reference mark.

K. A reactor operator or senior reactor operator shall initial the loading sequence sheet after each step.

L. A senior reactor operator will inspect the core prior to replacing the pressure vessel head.

M. Install the pressure vessel head. (If the pressure vessel head is to be left off at this point, install the aluminum protective head on the pressure vessel.).

N. Record that the reactor has been defueled or refueled indicating the identification numbers of the cores involved and the fact that the new core has been inspected.

O. Post the fuel element locations data sheet in the control room.

P. Turn the bridge ARMS back downscale.

Q. Secure the SRM and pull the fission chamber to full out.

II.2.3 When starting up the reactor after any fuel change in the core, the predicted critical position shall be verified by the Reactor Physicist. If the reactor has been loaded with a new mixed core, a 1/M plot shall be made on the subsequent start-up.

II.3 Control Blade Offset Mechanism Removal

II.3.1 Conditions Prior to Removal

A. The control rod offset mechanism will not be removed except by authorization of the Reactor Manager.

B. The removal of the assembly will be supervised by the shift supervisor or a senior operator.

C. When one offset mechanism is to be removed:

1. The core will be defueled of two fuel elements;
2. The balance of the other three rods will not be raised from their fully lowered position without approval of the Reactor Manager.

D. When more than one offset mechanism is to be removed, the core will be defueled of at least two elements for each offset mechanism removed.

E. A Health Physicst or a Health Physics Technician is to be present when the pool water is lowered and when the mechanism is brought out of the water.

REVISION NO. 5

1/30/81

SOP/VII-63	Revised 1/81
SOP/VII-64	Revised 1/81
SOP/A-4	Revised 1/81

door 101 and the personnel air lock doors.

With the reactor operating the compressor for isolation valve 16B may only be electrically secured when the valves are placed in the closed position. Should this be necessary, open the local switch only, because the main switch also provides power to the facility and reactor isolation systems.

The instrument air compressor may be shutdown by opening its local breaker. Its main supply may be secured at breaker #3 of LP-11. If secured and air supply is still required, the cross connect valve from the main compressor may be opened.

If any of the components or compressors above are secured or placed in a position other than normal, the component shall be tagged in accordance with the tag-out procedure.

VII.11 Beamport Water System
See Section VIII.4

VII.12 Sulphuric Acid System

VII.12.1 Receiving Bulk (concentrated) Acid

CAUTION: This process is extremely dangerous. Protective equipment must be worn. Always have an available supply of water and sodium bicarbonate.

Bulk sulphuric acid is delivered by tank truck and is transferred to the storage tank by air pressure or gravity drain. When possible the gravity drain method should be used. In the event air pressure must be used, extreme caution should be exercised. The tank truck can easily exceed the receiving capacity of the system. Insure that the tank pressure does not exceed 15 psig. and closely monitor tank levels.

A. Check valve 1 closed and valves 2 and 3 open.

B. Crack open the Tank-O-Meter bubbler valve 7 to give an air flow of 3-4 bubbles per second. Note and record the tank level indicated on the Tank-O-Meter.

C. Remove the cap on the fill line to enable connection of the transfer line from the truck. Commence filling the tank.

D. While the tank is filling, watch the Tank-O-Meter to insure that an air flow of 3-4 bubbles per second is maintained.

CAUTION: If the system is over filled acid will spill into the mixing tank. The heat generated at this point could result in damage to the acid handling system.

E. When the tank volume reaches 750 gallons, secure the transfer.

F. Disconnect th transfer hose into the storage tank.

G. Record the final volume of the tank and report to the truck driver the amount of acid received. Close the bubbler valve

VII.12.2 Transferring Acid from the Storage Tank to the "Day Tank"

When the acid in the day tank has been used, the tank is refilled with acid from the storage tank by carrying out the following procedure.

A. Check valves 2 and 3 open.

B. Crack open the bubbler valve (7) to give an air flow of 3-4 bubbles per second.

UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY
REACTOR SHUTDOWN CHECKSHEET

App'd [signature]
Rev. 1/22/81
DATE ______

1. Time of reactor shutdown.. ____
2. All blades bottomed and drive mechanism full in.................................... ____
3. Magnet current switch off.. ____
4. SRM set to required position.. ____
5. Reactor primary system shutdown per SOP IV.. ____
6. Pool system shutdown per SOP V.. ____
7. Secondary system shutdown per SOP VI.. ____
   a. Cooling tower fans off.. ____
8. Digital readout switch off.. ____
9. Annunciator board on ____ off ____.. ____
10. Reverse osmosis unit secured.. ____
11. Sample inventory satisfactory and data sheets updated.. ____
12. Si integrators recorded.. ____
13. All bypass switches off and keys in key box.. ____
14. Master switch off ______ on ______.. ____
15. DCT system secured.. ____
16. Room 114 check:
   a. Cooling flow to P501A/B secured.. ____
   b. Valves S1 and S2 hydraulic motor off.. ____
   c. N_2 system and air to valve header secured.. ____
   d. Calgon units secured.. ____
   e. Room 114 pump controllers locked out.. ____
17. Completed and logged reactor shutdown checksheet.. ____

BUILDING SHUTDOWN CHECKSHEET

1. Pool level normal.. ____
2. ARM trip levels set per SOP.. ____
3. Annunciator board off.. ____
4. TV unit secured.. ____
5. ARM and off-gas recorder paper supply okay, charts timed and dated.. ____
6. Primary/pool drain collection system secured per SOP.. ____
7. Routine patrol completed.. ____
8. SRM, IRM, WRM, PRM, ARM and process radiation monitors in operate mode.. ____
9. Master key switch off and in key box.. ____
10. Test of containment intrusion alarm completed. System energized.. ____
11. All keys accounted for.. ____
12. Building shutdown and reactor secured.. ____
13. Control room doors locked.. ____
14. Completed building shutdown checksheet.. ____
15. Logbook entries complete, crews signed out.. ____

____
Senior Reactor Operator

REVISION NO. 6

4/23/81

SOP/A-1a	Revised 4/81
SOP/A-4b (Page 2 of Reactor Shutdown Checksheet)	Revised 4/81

REACTOR STARTUP CHECKSHEET
FULL POWER OPERATION
(or Low Power Forced Circulation)

DATE: April 1, 1981

BUILDING AND MECHANICAL EQUIPMENT CHECKLIST

_____ 1. Run emergency generator for 30 minutes and check the governor oil level. (Required if shutdown for 24 hours or after each maintenance day.)

_____ 2. a. Check operation of fan failure buzzer and warning light. Shift fans. (required if shutdown longer than 4 hours)

_____ b. Test stack monitor per SOP while in west tower.

_____ c. Test the stack monitor low flow alarm.

_____ 3. Visual check of room 114 equipment completed.

_____ a. P501A and P501B coolant water valves open.

_____ b. S1 and S2 hydraulic pumps on (oil level normal).

_____ c. Pump controllers unlocked to start (as required).

_____ d. Insure N_2 backup system on per SOP.

_____ e. Open air valve for valve operating header (VOP 31).

_____ f. N_2 backup valve open.

_____ g. Pipe trench free of water (on Monday startups, check the four-pipe annulus drain valves for water leakage).

_____ 4. Visual check of CT equipment completed.

a. Oil level in CT fans normal (Monday startups).

_____ 5. Beamport Floor

_____ a. Beamport radiation shielding (as required)

_____ b. Unused beamports checked flooded (Monday)

_____ c. Seal trench low level alarm tested (Monday)

_____ 6. Emergency air compressor (load test for 30 minutes on Monday)

_____ 7. Reactor pool

_____ a. Reflector experimental loadings verified and secured for start-up.

_____ b. Flux trap experimental loading verified and secured for start-up, or strainer in place.

REACTOR CONTROL SYSTEM CHECKLIST

_____ 1. All chart drives on; charts timed and dated. IRM recorder to slow.

_____ 2. Fan failure warning system cleared.

_____ 3. Annunciator board energized; horn off.

_____ 4. Television receiver on.

_____ 5. Primary/pool drain collection system in service per SOP.

_____ 6. Secondary system on line per SOP (as needed).

_____ 7. Primary system on line per SOP.

_____ a. Primary cleanup system on line.

_____ 8. Pool system on line per SOP.

_____ a. Pool cleanup system on line.

_____ b. Pool skimmer system vented.

_____ c. Pool reflector Δp trips set per SOP.

_____ 9. Valves S1 and S2 cycled in manual mode and positioned as required.

_____ 10. Nuclear instrumentation check completed per SOP.

a. the following trip values were obtained during the check.

IRM-2, run-in	_____ seconds	Scram	_____ seconds
IRM-3, run-in	_____ seconds	Scram	_____ seconds
WRM-4, run-in	_____ %	Scram	_____ %
PRM-5, run-in	_____ %	Scram	_____ %
PRM-6, run-in	_____ %	Scram	_____ %

_____ 11. Channel 4, 5, and 6 pots returned to last heat balance position.

_____ 12. SRM-1 detector response checked and set to indicate > 1 cps.

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REVISION NO. 7

5/14/81

SOP/IV-2	Revised 5/81
SOP/IV-3	Revised 5/81
SOP/IV-4	Revised 5/81
SOP/IV-5	Revised 5/81
SOP/V-2	Revised 5/81
SOP/V-3	Revised 5/81

d. Primary system flow recorder and temperature recorders are energized and the primary demineralizer flow recorder is energized. Time and date the recorders.
e. Place heat exchanger bypass switch 2S41 in the position required for the heat exchanger combination to be used.

B. Verify antisiphon vent valve closed.
C. Close antisiphon system manual drain valve.
D. Set the anti-siphon system air regulator to 35 psig and open the air inlet valve.
E. Place master switch 1S1 to test.
F. Open valves 527 E and F.
G. Place valve 545 switch to auto/closed.
H. Place valve 527A switch to auto/closed.
I. Place valve 527B switch to auto/closed.
J. Place pump P-533 switch to on, P-533 may or may not start, depending upon demand.
K. After P-533 has completed charging, place valve 526 switch to auto/closed.
L. Place valve 507A/B switch to manual/open. Valves 543A/B will automatically close at this time.
M. Immediately place valve 527C switch to open. The primary system is now pressurized.
N. Cycle valves 546A/B switches to manual/closed.
O. Immediately start pump 501A or B. Verify proper flow.
P. Cycle valves 546A and B open and then closed one at a time and verify the increase and then decrease in primary system flow as each valve is cycled.
Q. Start the remaining pump 501A or B. Verify proper primary system flows.
R. Start pump 513A and verify proper flow.
S. Open the antisiphon system drain valve and blow the system dry. Close the valve, wait 10 seconds and repeat. This may have to be done three or four times to insure that all the water is drained.
T. Close the antisiphon system drain valve.
U. Insure that the antisiphon system pressure is set at 36 psig; then close the air inlet valve.

V. Place the following valve controls in the indicated positions.

Valve	Mode	Position
V507A/B	Auto	Closed
V546A/B	Auto	Open
V543A/B	---	Open
V545	Auto	Closed
V526	Auto	Closed
V527A	Auto	Closed
V527B	Auto	Closed
V527C	---	Open

W. Verify that all the valve position indicating lights are operating with the valves in the positions listed in Step V. If not, replace the appropriate light bulb. If this does not clear the malfunction, shutdown the primary system as per IV.2 and verify proper valve operation by a visual examination of the actuator linkage during operation. In the case of V543A or B indication failure, perform CP-24 Compliance Check. (NOTE: If the malfunction is determined to be an electrical indication problem not used in the safety system, the reactor may be operated with repairs being made at the next maintenance shutdown.)

X. For 10 MW, 2 pump operation, balance loop flows as follows:

1. Check the flow in the two heat exchanger loops and adjust the 540 valves to balance the flow.
2. Check the ΔP across each of the pumps and adjust the bypass valves to balance the flow delivered by each pump.

IV.2 Shutdown of Primary System

NOTE: The primary system should remain in operation for fifteen minutes after reactor shutdown to remove decay heat.

IV.2.1 Procedure

A. Place master switch 1S1 in test.

B. Close valve 527C.

C. Secure pump P533.

D. Secure P513A

E. If both pumps P501A and/or P501B are running, secure them simultaneously to reduce check valve slam.

F. Verify that valves 546A/B open on the loss of flow.

G. Place the 507A/B mode switch to manual.

H. Verify that V507A/B close and that valves 543A/B open.

I. Open the drain valve on the antisiphon system and then slowly open the vent valve and bleed the pressure to zero. Reclose the valves when depressurized.

J. Place the following valve controls in the indicated positions.

Valve	Mode	Position	Valve	Mode	Position
V507A/B	Manual	Closed	V527A	Manual	Closed
V546A	Manual	Open	V527B	Manual	Closed
V546B	Manual	Open	V545	Manual	Closed
V543A/B	------	Open	V526	Manual	Closed

K. Verify that valves 507A and B have operated and sealed closed by cycling V507A/B while noting the system pressure drop. There will always be some pressure drop due to pressure trapped on the pump side of V507A/B, if not, repair of V507A or B actuator or valve is required prior to any reactor start-up.

L. Close valves 527E/F.

M. Verify that all the valve position indicating lights are operating with the valves in the positions listed in Step J. If not, replace the appropriate light bulb. If this does not clear the malfunction, determine the cause and make repairs prior to any reactor start-up. For V543A or B, perform CP-24 Compliance Check. (NOTE: If the malfunction is determined to be an electrical indication problem not used in the safety system, the reactor may be operated with repairs being made at the next maintenance shutdown.)

N. Secure the primary flow and temperature recorders and the primary demineralizer flow recorder. Time and date the recorders.

O. Secure power to pumps P501A/B, P513A, and P533.

P. Secure shaft cooling water supply to pumps P501A/B.

IV.3. Operation of the Anti-Siphon System

IV.3.1 General Operating Philosophy

The anti-siphon system is designated to provide sufficient aire (under pressure) to break a siphon of the primary coolant system in the event of a pipe rupture. To perform its function, this system must be maintained at a pressure greater than 27 psig, and the water level above the anti-siphon valves must be less than six inches. The procedures below will be followed to insure that the anti-siphon system is operated within the above limitations.

IV.3.2 Decreasing Pressure in the Anti-Siphon System

The system contains a pressure switch which will initiate an annunciator alarm when the system pressure falls below 30 psig upon receipt of the low pressure alarm an attempt shall be made to establish normal system pressure by admitting air through the valve and regulator on the bridge. If system pressure cannot be maintained above 27 psig, the reactor shall be shutdown until the problem is corrected.

IV.3.3 Increasing Pressure in the Anti-Siphon System

After the primary coolant system has been placed in service, open the system drain valve and check that the system is drained of all water. The system's pressure will then be returned to the middle of the operating band (~36 psig) and this pressure will be recorded on the routine patrol sheet.

On each subsequent routine patrol, read the system pressure and compare it to the base pressure recorded after the startup. If the pressure has increased by more than 4 psi, action must be taken to insure that the pressure increase is not due to in-leakage of primary coolant water. If the pressure has increased by more than 4 psi, carry out the following procedures:

A. Open the drain valve and observe the water flowing from the drain line.
B. Drain until you no longer receive a solid stream of water, then close the drain valve.
C. If the amount of water drained is significant, record this fact on the routine patrol sheet and in the console log.
D. Return the system pressure to normal (~36 psig) by venting or adding air.
E. Record the new base pressure on the routine patrol sheet.

A new base pressure will be established during the first routine patrol of every day that the reactor is operating. To establish the new base pressure, carry out steps A through E above.

D. Visually check for proper in-pool loadings:

1. Make certain experiments are securely loaded and are seated within their proper loading facilities.
2. Make certain the flux trap facility appears normal and the test hole guard web is properly in place, or the test hole sample holder is correctly and securely positioned.

E. Turn on the pool flow and temperature recorders and time and date.

F. Verify that the local pump stop switches in room 114 are unlocked.

NOTE: If the breaker is closed, the selector switch is in the auto mode and the stop switch is unlocked, the off indicator in the control room for P508A/B will be lighted.

G. Place HX bypass switch 2S40 in the position required for the HX lineup intended.

H. Master control switch 1S1 should be in the test position.

I. Place valve V509 switch to the manual/open position.

J. Turn on pool pump P508A/B as appropriate by turning the control switches to on. Verify proper flow.

K. Start cleanup pump P513B and verify flow.

L. Adjust pool flow if required by throttling the HX outlet valves (522A and 522D) as necessary.

M. With normal flow and pressure, place V509 switch to auto/closed.

N. Verify that all the valve position indicating lights are operating. If not, replace the appropriate light bulb. If this does not clear the malfunction, shutdown the pool system as per V.2 and verify proper valve operation by a visual examination of the actuator linkage during operation. (NOTE: Determine the cause of the failure and make repairs prior to any start up.)

O. If not required for other evolutions, turn master control switch 1S1 to the on position.

V.2 Pool System Shutdown Procedure

V.2.1 The pool cooling system should remain in operation for a short period of time (5 minutes minimum) after a normal reactor shutdown in order to remove core decay heat from the reflector and experimental facility. The procedure for attaining a normal pool system shutdown mode is as follows:

A. Place master switch 1S1 in test.

B. Turn off cleanup pump P513B.

C. Turn off P508A/B using the control switches in the control room. To minimize check valve slam, secure both pumps simultaneously.

D. Verify that valve V509 closes automatically.

E. Place V509 in the manual/closed position.

F. Verify that all the valve position indicating lights are operating. If not, replace the appropriate light bulb. If this does not clear the malfunction, determine the cause and make repairs prior to any reactor start-up.

G. Turn off the pool flow and temperature recorders.

H. Secure power to P508A/B.

V.3 Partial Pool Filling Procedures (pool at refuel level or above)

V.3.1 To increase the water level in the pool with demineralized water from T301 or T300, one of the two following procedures can be used, however, all water in T301 should be used first.

A. Filling may be accomplished with the skimmer system (Section VII.5.1) with or without the skimmer pump operating and the reactor either operating or shutdown. Required operational pool makeup will be accomplished in this manner.

1. Check capacities of tanks T300 and T301 and check proper valve lineup.
2. Observe the pool level and check that the skimmer pump is secured.
3. Remotely open valve 565B from the primary/pool drain collection system control panel. Insure valve does indicate open.
4. The skimmer pump may be started at this point, however, it will fill by gravity if desired.
5. When proper pool level is obtained, secure the skimmer pump and remotely close valve 565B. Insure it does indicate closed.

B. The second approved method of filling the pool is via the 4" line from tank T300/301 to the pool pump suction and discharge line.

1. Check capacities of tanks T300 and T301 and check proper valve lineup.
2. With the pool system in the normal shutdown mode, filling the pool through a pool pump can be avoided by opening valve V522C and permitting T301 or T300 to drain by gravity feed alone.
3. Close valve V522C when the filling operation is completed.

REVISION NO. 8

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SOP/A-1a Revised 5/81

REACTOR STARTUP CHECKSHEET
FULL POWER OPERATION
(or Low Power Forced Circulation)

DATE: ____________

BUILDING AND MECHANICAL EQUIPMENT CHECKLIST

____ 1. Run emergency generator for 30 minutes and check the governor oil level. (Required if shutdown for 24 hours or after each maintenance day.)

____ 2. a. Check operation of fan failure buzzer and warning light. Shift fans. (Required if shutdown longer than 4 hours.)
____ b. Test stack monitor per SOP while in west tower.
____ c. Test the stack monitor low flow alarm.

3. Visual check of room 114 equipment completed.
____ a. P501A and P501B coolant water valves open.
____ b. S1 and S2 hydraulic pumps on (oil level normal).
____ c. Pump controllers unlocked to start (as required).
____ d. Insure N_2 backup system on per SOP.
____ e. Open air valve for valve operating header (VOP 31).
____ f. N_2 backup valve open.
____ g. Check valves 599A and 599B open.
____ h. Pipe trench free of water (on Monday startups, check the four-pipe annulus drain valves for water leakage).

____ 4. Visual check of CT equipment completed.
____ a. Oil level in CT fans normal (Monday startups).

5. Beamport Floor
____ a. Beamport radiation shielding (as required).
____ b. Unused beamports checked flooded (Monday).
____ c. Seal trench low level alarm tested (Monday).

____ 6. Emergency air compressor (load test for 30 minutes on Monday).

7. Reactor Pool
____ a. Reflector experimental loadings verified and secured for start-up.
____ b. Flux trap experimental loading verified and secured for start-up, or strainer in place.

REACTOR CONTROL SYSTEM CHECKLIST

____ 1. All chart drives on; charts timed and dated. IRM recorder to slow.
____ 2. Fan failure warning system cleared.
____ 3. Annunciator board energized; horn off.
____ 4. Television receiver on.
____ 5. Primary/pool drain collection system in service per SOP.
____ 6. Secondary system on line per SOP (as needed).
____ 7. Primary system on line per SOP.
____ a. Primary cleanup system on line.
____ 8. Pool system on line per SOP.
____ a. Pool cleanup system on line.
____ b. Pool skimmer system vented.
____ c. Pool reflector Δp trips set per SOP.
____ 9. Valves S1 and S2 cycled in manual mode and positioned as required.
____ 10. Nuclear instrumentation check completed per SOP.
a. The following trip values were obtained during the check.

IRM-2, run-in	____ seconds	Scram	____ seconds
IRM-3, run-in	____ seconds	Scram	____ seconds
WRM-4, run-in	____ %	Scram	____ %
PRM-5, run-in	____ %	Scram	____ %
PRM-6, run-in	____ %	Scram	____ %

____ 11. Channel 4, 5, and 6 pots returned to last heat balance position.
____ 12. SRM-1 detector response checked and set to indicate >1 cps.

REVISION NO. 9

5/29/81

SOP/A-8a Revised 5/81

Date ______________

Reactor Routine Patrol

1.	Time of start of patrol										
2.	Time and date all charts										
3.	Check ARMS trip settings										
4.	Visual check of entire pool										
5.	Anti-siphon tank pressure	______ +3.0 psig									
6.	North iso door seal press	18-28 psig									
7.	South iso door seal press	18-28 psig									
8.	5th level backup doors	Open									
9.	5th level detector [illegible]ding	0-3.5 mr/hr									
10.	5th level trip point s[illegible]	3.5 mr/hr									
11.	16" iso vlv A air pressure	45-55 psig									
12.	Emerg compress on standby	Bkr closed, vlv open, gage 90-120 psig									
13.	Containment hot sump pumps	Operable									
14.	Door 101 seal pressure	18-28 psig									
15.	BP floor	Conditions normal									
16.	Fuel vault	Locked									
17.	Inner airlock door seal press	18-28 psig									
18.	Outer airlock door seal press	18-28 psig									
19.	T-300 level	> 2000 gal									
20.	T-301 level	< 6000 gal									
21.	Labyrinth sump	Level < Alarm Pt.									
22.	RO UNIT POWER ON (Run daily: to T-300 or drain.)	ON (Run on 0700 routine for ≥ 4 hrs.)									
23.	RO Unit Temp	24-28°C /standby									
24.	RO Unit Pressure	190-200 psig /standby									
25.	EG rm. (EG Op switch to Auto) (Gas > sight glass.) (batt. check Sun. wids).	Thermostat > 50°F Temp > 40°F									
26.	T-300, 301 room	Thermostat > 55°F Thermostat > 40°F									
27.	Rm 114 particulate filter ΔP	< 2.5" H_2O									

On the first routine patrol of the day or the first patrol after a startup, drain all water from the anti-siphon system. If draining causes the pressure to drop significantly, return to the middle of the band (36 psig) and record the pressure here. ______

Rev. 5/81 App'd JCM SOP/A-8a

REVISION NO. 10

5/30/81

SOP/A-11 Revised 5/81

RETURN ORIGINAL TO HEALTH PHYSICS OFFICE NO. ______

WASTE TANK SAMPLE REPORT

TANK NO. ______ TANK LEVEL ______ (Liters)

TIME ______ DATE ______ Completed adding water to this tank.

SAMPLER ______ TIME ______ DATE ______

1. Analysis Results

Nuclide	Half Life	Physical Form	Concentration (μCi/ml)	MPC	Activity (μCi)
a. H-3	12.3Y				
b.					

pH ______ TOTAL CONCENTRATION (b) ______

Analysis by ______ Date ______ Time ______

	Concentration (μCi/m)		Total Volume (liters)		Activity (mci)
(a)	______	x	______	=	______
(b)	______	x	______	=	______

2. Approvals Required For

Any Discharge . . . . ______
Shift Supervisor

Discharge of Total Activity > 4 mci or to Secondary System ______
Reactor Manager

Discharge Limit Approved . . . . ______
Health Physics

3. Action Taken

Date Discharged ______ Time Discharged ______ Volume Discharged ______ (Liters)

Tank Discharged to (check one) ___ Sanitary Sewer ___ Secondary System ___ Not Discharged

Remarks ______

Rev. 5/81 App'd. [signature] SOP/A-11

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

Hazards Summary Report, Section 9.7.3, changed to read:

9.7.3 Off-Gas Radiation Monitoring System

The off-gas monitoring system has an isokinetic probe in the off-gas system plenum that supplies sample air to a filter paper monitored by a beta scintillation detector followed by a charcoal filter monitored by a gamma scintillation detector followed by a shielded gas chamber monitored by a Geiger-Miller tube. Output from each detector is shown on a log scale count rate meter on the instrument cabinet and on continuous chart recorders in the reactor control room.

Audio alarms sound in the control room for low air flow, and for high radiation above a manually set limit for each detector.

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

August 1980

Modification 80-4: Moves the air supply for the containment back-up doors to the emergency air supply side of the air system. This change provides increased reliability for the system.

Safety Analysis Summary: Modification 80-4 presents no unresolved safety question. It adds the capacity to operate the ventilation back-up doors in the event of loss of the main air compressor.

March 1981

Modification 81-3. Purpose is to separate the power supplies for the stack monitoring system and its associated alarm function. This allows testing of the low flow alarm.

Safety Analysis Summary: Modification 81-3 has no effect on safety related equipment. It provides an additional power supply for the low flow alarm improving the capability to monitor the system's functions.

Modification 81-5: Installs a poly bushing beneath the anvil on offset "C". The bushing prevents metal to metal contact between the anvil and offset tube and reduces friction in the system.

Safety Analysis: The installed bushing presents no unreviewed safety hazard. The modification should help minimize problems with misalignment of the anvil and magnet.

Modification 81-6: Improves the mechanical stability and reduces the amount of stainless steel which can be activated in an offset mechanism. The concept is identical to existing Type II offset mechanism.

Safety Analysis Summary: The new materials and increased mechanical stability present no unresolved safety questions. The reduction in stainless steel will help to decrease operator dose during maintenance on the offset.

Modification 81-8: Replaces the waste tank system two steel filter housings with one non-corrosive plastic filter housing.

Safety Analysis Summary: The modified system components propose no unreviewed safety hazard. All components are being replaced with materials of superior quality than presently installed, increasing ease of operation of the waste tank filter system.

April 1981

Modification 81-4: Installs a means for filling the loop seal for the pool overflow in Room 114 pipe tunnel with DI water.

Safety Analysis Summary: The modification to the pool overflow line presents no unresolved safety question. The installation allows easier operation and use of DI water versus pool water for filling the pipe.

Modification 81-9: This modification installed a pump from T-300 discharging to DI-200 regeneration station. The T-300 pump provides an alternate means of supplying DI water to DI-200 regeneration station, minimizing depleting DI-300 during a DI-200 regeneration. The use of the T-300 pump will greatly increase DI-300 resin life and decrease the cost in making DI water.

Safety Analysis: Modification 81-9 presents no unresolved safety questions. The installed alarms insure proper level is maintained in T-300.

Modification 81-10: This modification was the replacement of the carbon steel tank and some waste tank system piping modifications. This modification reduces maintenance required for the tank plus provides additional or alternative tanks for pool water storage.

Safety Analysis Summary: Modification 81-10 presents no unresolved safety questions. The new tank is essentially the same as the tank it replaces with the water management and operation as before.

Modification 81-13: Replaces the unitized fan cross piping for cooling tower cells #1 and #2 with new pipes of identical design. The replacement is due to corrosion over the years.

Safety Analysis Summary: The parts installed in CT #1 and #2 are identical to those originally installed and pose no new or unresolved safety question.

<u>June 1981</u>

Modification 81-12: Replaced the wet firemain pipe in the seal trench with 6" CPVC pipe. The piping replaced was 4", 150 psig carbon steel and is replaced with 6", 300 psig, CPVC increasing the pressure rating and pipe diameter. The flow path is the same and, due to the larger diameter, pipe will allow better flow.

Safety Analysis Summary: Modification 81-12 presents no unresolved or new safety questions. The larger diameter pipe helps increase the total flow delivered for emergency pool make-up.

SECTION V

NEW TESTS AND EXPERIMENTS

New experimental programs during the period of July 1980 through June 1981 are as follows.

RUR 262 Experimenter: Guy Schupp

Purpose: To use gamma rays from an intense radioactive source to investigate crystal properties and structures by inelastic and elastic scattering measurements.

Description: Intense gamma ray sources will be produced by activating in the flux trap sources foils welded in aluminum cans. The source is then transferred to the experiment station on the north end of the beamport floor where the experiment is performed.

SECTION VI

SPECIAL NUCLEAR MATERIAL ACTIVITIES

1. SNM Receipts: During the year, the MURR received fuel from Rockwell International Energy Systems Group (Atomics International). A total of 24 new fuel elements were received.

Shipper	Elements	Grams U	Grams U-235
Atomics Int'l.	47, 48 and 53 thru 69 and 72, 74 thru 77	19,869.88	18,507.61

2. SNM Shipments: Three shipments of spent fuel elements were sent to U.S.D.O.E. Savannah River Plant for reprocessing.

Shipper	Elements	Grams U	Grams U-235
MURR	775F79, 86, 89, 93, 98, 105, 106, 107, 108, 109, 110, 111, 112, M01, M02, 4, 6, 7, 8, 9, 10, 11, 12, 13	17,126.28	15,016.98

3. Inspections: On May 5-6, 1981, a Physical Protection Inspection was conducted by Ms. G. M. Christoffer of Region III, USNRC. No items of noncompliance were identified during the course of their inspection.

4. SNM Inventory: As of 30 June 1981, the MURR financially responsible inventory was as follows:

Total U = 41,894 grams

Total U-235 = 37,426 grams

All of this material is physically located at the MURR. In addition, MURR has three 350 gram elements stored at Atomics International.

Fuel elements on hand have accumulated the following burnup as of 30 June 1980:

Fuel Element Number	Accumulated MWD	Fuel Element Number	Accumulated MWD
M03	149.33	M042	145.49
M05	149.33	M043	125.12
M014	145.47	M044	145.49
M016	144.01	M045	148.08
M015	98.75	M046	73.23
M017	135.98	M047	148.08
M018	148.15	M048	73.23
M019	147.73	M053	92.16
M020	143.14	M054	92.16
M021	125.64	M055	82.05
M022	108.94	M056	0.0
M023	147.69	M057	82.05
M024	146.79	M059	56.68
M025	147.69	M060	67.81
M026	135.98	M061	56.68
M027	120.41	M062	67.81
M028	148.00	M063	54.81
M029	120.41	M064	66.99
M030	148.00	M065	54.81
M031	107.98	M066	66.99
M032	145.33	M067	19.40
M033	115.37	M068	26.57
M034	145.33	M069	19.40
M035	147.14	M076	26.57
M036	142.66	M072	0.0
M037	131.76	M074	0.0
M038	120.44	M075	0.0
M039	142.66	M077	0.0
M040	120.44		
M041	125.12		

M049, 50, 51, 52 not issued and M058 returned June 23, 1981.

Total U = 1,112.39 grams

Total U-235 = 1,036.19 grams

Also MURR owns a total of 128 grams U and 49 grams U-235. The 12 gram increase in U and U-235 from last year is due to acquiring two sets of plates for Nuclepore for use in the thermal column.

SECTION VII

REACTOR PHYSICS ACTIVITIES

1. Fuel utilization: During this period, the following elements reached their licensed burnup and were retired.

M018	M028
M019	M030
M023	M032
M024	M034
M025	M035

Normally 24 fuel elements are listed as retired, but due to increased shipping costs for new and irradiated fuel, fuel elements that cannot be utilized during a normal fuel cycle (previous definition for retirement) are retained in the active fuel cycle structure for possible use in an abbreviated fuel cycle.

Due to requirements of having less than 5 kg of unirradiated fuel on hand at one time, initial criticalities are normally conducted with 4 new elements or fewer as conditions dictate.

Core XXVI	M041, 42, 43, 44	(initial criticality was last fiscal year)	
	M045, 47	25 August	1980
	M046, 48	11 November	1980
	Note: Serial #'s 49 thru 52 were not issued.		
Core XXVII	M053, 54	1 December	1980
	M055, 57	29 December	1980
	M056, 58*	(initial criticality will be next fiscal year)	
	M059, 60	9 February	1981

*As of June 30, M058 was returned to Atomics International for adjustment of end fitting.

Core XXVIII	M061, 62	9 February	1981
	M063, 64, 65, 66	9 March	1981
	M067, 68	4 May	1981
Core XXIX	M069, 76	4 May	1981
	M070, 71, 73	(have not been received for use)	
	M072, 74, 75	(initial criticality will be next fiscal year)	
Core XXX	M077	(initial criticality will be next fiscal year)	
	M078-84	(have not been received for use)	

2. Fuel Shipping: Three spent fuel shipments departed the facility during the fiscal year. The shipments contained the following elements:

775F79	775F108	M006
775F86	775F109	M007
775F89	775F110	M008
775F93	775F111	M009
775F98	775F112	M010
775F105	M001	M011
775F106	M002	M012
775F107	M004	M013

3. Fuel Procurement: At the present time, MURR fuel is being fabricated by Rockwell International Energy Systems Group of Canoga Park, California. This work is contracted with U.S.D.O.E. and administered by the Idaho Operations Office.

4. Licensing Activities: A revised physical security plan as per 10CFR70:67 that was submitted May 16, 1980 is still pending. Amendment #13 to Facility Operating License No. R-103 was issued March 5, 1981. This amendment changes the organizational structure as outlined in Figure 6.0 of the Technical Specification 6.1 to reflect the current administrative organization for our facility. Amendment No. 14 to Facility Operating License No. R-103 was issued April 14, 1981. This amendment changed the definition of "Reactor Secured," item 1.20, Appendix A, of the Technical Specifications of our facility license.

5. Reactor Characteristic Measurements: Shim Blade "D" Reactivity calibration measurements were performed in April on Core AO-2 at 605 MWDs. A series of five (5) reactivity measurements for various flux trap sample loadings were performed during April, May and June. A physical inspection of the following fuel elements was performed at approximately 130 MWDs to verify the operational parameters:

M028 from Core 24 on 4/14/81

M035 from Core 25 on 6/04/81

M042 from Core 26 on 4/14/81

All measurements were within operational requirements.

SECTION VIII

SUMMARY OF RADIOACTIVE EFFLUENTS RELEASED TO THE ENVIRONMENT

Liquid Effluent - 7-1-80 to 6-30-81

Nuclide	Amount (Ci)
H-3 via cooling tower drain	< .001
H-3	.434*
Na-24	.001
K-42	< .001
Sc-46	.007
Cr-51	.029
Mn-54	.005
Mn-56	< .001
Co-57	< .001
Co-58	.001
Fe-59	.001
Co-60	.032
Zn-65	.110
Ni-65	< .001
Se-75	< .001
As-76	< .001
As-77	.005
Ag-110^{m}	.002
Sn-113	< .001
Sb-122	< .001
Sb-124	.006
Sb-125	< .001
I-131	< .001
I-133	< .001
Ba-133	< .001
Cs-134	< .001
Cs-137	< 1
Ba-140	< .001

HF-181	< .001
Au-196	< .001
Au-198	< .001
Hg-203	< .001
Ra-226	< .001

*0.334 Ci of the H-3 released after 3-11-81.

Stack Effluent - 7-1-80 to 6-30-81

Nuclide	Amount (Ci)
H-3	10.42*
Na-24	.000003
Cl-38	.000117
Ar-41	1733.48
Sc-46	.000001
Cr-51	.000001
Mn-54	< .000001
Mn-56	.000001
Co-57	< .000001
Co-58	< .000001
Co-60	.000002
Cu-64	.000020
Zn-65	.000003
Se-75	.000003
As-76	< .000001
As-77	.000332
Br-82	.000048
Kr-85m	< .000001
Kr-87	< .000001
Rb-89	< .000001
Sr-92	< .000001
Nb-97	< .000001
Zr-97	< .000001
Mo-99	< .000001

Tc-99m	< .000001
Tc-101	.000005
In-113m	< .000001
In-114m	< .000001
In-115m	< .000001
Cd-115	.000003
Sb-122	< .000001
I-128	.000023
I-131	.000603
I-132	.000223
Te-132	.000001
Ba-133	< .000001
I-133	.001082
Xe-133	.000026
Xe-133m	.000003
I-134	.000440
I-135	.000885
Xe-135	.000100
Xe-135m	.000410
Cs-137	< .000001
Cs-138	.000006
Ba-139	.000053
Ce-139	.000002
Ba-140	.000001
La-140	.000001
Ce-144	.000001
Hf-181m	< .000001
Ta-182	.000001
Ta-183	.000004
Ir-192	< .000001
Au-196	< .000001
Hg-203	.000068
Bi-214	.000007
Pb-214	.000005

*Less than 0.001 Ci H-3 released to air by evaporation from cooling tower.

SECTION IX

SUMMARY OF ENVIORNMENTAL SURVEYS

Environmental samples are collected yearly at nine locations and analyzed for radioactivity. These locations are shown in Figure 1. Soil and vegetation samples are taken at each location. Water samples are taken at four of the nine locations. Results of the samples are shown in the following tables.

Detection Limits

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.2 pCi/l	2.5 pCi/l	0.04 pCi/l	9.1 pCi/ml
Soil and vegetation	0.2 pCi/g	2.5 pCi/g	0.04 pCi/g	9.1 pCi/g

1. Sampling Date: 11-5-80

Determined Radioactivity Levels

Sample	Alpha	Beta	Gamma	Tritium
1 v 18	<0.2 pCi/g	18.00 pCi/g	<0.04 pCi/g	<9.1 pCi/g
2 v 18	0.8 pCi/g	11.85 pCi/g	<0.04 pCi/g	<9.1 pCi/g
3 v 18	0.3 pCi/g	10.25 pCi/g	<0.04 pCi/g	<9.1 pCi/g
4 v 18	<0.2 pCi/g	17.72 pCi/g	<0.04 pCi/g	<9.1 pCi/g
5 v 18	<0.2 pCi/g	21.55 pCi/g	<0.04 pCi/g	<9.1 pCi/g
6 v 18	0.2 pCi/g	19.51 pCi/g	<0.04 pCi/g	<9.1 pCi/g
7 v 18	<0.2 pCi/g	21.43 pCi/g	<0.04 pCi/g	<9.1 pCi/g
8 v 18	0.2 pCi/g	18.48 pCi/g	<0.04 pCi/g	<9.1 pCi/g
9 v 18	0.2 pCi/g	15.29 pCi/g	<0.04 pCi/g	<9.1 pCi/g
1 S 18	0.7 pCi/g	11.93 pCi/g	<0.04 pCi/g	

2 S 18	0.3 pCi/g	8.06 pCi/g	<0.04 pCi/g	
3 S 18	0.6 pCi/g	12.4 pCi/g	<0.04 pCi/g	
4 S 18	<0.2 pCi/g	7.41 pCi/g	<0.04 pCi/g	
5 S 18	<0.2 pCi/g	11.91 pCi/g	<0.04 pCi/g	
6 S 18	<0.2 pCi/g	8.26 pCi/g	<0.04 pCi/g	
7 S 18	0.3 pCi/g	7.22 pCi/g	<0.04 pCi/g	
8 S 18	0.3 pCi/g	7.53 pCi/g	<0.04 pCi/g	
9 S 18	0.3 pCi/g	10.60 pCi/g	<0.04 pCi/g	
4 W 18	0.5 pCi/l	7.32 pCi/l	<0.04 pCi/l	<9.1 pCi/ml
6 W 18	0.5 pCi/l	5.14 pCi/l	<0.04 pCi/l	<9.1 pCi/ml
8 W 18	<0.2 pCi/l	13.05 pCi/l	<0.04 pCi/l	<9.1 pCi/ml
9 W 18	<0.2 pCi/l	6.33 pCi/l	<0.04 pCi/l	<9.1 pCi/ml

Detection Limits

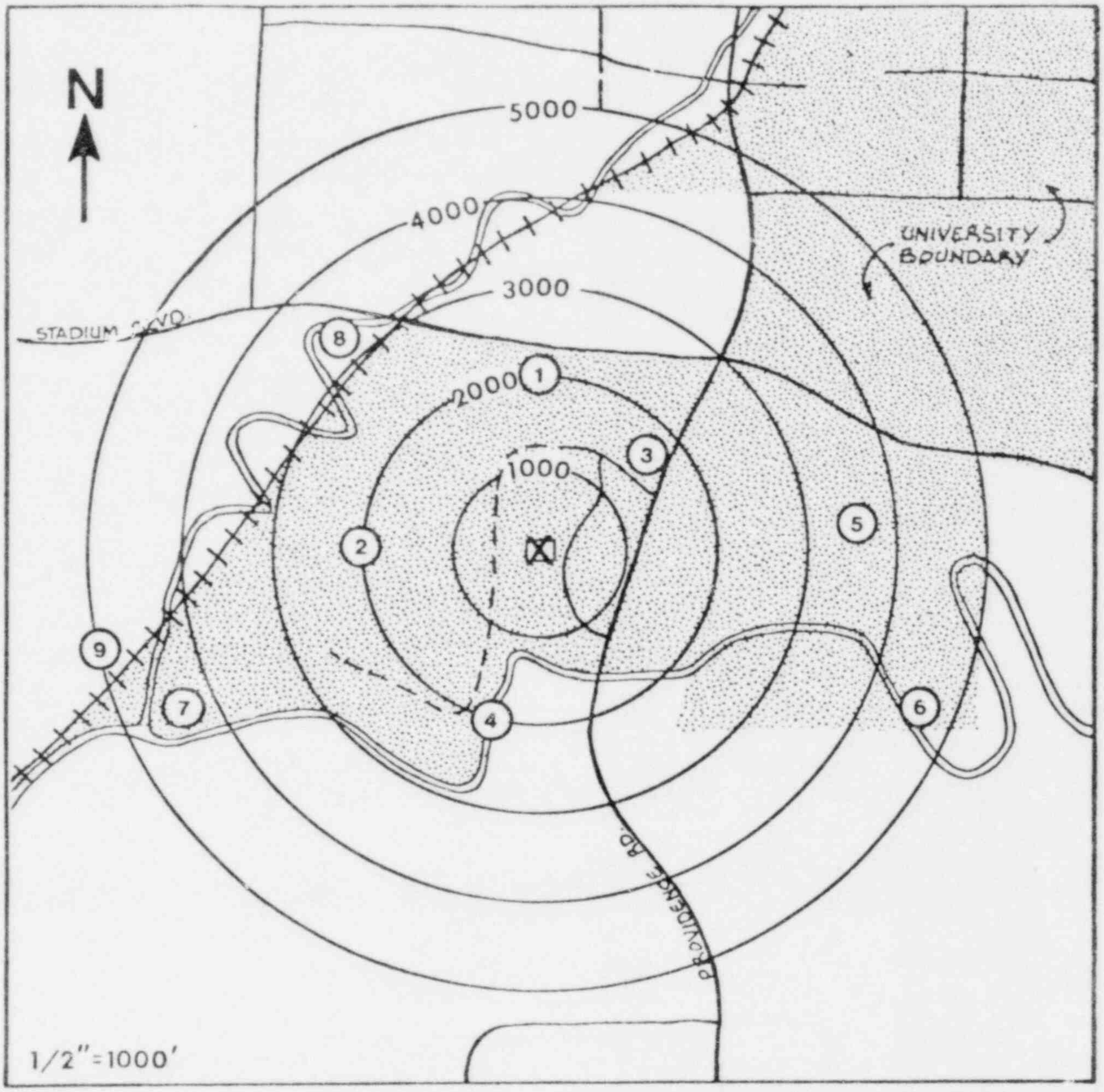
Matrix	Alpha	Beta	Gamma	Tritium
Water	0.2 pCi/l	2.5 pCi/l	0.04 pCi/l	9.1 pCi/ml
Soil and vegetation	0.2 pCi/g	2.5 pCi/g	0.04 pCi/g	9.1 pCi/g

2. Sampling Date: 4-24-81

Determined Radioactivity Levels

Sample	Alpha	Beta	Gamma	Tritium
1 V 19	<0.2 pCi/g	39.1 pCi/g	<0.04 pCi/g	<9.1 pCi/g
2 V 19	0.71 pCi/g	32.6 pCi/g	<0.04 pCi/g	<9.1 pCi/g
3 V 19	<0.2 pCi/g	18.6 pCi/g	<0.04 pCi/g	<9.1 pCi/g
4 V 19	<0.2 pCi/g	22.1 pCi/g	<0.04 pCi/g	<9.1 pCi/g
5 V 19	<0.2 pCi/g	25.2 pCi/g	<0.04 pCi/g	<9.1 pCi/g
6 V 19	0.23 pCi/g	29.0 pCi/g	<0.04 pCi/g	<9.1 pCi/g

7 V 19	< 0.2 pCi/g	15.8 pCi/g	< 0.04 pCi/g	< 9.1 pCi/g
8 V 19	< 0.2 pCi/g	25.8 pCi/g	< 0.04 pCi/g	< 9.1 pCi/g
9 V 19	0.85 pCi/g	19.5 pCi/g	< 0.04 pCi/g	< 9.1 pCi/g
1 S 19	0.34 pCi/g	4.6 pCi/g	< 0.04 pCi/g	
2 S 19	0.52 pCi/g	10.2 pCi/g	< 0.04 pCi/g	
3 S 19	0.92 pCi/g	11.1 pCi/g	< 0.04 pCi/g	
4 S 19	0.49 pCi/g	11.4 pCi/g	< 0.04 pCi/g	
5 S 19	0.77 pCi/g	8.5 pCi/g	< 0.04 pCi/g	
6 S 19	0.46 pCi/g	7.5 pCi/g	< 0.04 pCi/g	
7 S 19	< 0.20 pCi/g	11.6 pCi/g	< 0.04 pCi/g	
8 S 19	.54 pCi/g	11.8 pCi/g	< 0.04 pCi/g	
9 S 19	1.34 pCi/g	13.7 pCi/g	< 0.04 pCi/g	
4 W 19	0.52 pCi/l	8.9 pCi/l	< 0.04 pCi/l	< 9.1 pCi/ml
6 W 19	< 0.2 pCi/l	10.0 pCi/l	< 0.04 pCi/l	< 9.1 pCi/ml
8 W 19	0.25 pCi/l	8.3 pCi/l	< 0.04 pCi/l	< 9.1 pCi/ml
9 W 19	< 0.2 pCi/l	10.4 pCi/l	< 0.04 pCi/l	< 9.1 pCi/ml



LOCATION OF SAMPLE STATIONS
RESEARCH REACTOR FACILITY
UNIVERSITY OF MISSOURI

Figure 1

SECTION X

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

Personnel Monitoring (exposure in mrem)

1980

A	July B	July C	July D	July E	August B	August C	August D	August E	September B	September C	September D	September E
G	38	5	42	80	35	4	25	40	51	2	45	70
U(G)	14	5	626	1830	8	6	75	190	11	4	177	330
G-Spare*	8	1	10	10	1	0	0	0	9	0	0	0
U(G)Spare*	4	1	40	40	2	0	0	0	2	0	0	0
H	35	78	43	230	65	50	50	260	75	32	70	150
U(H)	11	36	153	850	12	33	133	480	14	21	181	600
H-Spare*	3	8	18	50	12	2	30	40	5	1	20	20
U(H)Spare*	1	3	142	540	0	0	0	0	2	2	70	110
D	0	51	62	335	6	48	48	160	0	50	73	225

A	October B	October C	October D	October E	November B	November C	November D	November E	December B	December C	December D	December E
G	51	4	23	30	35	41	21	90	43	11	22	60
U(G)	11	4	97	120	13	10	1073	4730	13	4	290	770
G-Spare*	12	2	15	20	0	9	19	30	10	6	63	220
U(G)Spare*	0	0	0	0	1	0	0	0	2	3	180	310
H	52	84	54	270	74	47	112	330	81	37	112	410
U(H)	17	26	281	740	10	23	155	640	20	21	231	790
H-Spare*	6	18	125	670	10	12	31	190	18	5	98	240
U(H)Spare*	4	3	193	270	4	3	208	320	4	3	346	[illegible]30
D	0	49	67	190	0	45	84	180	0	45	[illegible]	370

A	January B	January C	January D	January E	February B	February C	February D	February E	March B	March C	March D	March E
G	46	2	20	30	48	2	10	10	46	7	45	220
U(G)	15	2	270	470	14	3	43	60	14	3	1653	4710
G-Spare*	16	1	10	10	15	1	10	10	15	2	10	10
U(G)Spare*	3	1	120	120	3	1	30	30	2	1	280	280
H	68	47	107	380	65	48	81	290	51	63	105	310
U(H)	18	21	175	750	18	27	189	1170	14	31	275	1260
H-Spare*	16	7	52	110	22	8	65	130	13	16	51	200
U(H)Spare*	2	5	136	220	2	6	158	250	3	2	100	160
D	0	48	78	170	0	48	84	225	0	51	108	360

A	April B	April C	April D	April E	May B	May C	May D	May E	June B	June C	June D	June E
G	52	2	25	30	52	1	10	10	40	4	32	100
U(G)	11	6	146	620	14	2	90	130	13	4	180	540
G-Spare*	16	1	110	110	6	0	0	0	12	7	51	170
U(G)Spare*	2	1	100	100	0	2	45	50	0	4	1607	5720
H	49	68	66	270	67	56	70	260	52	63	93	290
U(H)	15	30	185	1510	16	30	190	1720	11	34	277	2100
H-Spare*	13	8	10	120	10	11	88	320	22	7	57	130
U(H)Spare*	1	1	30	30	1	2	55	60	0	4	107	170
D	0	53	81	230	0	50	100	240	0	50	114	400

Note:
G = montly beta-gamma film badge
U(G) = monthly finger TLD
H = biweekly beta-gamma-neutron film badge
U(H) = biweekly finger TLD
D = self-reader dosimeters

Column Headings:
A = Type of dosimeter
B = Number reported as minimum
C = Number reported with exposures above minimum
D = Average of exposures above minimum
E = Single highest dosimeter reported

*Used for temporary workers, new workers prior to issue of permanent, and replacement for lost badges.

Radiation and Contamination Surveys

The following table gives the number of surveys performed during Fy 80-81.

Radiation	Contamination
331	333

Fifty (50) Radiation Work Permits were issued during the year.

Miscellaneous Items

July 1980 Reactor Health Physics accomplished the first step in a program to refine personnel neutron monitoring. Landauer H type dosimeter badges were replaced with C-1 dosimeter badges. The C-1 badges use a polycarbonate foil for fast neutron monitoring. In addition, a graduate student began neutron monitoring studies with a neutron spectrometer. This study will contribute to improved personnel neutron monitoring.

The duty of ALARA Coordinator was assigned to the Manager, Reactor Health Physics. This is a new duty at MURR. It is anticipated that the assignment will be rotated to other individuals at appropriate times.

Reactor Health Physics added two new continuous, recording, beta sensitive, air monitors and a neutron spectrometer (Bonner Spheres type) to the equipment inventory. Equipment to enable Health Physics to do alpha, beta and gamma spectroscopy has been ordered.

Radiation worker training was increased during the year. All new employees and temporary workers are now given an indoctrination which covers radiation safety, emergency procedures, and plant physical security. In addition, 155 attendees received training on specific topics of radiation safety. One Health Physics Technician attended a TLD Work Shop at the University of Wisconsin.

A personnel exposure that occurred in November, 1979 was resolved with NRC Region III to be a quarterly total of 2400 mrem wholebody.

Two Health Physics procedures were revised and two new procedures were added during the year.

A Health Physics Technician was hired to replace one who terminated. In addition, a student working half-time has been added to the Health Physics organization for this year. A student from Northeast Missouri State University at Kirskville served a 5-week Health Physics trial internship at MURR. All concerned considered the trial a good learning experience.

Laboratory room surveys were increased significantly and a daily "walk through" by Health Physics was added to routine duties to increase Health Physics knowledge of laboratory work.

Increased surveillance of personnel was accomplished by limiting general entry and exit to the main entrance only.

Disposal of radioactive waste to commercial sites has not been possible since a shipment July 10, 1980. The situation is too complex and irrational to discuss briefly, but the problem is being actively worked-on by Reactor Health Physics.

A local reporter who had accused MURR of storing radioactive waste generated by the UM Columbia Campus was invited to a Health Physics group meeting. As a result, the reporter became enthused about the value of research performed at MURR and published an informative article on that subject in a local paper.