Research Reactor Center
University of Missouri-Columbia

Research Park
Columbia, MO 65211

PHONE (573) 882-4211
FAX (573) 882-6360

February 26, 2001

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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

Enclosed is one copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers January 1, 2000 through December 31, 2000.

If you have any questions, please feel free to call.

Sincerely,

Paul S. Hobbs

Paul S. Hobbs, PE
Reactor Manager

:ls
enclosure

xc: Mr. Alexander Adams, USNRC
Mr. Craig Bassett, USNRC

A020

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2000 – December 31, 2000

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS

ANNUAL REPORT

January 1, 2000 – December 31, 2000

Compiled by the Reactor Staff

Submitted February 2001 by

Paul S. Hobbs, PE
Reactor Manager

Reviewed and Approved

Ralph Butler
Chief Operating Officer

SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2000 through December 31, 2000

The following table and discussion summarize reactor operations in the period January 1, 2000 through December 31, 2000.

Date	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Schedule*
Jan 2000	662.91	276.35	89.10	99.79
Feb 2000	639.56	266.56	91.89	102.92
Mar 2000	656.11	273.47	88.19	98.77
Apr 2000	611.26	254.84	84.90	95.08
May 2000	652.53	273.26	87.70	98.23
Jun 2000	521.53	217.51	72.43	81.13
Jul 2000	624.44	261.10	83.93	94.00
Aug 2000	670.43	279.43	90.11	100.92
Sep 2000	626.74	261.25	87.05	97.49
Oct 2000	611.50	254.91	82.19	92.05
Nov 2000	597.08	248.95	82.93	92.88
Dec 2000	674.76	281.25	90.69	101.58
Total for Year	7548.85	3148.88	85.94	96.24

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

There were 16 unscheduled shutdowns recorded during the period January 1, 2000 through December 31, 2000. Of these unscheduled shutdowns, fourteen were scrams, two were rod run-ins as follows:

- Four of the unscheduled shutdowns were manually initiated.
- Three scrams occurred due to faulty power level interlock mechanisms.
- Two scrams occurred due to loss of electrical power.
- Two scrams were caused by personnel error.
- One was a spurious scram associated with Channel 2 nuclear instrumentation.
- One high-power rod run-in occurred when nuclear instrument channels 4 and 6 indications rose to their rod run-in trip setpoints.
- One "rod not in contact with magnet" rod run-in occurred when control blade "D" disengaged from its magnet.

There were five Licensee Event Reports (LERs) submitted to the NRC in 2000. The first LER, filed in May, was in response to an April event when the reactor was operated with the regulating blade inoperable for approximately eight minutes. The second LER, filed in May, was in response to an April event when a radiation alarm sounded when a fuel element was placed in the lower Z basket with the shielding removed from the spent fuel gamma

irradiation facility. The third LER, filed in June, was in response a May event when the reactor was operated with the regulating blade inoperable for approximately three minutes. The fourth LER, filed in July, was in response to a June event when the control blade B was removed from the reactor without meeting the reactor secured definition by leaving two core fuel positions empty. The fifth LER, filed in September, was in response to a manual scram initiated when a reactor operator discovered the regulating blade rotary switch drive chain had disengaged from its sprocket.

All Technical Specification required surveillance tests were completed within specified time intervals. The surveillance test results are documented to allow for inspection. The surveillance testing demonstrated compliance with Technical Specification requirements.

January 2000

The reactor operated continuously in January with the following exceptions: five shutdowns for scheduled maintenance and refueling. There were no unscheduled shutdowns for this month.

Major maintenance items during the month included:

- Installing new jumpers G-24 and G-25 for pressure transmitter 917 and Y-18 for evacuation/isolation alarms per modification package 75-1, addendum one.
- Rebuilding pool secondary water bypass valve S-2 hydraulic pump.
- Repairing a small leak on the fission product monitor.
- Rebuilding primary demineralizer isolation valve 527E actuator and diaphragm.
- Replacing the solenoids and installing a test circuit on the north back-up door per modification package 99-3.

February 2000

The reactor operated continuously in February with the following exceptions: four shutdowns for scheduled maintenance and refueling. There were no unscheduled shutdowns for this month.

Major maintenance items during the month included:

- Installing a new Rosemount secondary flow transmitter.
- Replacing the reactor pressure vessel flexitallic head gasket.

March 2000

The reactor operated continuously in March with the following exceptions: four shutdowns for scheduled maintenance and refueling; and two unscheduled shutdowns.

On March 6, 2000, a spurious intermediate range nuclear instrument (Channel #2) short period scram occurred during a normal reactor startup. The reactor was sub-critical at the time. No actual short period was noted or indicated on any instrumentation. Channel #2 was tested and checked satisfactorily and a normal startup was subsequently completed with no further problems occurring.

On March 31, 2000, a reactor isolation occurred when the bridge upscale switch was inadvertently turned to the

downscale position while an alarm was locked in on the bridge Area Radiation Monitor (ARM). The bridge upscale switch is turned to the upscale position when sample evolutions are performed that may cause temporary elevated radiation levels near the pool surface. There are two bridge ARMs. Placing this switch in the upscale position bypasses the isolation trip function of the bridge ARM with the lower set point. This bypass is to prevent inadvertent reactor isolations. A second bridge ARM with an operable, but higher alarm level setpoint, isolation trip continues to function at all times. In this case, an alarm from handling samples in the pool was locked in on the bridge ARM with the low trip setpoint. With the sample moves completed, personnel mistakenly returned the switch to the downscale position without first checking to see if an alarm trip needed to be reset.

Major maintenance items during the month included:

- Repairing a leak in the fission product monitor sample line.
- Installing a new reflector wedge in the L-6 position.
- Installing new pool and primary flow recorders.
- Removing, repairing, and reinstalling the row-2 pneumatic tube terminal end.
- Installing a new solenoid test box for the south back-up isolation door.
- Replacing a blown fuse in the uninterruptable power supply 15 KVA transformer disconnect switch.
- Replacing a blown fuse in the control circuit for isolation door 504.

April 2000

The reactor operated continuously in April with the following exceptions: five shutdowns for scheduled maintenance and refueling, and three unscheduled shutdowns.

On April 7, 2000, a manual scram was initiated due to the failure of the regulating blade drive gear. A setscrew on one of the gears in the regulating blade drive gearbox had loosened, causing the gear to slip on its shaft, thereby disabling the drive mechanism. The regulating blade was determined to have been inoperable for approximately eight minutes. The circumstances and subsequent remedies related to this event were described in a report submitted to the NRC on May 5, 2000. A spare gearbox was installed and tested satisfactorily and the reactor was returned to normal operation.

On April 12, 2000, control blade "D" disengaged from its magnet, causing a "rod not in contact with magnet" rod run-in. The most likely cause of this event was the inadvertent bumping of the rod drive mechanism by reactor operators who were working with several samples located nearby. Also on April 12th, a radiation alarm occurred during the first step of the reactor refueling procedure. This event was reported to the NRC in a letter dated May 11, 2000. Subsequently, the reactor was refueled and returned to normal operation.

On April 30, 2000, a reactor scram occurred due to the loss of site electrical power. Site power was restored after forty-six minutes. The reactor was refueled and returned to normal operation.

Major maintenance items during the month included:

- Removing from service depleted pool deionization bed "V" and loading new bed "E".
- Replacing the regulating blade drive gearbox.

- Replacing the air regulator for ventilation door 504 gasket.
- Installing a new area radiation monitor designated "East Wall ARM".
- Replacing the flange gaskets on the pool demineralizer inlet/outlet filter isolation valves.

May 2000

The reactor operated continuously in May with the following exceptions: five shutdowns for scheduled maintenance and refueling; one startup/shutdown for a reactor operator license examination; and one unscheduled shutdown.

On May 8, 2000, a manual scram was initiated after discovering that the regulating blade was inoperable in the "out" direction. The gearbox for the regulating blade had been rebuilt and replaced earlier on this maintenance day. It was determined a gear on an internal shaft would slip under load because the setscrew was not inserted sufficiently to lock into the shaft. This slippage disabled the regulating blade drive capability. This was determined to be a violation of Technical Specification 3.2a, which states "all control blades, including the regulating blade, shall be operable during reactor operation." With the regulating blade inoperable, the rod run-ins associated with the regulating blade ($\leq$ 10% withdrawn and rod bottomed) listed under Technical Specification 3.4c were also inoperable. A report detailing the circumstances of this event and the remedial actions was sent to the Director of Nuclear Reactor Regulation on June 7, 2000.

Major maintenance items during the month included:

- Installing a rebuilt gearbox on the regulating blade drive mechanism and then repairing the gearbox
- Replacing the detector for nuclear instrument signal processor #1.
- Replacing the air regulator for motor operated isolation door 101.

June 2000

The reactor operated continuously in June with the following exceptions: five shutdowns for scheduled maintenance and refueling; and five unscheduled shutdowns.

On June 12, 2000, a scheduled maintenance day, the maintenance procedure for replacing control blade B was being completed. Prerequisites in this procedure required that the core shall have two less fuel elements (six compared to the normal eight) if the control blade is to be removed. It was discovered that the control blade had been removed without having two fuel elements removed from the core. The requirement for a minimum shut down margin of 0.02 $\Delta k/k$ was met at all times. It was determined the reactor was subcritical by 0.083 $\Delta k/k$ with control blade B removed. Upon discovery of the error, a fuel movement procedure, which directed the removal of the requisite fuel elements, was developed, approved and completed. The error resulted in the reactor being in non-compliance with Technical Specification 3.2.a. This violation was reported to the NRC in a letter dated July 18, 2000.

On June 15, 2000, a reactor scram occurred upon the loss of site electrical power. Site power was restored in seventy-five minutes and the reactor was returned to normal operation.

Power level interlock scrams occurred on June 16, 17, and 18. Electronic technicians initially suspected one of the two power level interlock relays was faulty – specifically, relay 1K13. This relay was replaced after the first scram with an identical relay, original vintage, and the reactor was returned to operation. Following the second scram and additional troubleshooting, the relay was replaced with a newer vintage relay identical to the other power level interlock relay 1K26. Following the third scram, both power level relays were found open. Upon further investigation, the cause was discovered to be a loose wire on the 24 VDC power supply to the core differential pressure transmitter 929 scram trip unit, which is part of the power level interlock circuit. The loose wire was repaired and the dual trip unit for core differential pressure transmitter 929 was replaced. The reactor was subsequently returned to operation and no further problems with this circuit have ocurred.

On June 30, the inner personnel airlock door shock absorber bolt suffered a fatigue failure, causing the door chain to come off its sprocket, rendering the door inoperable. The reactor was immediately shutdown. The entire shock absorber unit was replaced and the reactor was refueled and returned to normal operation.

Major maintenance items during the month included:

- Replacing the mechanical seal on pool demineralizer pump 513B.
- Installing a shafted sprocket on the Rod Position Indicator of control blade D per modification package 96-2 addendum.
- Replacing the reduction gear box on the regulating blade drive mechanism.
- Completing the pool liner inspection per special maintenance procedure #44.
- Replacing primary pump 501A.
- Replacing power level interlock relay IK13
- Replacing the dual trip unit for core differential pressure transmitter 929.
- Replacing a shock absorber unit on the inner personnel airlock door.

<u>July 2000</u>

The reactor operated continuously in July with the following exceptions: seven shutdowns for scheduled maintenance and refueling; and two unscheduled shutdowns.

On July 12, 2000, a reactor loop low-pressure scram occurred. The white rat scram monitor indicated a problem with either core discharge pressure transmitter 944B or core primary pressure transmitter 943. Electronics technicians tested the scram relay outputs for these instruments and isolated the problem to the PT 943 meter relay unit.

Further testing revealed that the light bulb that initiates the scram signal had degraded so that it initiated a scram at 65 psig. The trip set point is 56 psig. The bulb was replaced and the scram function was tested satisfactorily. The reactor was then returned to normal operation.

On July 21, a manual scram was initiated when a trolley bolt on the inner personnel airlock door broke, rendering the door inoperable. Machine shop personnel replaced the trolley bolt and the door was tested satisfactorily. The reactor was then returned to normal operation.

Major maintenance items during the month included:

- Completing the 10 year preventative maintenance activities on the uninterruptible power supply.
- Replacing the scram trip light for primary pressure transmitter 943.
- Replacing a trolley bolt on the inner personnel airlock door.

August 2000

The reactor operated continuously in August with the following exceptions: five shutdowns for scheduled maintenance, refueling, and sample removal. There were no unscheduled shutdowns this month.

Major maintenance items during the month included:

- Replacing the uninterruptible power supply (UPS) batteries.
- Replacing signal processor drawer #2 per Modification Package 95-1 Addendum 1
- Repairing the clutch assembly on the inner airlock door.
- Replacing the outer airlock door inflatable sealing gasket.
- Disposing of depleted pool deionization bed "K" and loading new pool deionization bed "V".
- Replacing primary pump 501A.
- Installing new primary and pool demineralizer outlet conductivity cells per Modificaton Package 99-4.

September 2000

The reactor operated continuously in September with the following exceptions: six shutdowns for scheduled maintenance and refueling; two unscheduled shutdowns.

On September 29, a high power rod run-in occurred when nuclear instrument channels 4 and 6 (power range monitors) indications rose to their rod run-in trip setpoints of 114% power. Nuclear instrument channel 5 also increased, however, the rod run-in caused by channels 4 and 6 prevented channel 5 from reaching it trip setpoint. The specific cause for this event has not been determined. However, some five hours after this event occurred, the regulating blade rod run-in drive chain disengaged from its drive sprocket. It is possible that prior to disengaging, the chain may have become momentarily caught on the mechanism frame, rendering the regulating blade unable to move and thereby allowing the power level to rise to the rod run-in setpoint. In the time period prior to and immediately after this event, all reactor instrumentation indications appeared normal. The drive chain was replaced and tested. The rod run-in was reset and reactor power returned to normal.

Approximately five hours after the above rod run-in, a manual scram was initiated when a reactor operator discovered the regulating blade rotary switch drive chain had disengaged from its sprocket. While this did not impede the regulating blade's ability to maintain reactor power, it did render the ≤10% withdrawn rod run-in function inoperable. The regulating blade full in rod run-in was still operable. Both rod run-ins are required to be operable per Technical Specification 3.4.c. while the reactor is in operation. The chain was replaced and tightened and the entire regulating blade drive mechanism was inspected and tested. A compliance check was satisfactorily completed on the regulating blade, testing its rod run-in functions.

A licensee event report describing this event and the remedial actions was submitted to the regional NRC office. As a corrective action the chain is now inspected as a part of the regulating rod start up testing procedure.

Major maintenance items during the month included

- Replacing the primary coolant system temperature recorder according to modification package 99-1.
- Replacing the valve body gaskets and diaphragms for pool demineralizer pump discharge valve 515 N and bypass valve 515 X.
- Adjusting the closed position "stop" adjustment on the actuator for anti-siphon valve 543 A.

October 2000

The reactor operated continuously in October with the following exceptions: six shutdowns for scheduled maintenance and refueling. There were no unscheduled shutdowns this month.

Major maintenance items during the month included:

- Rebuilding 16-inch containment exhaust ventilation valve B solenoid A-153.
- Replacing the millivolt transmitter for pool T_H instrument.
- Replacing the picoammeter in the NIS wide range monitor drawer.
- Replacing the drive shaft oil seal on cooling tower fan #2.
- Replacing the audible alarm units in the Area Radiation Monitoring System (ARMS) changing the alert sound to pulse in accordance with modification package 88-4 addendum 2
- Replacing the valve S-2 (pool heat exchanger bypass) controller in accordance with modification package 00-01.
- Completing the sprocket assembly modification on control blades A and B in accordance with modification package 96-2 addendum 1.
- Replacing the air regulator for containment ventilation isolation door 504.
- Replacing the air regulator for the inner personnel airlock door.
- Replacing the oil seal on primary pump 501 A (motor end).
- Performing a remote internal inspection of the south end of the pool hold-up tank welds.

November 2000

The reactor operated continuously in November with the following exceptions: five shutdowns for scheduled maintenance and refueling; one unscheduled shutdown.

On November 28, 2000, a reactor scram and isolation occurred when a reactor operator trainee inadvertently opened the door to the containment ventilation isolation valve solenoid cabinet. All personnel exited the containment building according to procedure. The reactor isolation was subsequently secured and after health physics' consultation, personnel returned to the containment building. The reactor was then returned to normal operation. As corrective actions, the reactor operator trainee was instructed in the proper operation of this door, and the door was subsequently modified to prevent inadvertent opening.

Major maintenance items during the month included:

- Replacing disc O-rings, and testing of the anti-siphon valves 543 A and 543 B.
- Rebuilding solenoid valve 529 G, the operator for pool isolation valve 509.
- Removing from storage, depleted pool deionization bed "E" – loading new deionization bed "G".
- Performing the biennial changeout of control blade D offset mechanism.
- Repairing the inner personnel airlock door brake.

December 2000

The reactor operated continuously in December with the following exceptions: four shutdowns for scheduled maintenance and refueling. There were no unscheduled shutdowns.

Major maintenance items during the month included:

- Replacing the Honeywell 928B D/P dual trip unit with a Moore dual trip unit in accordance with modification package 97-1 addendum 2.
- Removing depleted pool deionization bed "P"and loading new deionization bed "K".
- Repairing cracked welds on the upper, 10 element, Z fuel storage basket.
- Installing a suction isolation valve on the Eberline stack monitor in accordance with modification package 99-5, addendum 1.

SECTION II

MURR PROCEDURES

January 1, 2000 through December 31, 2000

This section includes the summary of procedure changes required by Technical Specification 6.1.h(4) to be part of the annual report. These procedure changes were reviewed and approved by the Reactor Manager or Health Physics Manager to assure the changes were in accordance with 10CFR50.59. These procedures are also reviewed by the Procedures Review Subcommittee of the Reactor Advisory Committee to meet Technical Specification requirements.

A. CHANGES TO THE STANDARD OPERATING PROCEDURES, 2nd ed., Effective Date: 5/2/89.

As required by MURR Technical Specifications, the Reactor Manager reviewed the Standard Operating Procedures and issued twenty Standing Orders regarding changes to the procedures in 2000. MURR is in the process of rewriting all of the reactor operations procedures, revising them in an entirely new format. This procedure upgrade is a result of the April 12th radiation event, and the June 12th control rod and offset mechanism event. The new Reactor Operations procedures will be reported in the 2001annual report.

B. CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

As required by the MURR Technical Specifications, the Reactor Manager reviewed the Emergency Procedures and found them to be adequate, although in need of format upgrade. The Emergency Procedures will be revised in the upcoming year. A highly experienced consultant has been hired to assist with this revision effort.

C. CHANGES TO HEALTH PHYSICS STANDARD OPERATING PROCEDURES, BYPRODUCT MATERIAL SHIPPING PROCEDURES AND PREPARATION OF BYPRODUCT MATERIAL FOR SHIPMENT PROCEDURES

Radiological control procedures, preparation for shipment, and shipment of byproduct material procedures were reviewed and are approved as written. The procedures were found to provide adequate control of radiation exposure to MURR personnel and to the public.

Health Physics Standard Operating Procedures

The following is a summary of new procedures or revisions to existing Health Physics Standard Operating Procedures issued in 2000:

HP/III-3, Rev. 5 — Calibration of Stack Particulate Channel: Eberline PING 1A: revised to provide instructions for the calibration of the new Eberline stack monitor and delete references to the old NMC monitor.

HP/III-4, Rev. 6 — Calibration of Stack Iodine Channel: Eberline PING 1A: revised to provide instructions for the calibration of the new Eberline stack monitor and delete references to the old NMC monitor.

HP/III-5, Rev. 8 — Calibration of Stack Gas Channel: Eberline PING 1A: revised to provide instructions for the calibration of the new Eberline stack monitor and delete references to the old NMC monitor.

HP/III-25, Rev. 0 — Calibration of Sodium Iodide Detector For Counting Air Sample Tanks Containing Ar-41: new procedure that provides instructions for calibrating the sodium iodide detector system.

Preparation of Byproduct Material for Shipment Procedures

The following is a summary of new procedures or revisions to existing preparation of byproduct material for shipment procedures issued in 2000:

Ho-166 DOTMP Process, Rev. 2: revised to incorporate the use of solid DOTMP and include instructions for calculating activity.

Lab 241 Glove Box Welding, Rev. 0: new procedure that provides instructions for welding irradiation capsules in a glove box.

RP-14 & 14A, Rev. 7 — Dissolving Lu-177 Nitrate: revised to provide instructions for performing concurrent verification of steps specific to the shipment of the material.

IGO-NTD-05, Rev. 0 — Pre-irradiation Processing of Exported Silicon: new procedure that provides instructions for preparing silicon for irradiation.

IGO-NTD-06, Rev. 0 — Post Irradiation Processing of Exported Silicon: new procedure that provides instructions for preparing silicon for shipment.

SECTION III
REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2000 through December 31, 2000

These changes were approved by the Reactor Manager and reviewed by licensed staff and members of the Safety Sub-committee and have been determined not to involve a change in Technical Specifications or an unreviewed safety question as defined in 10CFR50.59.

HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

Original HSR, page 8-2, Section 8.2, paragraph 1, sentence 2:

Delete: "... either inserting or removing a sample which would result in increased reactivity, or the possibility of insertion and inadvertent removal of a high poison content sample during reactor operation."

Replace with: "... inserting or removing a sample with high reactivity worth during reactor operation."

Original HSR, page 8-2, Section 8.2, paragraph 2:

Delete: Entire paragraph, which states: "To eliminate the possibility of either of these happenings, samples will be inserted or removed only during reactor shutdown. Means have been provided to eliminate sample movement during reactor operation."

Original HSR, page 8-2, Section 8.2, paragraph 3 (as revised by 1967-68 and 1996 Reactor Operations Annual Reports):

Delete: Sentences 2 and 3, which state: "This canister consists of a hollow aluminum tube or a triple tube assembly which is inserted in the flux trap prior to startup. The assembly position is positively determined by a locking canister located at the top of the assembly."

Replace with: "This canister is made of hollow aluminum tubes and is inserted in the flux trap prior to startup. A latching device located at the top of the canister positively determines the canister position."

Original HSR, page 8-3, Section 8.2, paragraph 5:

Add the following sentence to end of paragraph:

"Technical Specification Amendment 31, which allows movable and unsecured experiments in the flux trap, was approved by the NRC on September 20, 1999."

Original HSR, page 8-3, Section 8.2, paragraph 6 (as revised by 1996 Reactor Operations Annual Report):

Delete: Entire paragraph, which states: "It is felt that alternate means for usage of this facility should be provided only after operational experience has provided complete data on reactivity value. At some future date, after the acquiring of suitable information pertaining to the flux trap worth, a request will be made to the NRC for license amendment to permit insertion and removal of samples during reactor operation."

Original HSR, page 8-3, Section 8.2, paragraph 7 (as revised by 1967-68 and 1972-73 Reactor Operations Annual Reports):

Delete: Entire paragraph, which states: "The irradiation canister consists of three 1.334" I.D. aluminum tubes arranged in a cloverleaf pattern. The tubes are clearly identified as A, B, and C both physically on the canister and in all sample loading documentation. The tubes are welded into a single unit as depicted in figure 8.4."

Replace with: "The irradiation canister consists of aluminum tubes welded into a single unit as depicted in Figures 8.4 and 8.5. The tubes are clearly identified both physically on the canister and on all sample loading documentation so that sample position is positively controlled."

Original HSR, page 8-19, Figure 8.5

Add new figure: Figure 8.5 – Flux Trap 6 Barrel (MURR Dwg No. 2528, Sheet 1 of 3)

Original HSR, page 9-9, Table 9.2 (as revised by 1981-82, 1985-86, and 1995 Reactor Operations Annual Reports):

Delete: "Item No. 55 Nuclepore Radiation Monitor"

Replace with: "Item No. 55 East Wall Area Radiation Monitor"

Original HSR, page 9-20, Table 9.4 (as revised by 1990-91 and 1995 Reactor Operations Annual Reports):

Delete: "Nuclepore Filter"

Replace with: "Beam Port Floor East Wall"

Original HSR, page 9-23, Section 9.8.1.1, paragraph 3 (as revised by 1981-82 Reactor Operations Annual Report):

Delete: Sentence 1, which states: "If either sensor detects a temperature of more than 120% of normal value an alarm is initiated."

Replace with: "If reactor outlet temperature increases to greater than 120% of normal value an alarm is imitated."

Original HSR, page 13-2, Section 13.1, last paragraph:

Add the following sentence to end of paragraph:

"Technical Specification Amendment 31, which allows movable and unsecured experiments in the flux trap, was approved by the NRC on September 20, 1999."

HSR, Addendum 1, Section 3.17 (as revised by 1996 Reactor Operations Annual Report):

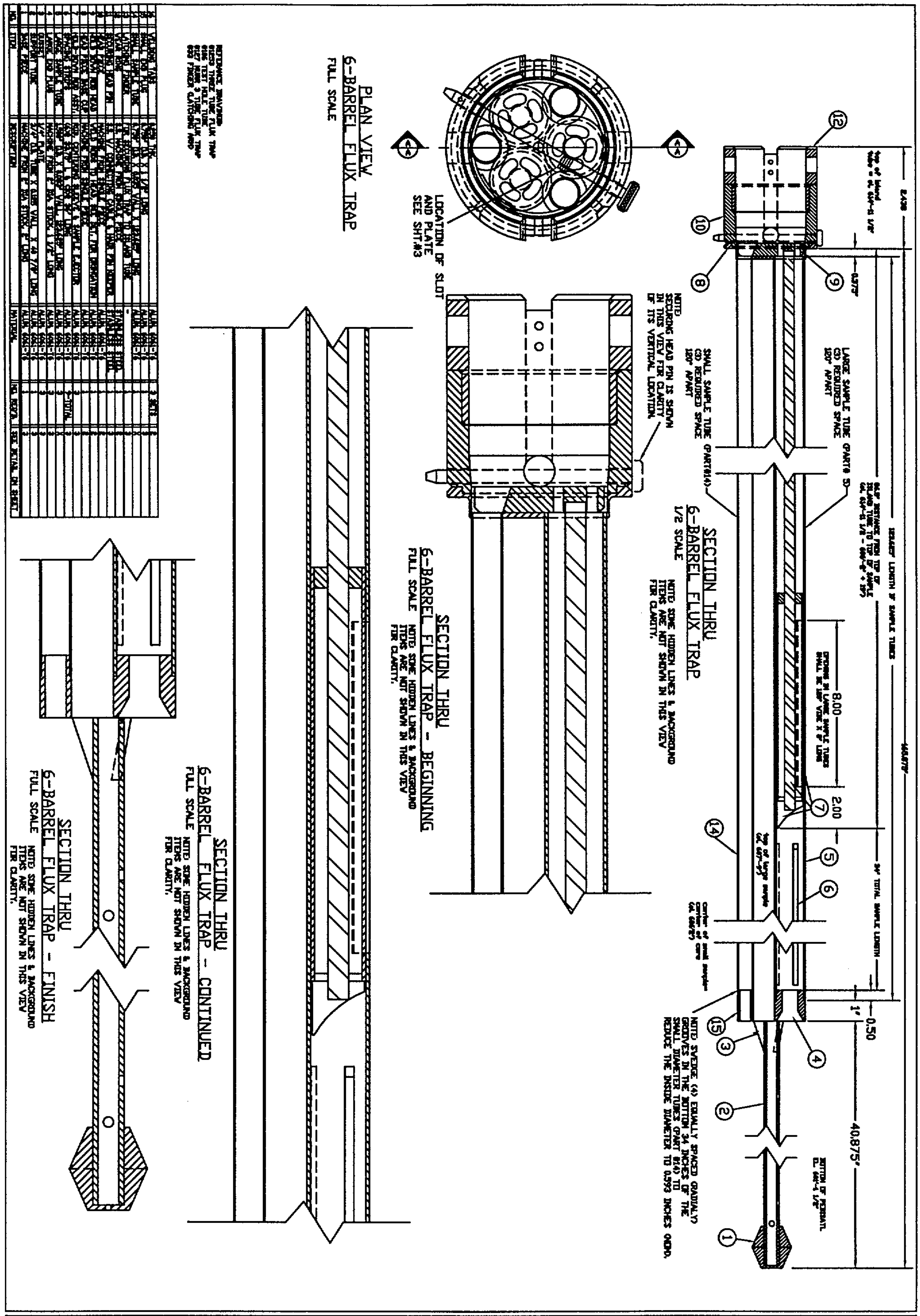
Delete: Last 2 sentences of paragraph 5, which state: "It is pertinent to point out that samples positioned in the flux trap will not be moved during reactor operation. Those samples in the graphite reflector and pneumatic tube positions may be moved in and out while the reactor is operating."

Replace with: "Secured and unsecured experiment samples positioned in the flux trap will not be moved during reactor operation. Moveable experiments in the flux trap, graphite reflector, and pneumatic tube positions may be moved in and out while the reactor is operating."

HSR, Addendum 3, Section 3.10, page 88, paragraph 2:

Delete: Entire paragraph, which states: "Because of its spatial importance the reactor is sensitive to reactivity changes in the center test hole and consequently this space receives particularly rigorous construction and administrative safety controls. Experiments are installed or removed from the center test hole only when the reactor is shutdown. Experiments are rigidly held in place and locked into position during reactor operation. The center test hole experiment holder has been described to the commission in the MURR August 1971 Annual Report."

Replace with: "Because of its spatial importance the reactor is sensitive to reactivity changes in the center test hole and consequently this space receives particularly rigorous construction and administrative safety controls. Only movable experiments in the center test hole shall be removed or installed with the reactor operating. All other experiments in the center test hole shall be removed or installed with the reactor shut down. Secured experiments shall be rigidly held in place during reactor operation. The center test hole experiment holder has been described to the commission in the 1972-73 Reactor Operations Annual Report and a Licensee Event Report dated November 17, 1982. Additional modifications are described in the 2000 Reactor Operations Annual Report."



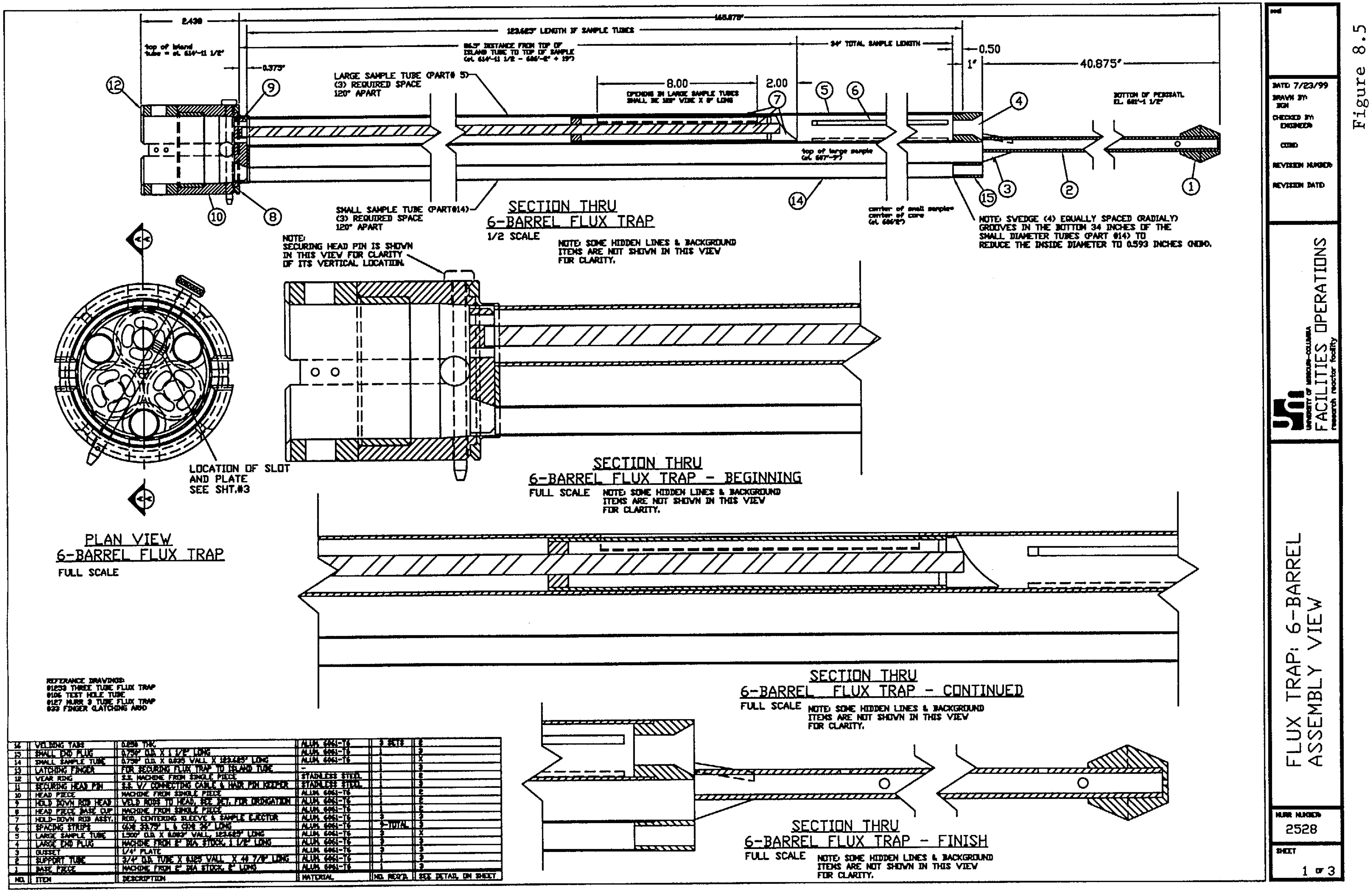
FLUX TRAP: 6-BARREL
ASSEMBLY VIEW

UNIVERSITY OF MISSOURI-COLUMBIA
FACILITIES OPERATIONS
research reactor facility

2528

1 of 3

Figure 8.4



NO.	ITEM	DESCRIPTION	MATERIAL	NO. REQ'D.	SEE DETAIL ON SHEET
16	WELDING TABS	0.250 THK.	ALUM. 6061-T6	3 SETS	2
15	SMALL END PLUG	0.750" O.D. X 1 1/2" LONG	ALUM. 6061-T6	1	3
14	SMALL SAMPLE TUBE	0.750" O.D. X 0.035 WALL X 123.625" LONG	ALUM. 6061-T6	1	X
13	LATCHING FINGER	FOR SECURING FLUX TRAP TO ISLAND TUBE	-	1	3
12	WEAR RING	S.S. MACHINE FROM SINGLE PIECE	STAINLESS STEEL	1	2
11	SECURING HEAD PIN	S.S. W/ CONNECTING CABLE & HAIR PIN KEEPER	STAINLESS STEEL	1	3
10	HEAD PIECE	MACHINE FROM SINGLE PIECE	ALUM. 6061-T6	1	2
9	HOLD DOWN ROD HEAD	WELD RODS TO HEAD, SEE DET. FOR ORIENTATION	ALUM. 6061-T6	1	2
8	HEAD PIECE BASE CUP	MACHINE FROM SINGLE PIECE	ALUM. 6061-T6	1	2
7	HOLD-DOWN ROD ASSY.	ROD, CENTERING SLEEVE & SAMPLE EJECTOR	ALUM. 6061-T6	3	3
6	SPACING STRIPS	(6)@ 33.75" L & (3)@ 36" LONG	ALUM. 6061-T6	9-TOTAL	3
5	LARGE SAMPLE TUBE	1.500" O.D. X 0.083" WALL, 123.625" LONG	ALUM. 6061-T6	3	X
4	LARGE END PLUG	MACHINE FROM 2" DIA. STOCK, 1 1/2" LONG	ALUM. 6061-T6	3	3
3	GUSSET	1/4" PLATE	ALUM. 6061-T6	3	3
2	SUPPORT TUBE	3/4" O.D. TUBE X 0.125 WALL X 40 7/8" LONG	ALUM. 6061-T6	1	3
1	BASE PIECE	MACHINE FROM 2" DIA. STOCK, 2" LONG	ALUM. 6061-T6	1	3

SECTION IV

PLANT AND SYSTEM MODIFICATION

January 1, 2000 through December 31, 2000

For each modification described below, MURR has on file the safety evaluation as well as documentation that it does not present an unreviewed safety question as per 10 CFR 50.59.

Modification 75-1, Addendum 1:
Electronic Circuit Jumper Board
This addendum to modification 75-1, "Electronics Circuits Jumper Panel," documents the addition of jumper circuits to the existing jumper board panels. The purpose of the jumper board panels is to make circuit test points more accessible to personnel while performing compliance and special procedures. The panels allow a method of jumpering circuits, along with providing a quick, positive means of checking circuits free of jumpers after checks have been completed.

Modification 86-1, Addendum 1:
Replacement of Graphite Wedge No. 5A
This addendum to modification 86-1, "Reflector Element "5A" and "5B" Replacement," documents the replacement of reflector element "5I" installed in position L6 of the graphite reflector region. Reflector element "5I" was manufactured and installed in March 1986. The replacement of this reflector element was necessitated by the degradation of the aluminum can, which encases the element fill materials.

Modification 88-4, Addendum 1:
Relocation of Nuclepore ARMS to the East Wall
This addendum to modification 88-4, "Area Radiation Monitoring System (ARMS) Replacement," documents the relocation of "Station 8" remote detector assembly and indicator from the west side of the biological shield to the east wall of the reactor containment building beamport floor. This station previously monitored the nuclepore experiment, an experiment that was abandoned in place following the removal of the gas lines, isolation valves, and valve controls as per modification 96-1. Since the nuclepore experiment is no longer operational, this channel of the ARMS was no longer required at this location. The east wall location was selected since the other three areas of the beamport floor – north, south, and west – have radiation monitors currently installed. This provided better utilization of the current ARMS.

Modification 88-4, Addendum 2:
Replacement of the Audible Alarm Units in the ARMS
This addendum to modification 88-4, "Area Radiation Monitoring System (ARMS) Replacement," documents the replacement of the continuous tone audible alarm units in the Area Radiation Monitoring System (ARMS) remote indicators with intermittent tone audible alarm units. The intermittent tone provides a discernable sound on the beamport floor and reactor bridge such that background noise does not diminish its sound or effectiveness. This ensures that personnel at these locations will promptly respond as required to a high radiation level trip.

Modification 88-5, Addendum 2:
Addition of an Isolation Valve on the Suction of the NMC Stack Monitor
This addendum to modification 88-5, "Stack Monitor Replacement," documents the installation of an isolation valve on the air sampling line to the Nuclear Measurements Corporation (NMC) Stack Monitor. The isolation valve provides the ability to secure airflow to the radiation detection chambers during the semi-annual calibration, thus eliminating the need to disconnect the compression fitting on top of the sampling unit.

Modification 96-1, Addendum 1:
Removal of the Nuclepore Experiment Filter Housing from the Biological Shield
This addendum to modification 96-1, "Removal of Nuclepore Gas Lines, Isolation Valves, and Valve Control Wiring," documents the removal of the nuclepore exhaust filter housing attached to the biological shield and associated exhaust ductwork. The nuclepore experiment was abandoned in place following the removal of the gas lines, isolations valves, and valve controls per modification 96-1.

Modification 97-1, Addendum 1:
Replace Differential Pressure Sensor (DPS) 929 Honeywell Vutronik Trip Unit with a Moore FCA Trip Unit
This addendum to modification 97-1, "Replace Honeywell Vutronik Dual Setpoint Monitor Switch with Moore Model FCA," documents the replacement of DPS 929 Honeywell Vutronik Dual Trip Unit with a new Moore Model FCA Dual Trip Unit. Because of its age and the unavailability of replacement parts, the dual trip unit had become obsolete.

Modification 97-1, Addendum 2:
Replace Differential Pressure Sensor (DPS) 928B Honeywell Vutronik Trip Unit with a Moore FCA Trip Unit
This addendum to modification 97-1, "Replace Honeywell Vutronik Dual Setpoint Monitor Switch with Moore Model FCA," documents the replacement of DPS 928B Honeywell Vutronik Dual Trip Unit with a new Moore Model FCA Dual Trip Unit. Because of its age and the unavailability of replacement parts, the dual trip unit had become obsolete.

Modification 99-1:
Replace Process Instrument Recorders
This modification documents the replacement of the General Electric Measurement and Control (GE/MAC) Model No. 531 strip-chart recorders, which provide primary and pool coolant system flow and temperature indications, with new Honeywell Model DPR 100C recorders. Because of their age and the unavailability of replacement parts, the GE/MAC strip-chart recorders had become obsolete.

Modification 99-2:
Six-Barrel Flux Trap
This modification documents the evaluation of changes to the flux trap sample holder (canister). The new design is similar to the previous sample canister holder with the exception of an added four vertical inches of irradiation capacity in the three 1.334-inch I.D. tubes and the addition of three small diameter tubes (0.68-inch I.D.) for movable or unsecured experiments. Amendment No. 31 to Facility License R-103 revised the Technical Specifications to allow movable and unsecured experiments in the center test hole.

Modification 99-3:
Replace Containment Back-Up Door Control Solenoid Valves
This modification documents the replacement of the four (4) 3-way solenoid poppet valves, which control the supply air to the reactor containment building back-up isolation doors, with equivalent Schrader-Bellows Model NC-N355-41-04853 solenoid valves. Because of their age and the unavailability of replacement valves or spare parts, the solenoid poppet valves had become obsolete.

Modification 99-5:
Installation of Eberline Model PING-1A Stack Monitor
This modification documents the installation of an Eberline Model PING-1A Stack Monitor. The stack monitor provides the ability to continuously monitor the air exiting the facility through the ventilation system exhaust stack for airborne radioactivity.

Modification 99-5, Addendum 1:

Addition of an Isolation Valve on the Suction of the Eberline Stack Monitor

This addendum to modification 99-5, "Installation of Eberline Model PING-1A Stack Monitor," documents the installation of an isolation valve on the air sampling line to the Eberline Stack Monitor. The isolation valve provides the ability to secure airflow to the radiation detection chambers during the semi-annual calibration, thus eliminating the need to disconnect the compression fitting on top of the sampling unit.

Modification 00-1:

S-1 and S-2 Temperature Controllers

This modification documents the replacement of the General Electric Measurement and Control (GE/MAC) Type 540-01 temperature controllers for the Secondary Coolant System Bypass Valves S-1 and S-2 with new Micro-DCI 53S6000 Bailey-Fischer and Porter Controllers. Because of their age and the unavailability of replacement parts, the temperature controllers had become obsolete.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 1999 through December 31, 1999

No new experimental programs were developed during this period.

SECTION VI

SPECIAL NUCLEAR MATERIAL ACTIVITIES

January 1, 2000 through December 31, 2000

1. SNM Receipts: A total of 20 new fuel elements were received from BWX Technologies, Inc., Lynchburg, Virginia.

Shipper	Elements	Grams U	Grams U-235
BWX	MO-553, MO-554, MO-555, MO-556, MO-557, MO-558, MO-559, MO-560, MO-561, MO-562, MO-563, MO-564, MO-565, MO-566, MO-567, MO-568, MO-569, MO-570, MO-571, MO-572	16,610	15,470

2. A total of 8 spent fuel elements were shipped to DOE facilities at Savannah River Plant, Aiken, South Carolina.

Shipper	Elements	Grams U	Grams U-235
MURR	MO-477, MO-479, MO-497, MO-498, MO-499, MO-500, MO-502, MO-504	5,417	4,731

3. Inspections: There were no NRC inspections reviewing SNM activities.

4. SNM Inventory: As of December 31, 2000, MURR was financially responsible for the following DOE-owned amounts:

Total U = 52,736 gms

Total U-235 = 47,174 gms

Included in these totals are 36 grams of U and 34 grams of U-235 in DOE-owned non-fuel. In addition to these totals, MURR owns 181 grams of U and 101 grams of U-235. All of this material is physically located at MURR.

The fuel elements on hand have accumulated the following burnups as of December 31, 2000.

Burned-up Elements (28)

Element No.	MWD	Element No.	MWD	Element No.	MWD
MO-506	144.600	MO-511	148.041	MO-519	146.712
MO-508	144.600	MO-512	146.348	MO-521	144.117
MO-505	147.435	MO-514	147.957	MO-523	144.117
MO-507	147.435	MO-516	147.957	MO-522	147.456
MO-501	147.901	MO-513	149.145	MO-524	147.456
MO-503	147.901	MO-515	149.145	MO-525	149.105
MO-490	146.322	MO-518	147.573	MO-527	149.105
MO-492	146.322	MO-520	147.573	MO-532	148.106
MO-509	148.041	MO-517	146.712	MO-534	148.106
MO-510	146.348				

Elements in Service (40)

MO-526	143.120	MO-544	34.595	MO-559	43.376
MO-528	143.120	MO-545	36.179	MO-560	25.412
MO-529	143.861	MO-546	90.484	MO-561	31.186
MO-530	94.158	MO-547	30.148	MO-562	42.785
MO-531	143.861	MO-548	90.484	MO-563	31.186
MO-533	117.106	MO-549	30.148	MO-564	42.785
MO-535	132.477	MO-550	70.384	MO-565	33.369
MO-536	131.540	MO-551	30.148	MO-566	24.347
MO-537	132.477	MO-552	70.384	MO-567	33.369
MO-538	131.540	MO-553	28.187	MO-568	24.347
MO-539	117.106	MO-554	26.459		
MO-540	94.158	MO-555	28.187		
MO-541	98.485	MO-556	26.457		
MO-542	34.595	MO-557	43.376		
MO-543	98.485	MO-558	25.412		

Average Burnup (all elements): 101.13 MWD

SECTION VII

REACTOR PHYSICS ACTIVITIES

January 1, 2000 through December 31, 2000

1. Fuel Utilization: During the period January 1, 2000 through December 31, 2000, the following elements reached feasible burn-up and were retired:

Serial Number	Final Core	Date Last Used	MWD
MO-506	99-64	01/03/00	145
MO-508	99-64	01/03/00	145
MO-513	00-6	02/14/00	149
MO-514	00-5	02/07/00	148
MO-515	00-6	02/14/00	149
MO-516	00-5	02/07/00	148
MO-517	00-24	05/15/00	147
MO-518	00-23	05/08/00	148
MO-519	00-24	05/15/00	147
MO-520	00-23	05/08/00	148
MO-521	00-31	06/17/00	144
MO-522	00-47	09/11/00	147
MO-523	00-31	06/17/00	144
MO-524	00-47	09/11/00	147
MO-525	00-48	09/18/00	149
MO-527	00-48	09/18/00	149
MO-532	00-62	12/11/00	148
MO-534	00-62	12/11/00	148

Due to the requirement of having less than 5 kg of unirradiated fuel in possession, initial criticalities are obtained with 2 new elements or fewer as conditions dictate. A core designation consists of 8 fuel elements of which only the initial critical fuel element serial numbers are listed in the following table of elements in service December 31, 2000. To increase operating efficiency, fuel elements are used in mixed core loadings. Therefore, a fuel element fabrication core number is different from its core load number.

MO-526	81	98-61	12-28-98
MO-528	82	98-61	12-28-98
MO-529	82	99-1	01-04-99
MO-530	82	99-26	05-17-99
MO-531	82	99-1	01-04-99
MO-533	82	99-17	03-29-99
MO-535	83	99-5	02-01-99
MO-536	83	99-16	03-22-99
MO-537	83	99-5	02-01-99
MO-538	83	99-16	03-22-99
MO-539	83	99-17	03-29-99
MO-540	83	99-26	05-17-99
MO-541	83	99-28	05-31-99
MO-542	83	99-36	07-19-99
MO-543	84	99-28	05-31-99
MO-544	84	99-36	07-19-99
MO-545	84	00-6	02-07-00
MO-546	84	99-45	09-20-99
MO-547	84	00-6	02-07-00
MO-548	84	99-45	09-20-99
MO-549	84	99-57	11-22-99
MO-550	84	99-59	11-29-99
MO-551	85	99-57	11-22-99
MO-552	85	99-59	11-29-99
MO-553	85	00-23	05-01-00
MO-554	85	00-24	05-08-00
MO-555	85	00-23	05-01-00
MO-556	85	00-24	05-08-00
MO-557	85	00-27	05-29-00
MO-558	85	00-36	07-10-00
MO-559	86	00-27	05-29-00
MO-560	86	00-36	07-10-00
MO-561	86	00-38	07-17-00
MO-562	86	00-49	09-18-00
MO-563	86	00-38	07-17-00
MO-564	86	00-49	09-18-00
MO-565	86	00-52	10-02-00
MO-566	86		
MO-567	87	00-52	10-02-00
MO-568	87		

2. Fuel Shipments: Eight spent fuel elements were shipped from MURR to Savannah River Site, Aiken, South Carolina. The identification numbers of these elements are:

   MO-477, MO-479, MO-497, MO-498, MO-499, MO-500, MO-502, MO-504

3. Fuel Procurement: BWX Technologies, Inc., Lynchburg, Virginia, is MURR's fuel assembly fabricator. This work is contracted with the U.S. Department of Energy and administered by the Idaho National Engineering and Environmental Laboratory (INEEL), Idaho Falls, Idaho. As of December 31, 2000, 373 fuel assemblies fabricated by BWX Technologies had been received and 369 used in cores.

4. Reactor Characteristic Measurements: Sixty-five refueling evolutions were completed. An excess reactivity verification was performed for each refueling. The largest excess measured reactivity was 3.12% MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

   Seven (7) reactivity measurements were made to measure the sample loading worth of all samples loaded in the flux trap region.

   Three Differential Blade worth measurements and one Primary Temperature Coefficient measurement were performed.

SECTION VIII

RADIOACTIVE EFFLUENT

January 1, 2000 through December 31, 2000

Table 1

SANITARY SEWER EFFLUENT

January 1, 2000 through December 31, 2000

Descending Order of Activity Released for Nuclide Totals > 1.00E-5 Ci

Nuclide	Activity (Ci)
H3	1.199E-01
S35	7.977E-03
CO60	5.359E-03
BA133	2.501E-03
ZN65	1.642E-03
HO166	1.223E-03
AG110M	5.963E-04
CA45	5.136E-04
AS77	3.118E-04
CS137	2.568E-04
GD159	2.517E-04
P32	2.232E-04
LU177	1.790E-04
EU152	1.498E-04
CR51	1.270E-04
EU154	1.176E-04
SN113	9.467E-05
PD109	8.444E-05
CD109	8.136E-05
TA182	5.592E-05
FE59	4.271E-05
MN54	2.328E-05
TM170	2.237E-05
EU155	1.862E-05
SM153	1.823E-05
Total H-3	**1.199E-01**
Total Other	**2.187E-02**

TABLE 2

STACK EFFLUENT

January 1, 2000 through December 31, 2000

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration mCi/ml	Total Release 1/00 -12/00 Ci	TS Limit Multiplier	% TS*
AR41	2.10E-09	9.75E+02	350	60.1066
EU152	2.70E-17	1.25E-05	1	0.0901
I131	1.50E-16	6.96E-05	1	0.0751
CO60	3.73E-17	1.73E-05	1	0.0747
H3	1.58E-11	7.34E+00	350	0.0453
CE144	8.34E-18	3.87E-06	1	0.0417
CD109	2.85E-17	1.32E-05	1	0.0407
TM170	2.61E-17	1.21E-05	1	0.0087
CS137	7.53E-18	3.49E-06	1	0.0038
I125	7.93E-18	3.68E-06	1	0.0026
LU177M	4.63E-18	2.15E-06	1	0.0023
RB86	2.27E-17	1.05E-05	1	0.0023
ZR95	8.65E-18	4.01E-06	1	0.0022
ZN65	8.61E-18	3.99E-06	1	0.0022
HG203	2.04E-17	9.46E-06	1	0.0020
OS191	3.69E-17	1.71E-05	1	0.0018
HF175	1.54E-17	7.12E-06	1	0.0015
CO57	1.20E-17	5.54E-06	1	0.0013
EU155	1.81E-18	8.40E-07	1	0.0009
CO58	7.92E-18	3.67E-06	1	0.0008
SC46	1.93E-18	8.93E-07	1	0.0006
NA22	4.75E-18	2.20E-06	1	0.0005
CE141	3.79E-18	1.76E-06	1	0.0005
SE75	3.69E-18	1.71E-06	1	0.0005
BA140	7.71E-18	3.58E-06	1	0.0004
AU196	9.46E-19	4.38E-07	350	0.0003
I134	9.36E-16	4.34E-04	350	0.0003
AS77	6.23E-15	2.89E-03	350	0.0003
CE139	1.53E-18	7.11E-07	1	0.0002
NB95	2.88E-18	1.33E-06	1	0.0001
I133	2.91E-16	1.35E-04	350	0.0001
CL38	1.59E-14	7.36E-03	350	0.0001
BR82	1.18E-15	5.49E-04	350	0.0001
S35	1.52E-18	7.06E-07	1	0.0001
SN113	4.03E-19	1.87E-07	1	0.0001
Total				**60.5**

*Isotopes observed at < 0.0001 % TS limit are not listed

Stack Flow Rate = 30,000 cfm.

SECTION IX

ENVIRONMENTAL MONITORING AND HEALTH PHYSICS SURVEYS

January 1, 2000 through December 31, 2000

Environmental samples are collected two times per year at eight locations and analyzed for radioactivity. The sampling locations are shown in Figure 1. Soil and vegetation samples are taken at each location. Water samples are taken at three of the eight locations. Analytical results are shown in Tables 1 and 2.

Table 3 lists the radiation doses recorded by environmental monitors deployed around MURR in 2000. All doses are about 50 mrem/year or less, except monitor numbers 9 and 15. These monitors are located near the loading dock where packages containing radioactive material are loaded on transport vehicles. The doses recorded by these monitors are considered to be the result of exposure to packages in transit.

The number of radiation and contamination surveys performed each month are provided in Table 4.

Table 1
Summary of Environmental Set 57
April 2000

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.19 pCi/l	3.03 pCi/l	175.97 pCi/l	4.18 pCi/ml of sample
Soil	1.19 pCi/g	3.03 pCi/g	1.55 pCi/g	N/A
Vegetation	2.39 pCi/g	6.07 pCi/g	3.19 pCi/g	4.18 pCi/ml of distillate

*Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

Activity Levels -- Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
10V57	< 2.39	111.8	<3.19	< 4.18
1V57	< 2.39	284.4	<3.19	< 4.18
2V57	< 2.39	192.1	<3.19	< 4.18
3V57	< 2.39	20.5	<3.19	< 4.18
4V57	< 2.39	36.9	<3.19	5.21
5V57	< 2.39	36.7	<3.19	< 4.18
6V57	< 2.39	28.3	<3.19	< 4.18
7V57	< 2.39	9.6	<3.19	< 4.18

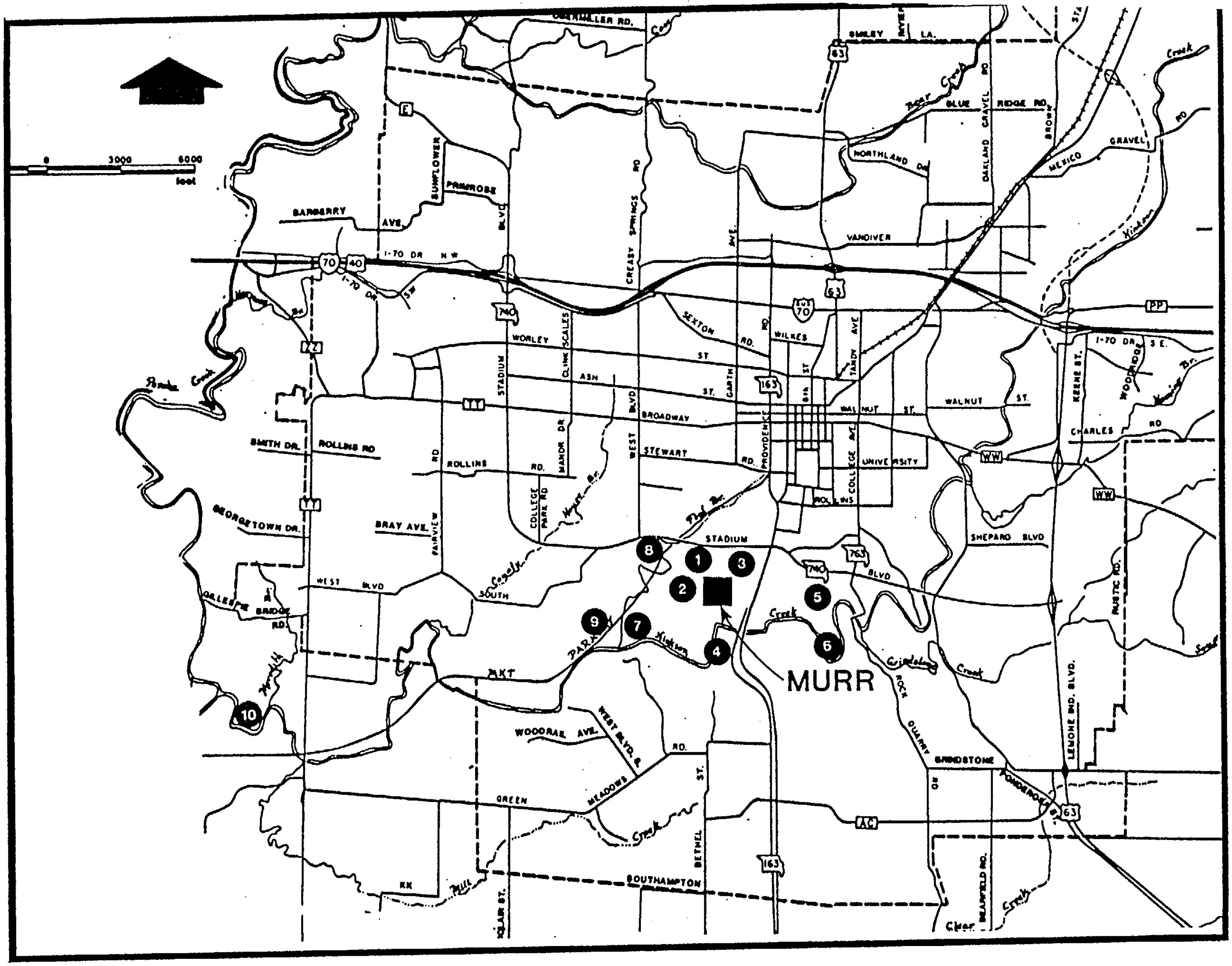


Figure 1. MURR Environmental Program Sample Stations

NOTE: September 1983 City sewerage plants at stations 8 and 9 closed. All waste water now processed at City Waste Treatment Facility at station 10.

Activity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S57	< 1.19	13.5	8.06
1S57	< 1.19	11.7	19.59
2S57	< 1.19	10.9	4.78
3S57	< 1.19	10.3	7.98
4S57	1.19	6.6	6.09
5S57	< 1.19	6.4	8.92
6S57	< 1.19	7.5	8.08
7S57	< 1.19	7.5	6.50

Activity Levels – Water

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
10W57	< 1.19	24.44	1807.48	< 4.18
4W57	< 1.19	4.81	< 175.97	< 4.18
6W57	2.18	7.28	1183.86	< 4.18

Sample 10W57 and 4W57 > MDA on NaI well detector. Analyzed sample 10W57 and 6W57 on HRGRS to determine specific radionuclides. Sample 10W57 was determined to contain 5.246 E-7 uCi/ml of Tc-99m. This radioisotope is utilized by hospitals and is often found in sample 10W. Sample 6W56 was determined to contain no activities significantly greater than background.

Table 2
Summary of Environmental Set 58
October 2000

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.69 pCi/l	2.09 pCi/l	204.74 pCi/l	1.06 pCi/ml of sample
Soil	0.69 pCi/g	2.09 pCi/g	1.02 pCi/g	N/A
Vegetation	1.38 pCi/g	4.19 pCi/g	2.76 pCi/g	1.06 pCi/ml of distillate

*Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
10V58	< 1.38	18.97	< 2.76	< 1.06
1V58	< 1.38	12.73	< 2.76	2.91
2V58	< 1.38	9.09	< 2.76	< 1.06
3V58	<2.32	12.47	< 2.76	1.27
4V58	< 1.38	9.87	< 2.76	1.39
5V58	< 1.38	15.33	2.96	< 1.06
6V58	< 1.38	13.25	< 2.76	2.47
7V58	< 1.38	21.57	< 2.76	< 1.06

Activity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S58	< 0.69	12.99	8.10
1S58	< 0.69	15.59	5.88
2S58	1.66	11.04	7.28
3S58	< 0.69	11.82	8.03
4S58	1.66	10.00	7.99
5S58	< 0.69	7.67	6.02
6S58	0.83	6.37	5.67
7S58	1.16	12.99	7.30

Activity Levels -- Water

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
10W58	< 0.69	5.13	372.19	< 1.06
4W58	< 0.69	< 2.09	< 204.74	< 1.06
6W58	< 0.69	2.40	< 204.74	< 1.06

Sample 10W58 and sample 5V58 > MDA on NaI well detector. Analyzed sample 10W56 on HRGRS to determine specific radionuclides. No nuclides were identified at greater than background levels.

Table 3							
Environmental TLD Summary							
January through December 2000							
Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2000 Net mR	2nd Qtr. 2000** Net mR	3rd Qtr. 2000 Net mR	4th Qtr. 2000 Net mR	Total Net mR
1	Control	N/A	-4.5	-2.8	-1.0	1.1	-7.2
2	Control	N/A	-1.1	-1.1	-1.0	-1.4	-4.6
3	WSW	N/A	2.2	4.7	7.1	absent	14.0
4	Control	N/A	-5.9	-3.2	-0.5	0.7	-8.9
5	Control	N/A	-6.8	-5.6	-4.3	0.6	-16.1
6	N	34	-3.3	-0.3	2.7	1.3	0.4
7	NE	57	4.9	5.5	6.1	2.1	18.6
8	SW	27	-2.9	0.2	3.3	5.0	5.6
9	S	27	53.3	51.4	49.5	48.5	202.7
10	NE	149	-5.8	-3.9	-1.9	-1.8	-13.4
11	NW	149	-3.0	-1.3	0.5	0.8	-3.0
12	ENE	301	-2.9	0.4	3.6	1.9	3.0
13	NNE	316	-4.3	-1.1	2.1	2.8	-0.5
14	S	156	-11.7	-4.3	3.1	6.1	-6.8
15	S	65	11.1	12.0	12.9	18.3	54.3
16	SE	107	-8.7	-4.5	-0.2	2.0	-11.4
17	E	293	-5.5	-3.4	-1.3	0.1	-10.1
18	NE	476	-9.1	-5.6	-2.1	-1.9	-18.7
19	NNE	606	-10.4	-6.3	-2.2	absent	-18.9
20	NE	907	15.1	4.7	-5.8	-5.6	8.4
21	SE	236	-9.2	-4.6	0.1	0.5	-13.2
22	ESE	168	absent	-1.6	-3.1	-3.8	-8.5
23	NW	110	-2.3	-1.8	-1.2	3.7	-1.6
24	SSW	328	-7.0	-4.4	-1.7	-2.1	-15.2
25	SSW	480	-2.1	-0.8	0.5	2.5	0.1
26	SW	301	-1.1	-0.9	-0.7	1.2	-1.5
27	WSW	141	-3.1	-2.6	-2.1	-5.7	-13.5
28	WNW	210	-1.9	-0.6	0.8	1.7	0.1
29	NW	255	-1.2	1.5	4.2	absent	4.5
30	NNW	328	-3.9	-2.1	-0.2	0.1	-6.1
31	NNW	671	-1.5	-1.6	-1.6	1.8	-2.9
32	NNW	724	-6.2	-3.9	-1.6	1.7	-10.0
33	E	671	-4.0	-2.7	-1.3	1.1	-6.9
34	ENE	587	-7.9	-6.1	-4.2	-3.9	-22.1
35	SSE	499	absent	1.2	2.4	-0.3	3.3
36	SE	419	-3.3	-1.7	-0.1	-1.9	-7.0
37	NE	690	-6.7	-4.7	-2.6	absent	-14.0
38	NW	556	-0.9	0.7	2.3	absent	2.1
39	W	491	6.4	2.9	-0.6	1.8	10.5
40	N	514	-3.3	-1.1	1.2	-0.5	-3.7
41	NNE	137	-12.1	-7.4	-2.6	-0.8	-22.9
42	In Building	N/A	3.4	4.8	6.2	9.2	23.6
43	In Building	N/A	3.2	5.5	7.7	8.9	25.3
44	Distant Site	N/A	-1.0	-0.3	0.4	-3.1	-4.0
45	S	65	3.3	3.1	2.8	1.7	10.9

**Note: The reported values for the second quarter of 2000 were unusually low due to the relatively high reading on the control that is subtracted out of these badges. This control generally reads about 30 mR, but read 81.5 mR for that quarter. Since this badge was handled exactly the way it is for all other quarters and we could determine no explanation for where the higher dose may have come from, we are assuming there was a flaw in this control. The data for the badges for the second quarter of 2000 are an average of the first and third quarters. This is a conservative reporting for these badges.

Table 4

Number of Facility Radiation and Contamination Surveys

2000	Radiation	Surface Contamination*	Air Samples	RWP
January	35	35	12	13
February	57	57	12	3
March	41	41	15	9
April	79	80	12	6
May	44	41	15	6
June	73	73	12	7
July	55	53	9	8
August	49	49	9	12
September	41	41	15	9
October	62	61	12	2
November	51	51	12	12
December	46	46	15	6
TOTALS	**633**	**628**	**150**	**93**

* Note: In addition, general building contamination surveys are conducted each normal work day.

Miscellaneous Items

MURR made three radioactive waste shipments in 2000 for a total of 3,043 pounds of LSA waste. In addition, two contaminated storage tanks were shipped as radioactive waste.

SECTION X
SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

January 1, 2000 through December 31, 2000

1. Largest single exposure and average exposure are expressed in millirem.
2. Minimal exposure is defined to be gamma <10 mrem; beta < 40 mrem; neutron < 20 mrem.
3. ME = Number of monthly units reported with minimal exposure.
4. AME = Number of monthly units reported with exposure above minimal.
5. AE = Average mrem reported for all units above minimal.
6. HE = Highest mrem reported for a single unit for the month.
7. Dosimetry services except for "Self Reading Dosimeters" are provided by R. S. Landauer, Jr. & Co., Dosimeter Types: "C" - X, Gamma, Beta, Fast Neutron (Neutrak 144), Thermal Neutron; "G" - X, Gamma, Beta; "U" - TLD (1 Chip Ring).

PERMANENT ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	81	83	78	86	78	90	87	75	81	82	85	91
AME	38	43	43	39	51	43	46	52	51	46	48	42
AE	47.4	53.7	82.8	65.4	74.1	60.0	51.7	68.5	62.5	70.7	81.7	79.0
HE	130	160	200	150	260	220	190	200	190	180	420	340

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	52	54	49	58	59	41	52	53	54	50	59	60
AME	6	10	9	8	9	22	12	9	14	12	8	6
AE	35.0	47.0	83.3	50.0	54.4	30.0	40.0	65.6	42.1	65.0	51.3	55.0
HE	60	140	200	90	110	100	120	140	90	180	140	120

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	126	94	90	115	102	105	110	89	105	89	113	114
AME	66	88	88	79	88	84	79	92	88	96	77	73
AE	139.4	116.4	184.7	169.0	174.9	164.4	128.6	177.0	148.3	199.1	154.2	162.7
HE	440	480	670	830	760	1520	560	620	700	860	760	580

Self Reading Dosimeters:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	15	9	17	25	9	12	8	6	2	12	17	3
A M E	81	86	77	73	90	89	91	94	95	86	85	96
A E	45.7	40	61.6	56.9	52.7	51	42.6	50.7	62.9	54.7	72.9	65.8
H E	184	170	220	172	283	258	179	192	205	171	510	340

SPARE ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	31	44	35	37	43	50	43	38	45	40	53	55
A M E	2	0	8	4	2	1	4	9	2	5	5	2
A E	60.0	0.0	33.8	52.0	15.0	10.0	22.5	31.1	55.5	106.0	102.0	50.0
H E	110	0	100	150	20	10	40	140	60	180	270	70

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	64	50	65	49	63	46	61	68	58	55	54	34
A M E	0	0	5	0	0	0	4	4	0	4	4	1
A E	0.0	0.0	24.0	0.0	0.0	0.0	10.0	30.0	0.0	17.5	17.5	20.0
H E	0	0	40	0	0	0	10	60	0	30	40	20

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	13	9	23	14	10	8	14	6	7	8	11	8
A M E	5	7	10	3	18	15	11	23	6	11	9	5
A E	82.0	70.0	100.0	133.3	158.3	108.0	107.3	97.4	125.0	90.0	61.1	178.0
H E	140	170	160	240	780	300	190	290	220	220	120	300