Research Reactor Center
University of Missouri-Columbia

Research Park
Columbia, MO 65211
PHONE (573) 882-4211
FAX (573) 882-6360

February 25, 2002

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

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

Please find enclosed one copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers January 1, 2001 through December 31, 2001.

This document is submitted to the Nuclear Regulatory Commission as required by University of Missouri Research Reactor Technical Specification 6.1.h (4)

If you have questions regarding the contents of this document, please feel free to call Paul Hobbs, Reactor Manager at 573 882 5264.

Sincerely,

Paul S. Hobbs, P.E.
Reactor Manager

Enclosure

cc: Mr. Alexander Adams, U.S. NRC
Mr. Craig Bassett, U.S. NRC

A020

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI
RESEARCH REACTOR

REACTOR OPERATIONS
ANNUAL REPORT

January 1, 2001 – December 31, 2001

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS

ANNUAL REPORT

January 1, 2001 – December 31, 2001

Compiled by the Reactor Staff

Submitted February 2002 by

Paul S. Hobbs, PE
Reactor Manager

Reviewed and Approved

Ralph A. Butler, PE
Interim Director
Chief Operating Officer

UNIVERSITY OF MISSOURI – COLUMBIA
RESEARCH REACTOR

ANNUAL REPORT

January 1, 2001 through December 31, 2001

INTRODUCTION

The purpose of this report is to meet the requirements of Administration technical specification 6.1 (4).

ACKNOWLEDGMENTS

The success of the University of Missouri Research Reactor (MURR) is due to the dedication and hard work of many individuals and organizations. To these individuals and organizations the staff of MURR wishes to extend its appreciation: The University administration; the governing officials of the State of Missouri; the Missouri State Police, our regulators; those who provided funding including the U. S. Department of Energy (USDOE); the Researchers; the Students; the Campus Facilities organization and others who made a contribution to our success.

For the year 2001, the staff of MURR owes special thanks and recognition to the University Police Department and to the Missouri National Guard for their assistance.

MURR Management wishes to thank all of the staff members for their support and cooperation in a time of great change within our unique facility. The work environment at MURR has taken on new or unfamiliar phrases such as Corrective Action Program, Safety Conscious Work Environment, questioning attitude, fifty fifty-nine evaluation and others. Your continuing positive attitude toward these changes and challenges is sincerely appreciated.

Achievements and milestones at MURR this past year include the recapture of the facility construction time which added nearly 5 years to our current operating license. To those who assisted with this very challenging effort, thank you.

Our friends and neighbors who drive by can see that many physical changes have been made to our facility over this past year. What they can't see are the changes that have occurred inside. The MURR heartbeat has grown stronger, and with that has also grown a greater sense of unity and purpose.

TABLE OF CONTENTS

SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2001 through December 31, 2001

The following table and discussion summarize reactor operations in the period January 1, 2001 through December 31, 2001.

Date	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Schedule*
Jan 2001	644.28	270.10	86.60	96.96
Feb 2001	599.82	250.03	89.26	99.97
Mar 2001	665.87	277.55	89.50	100.21
Apr 2001	589.69	245.84	81.90	91.85
May 2001	656.16	273.74	88.19	98.74
Jun 2001	644.15	268.73	89.46	100.33
Jul 2001	638.64	266.22	85.84	96.11
Aug 2001	650.58	271.24	87.44	97.70
Sep 2001	654.72	272.95	90.93	101.98
Oct 2001	646.89	269.69	86.95	97.35
Nov 2001	635.98	265.16	88.33	99.06
Dec 2001	659.35	274.84	88.62	99.22
Total for Year	7686.13	3206.09	87.75 %	98.29 %

*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.

January 2001

The reactor operated continuously in January with the following exceptions: There were five shutdowns for scheduled maintenance and/or refueling. There was one unscheduled shutdown.

On January 3, 2001, a reactor scram was caused by a momentary electrical transient that occurred when campus maintenance personnel inadvertently dropped a section of PVC piping onto an electrical conduit on the fifth level of the containment building. All of the electrical wiring and circuitry affected by this was checked and tested satisfactorily. The reactor was subsequently refueled and returned to normal operation. The workers involved were instructed to be more careful while working around sensitive equipment.

Major maintenance items for the month included: replacing the pump end of primary pump 501A due to a leaking oil seal; completing modification package 00-02 which involved modifying the regulating blade gearbox by replacing gear/shaft set screws with pins in order to eliminate slippage; installing a new pool T_c RTD transmitter in accordance with modification package 01-1; replacing the manual rod run-in switch; placing synthetic metal compound patches on several small leaks on the secondary side of primary heat exchanger 503 A.

February 2001

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

Major maintenance items for the month included: placing a synthetic metal compound patch on a small leak on the pool hold up tank; replacing the primary temperature chart recorder; replacing anti-siphon valve 543B actuator; repairing a broken wire on the brake for the outer personnel airlock door; replacing the pico-ammeter for the wide range nuclear instrument monitor.

March 2001

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

On March 2, a reactor scram occurred when the master control switch (1S1) was inadvertently bumped by a reactor operator trainee, momentarily interrupting power to the rod control circuit. It was subsequently determined that this

switch - which has a positive ball/detent latching mechanism – may not have been positively latched in the "on" position. Operators were instructed to review Standing Order 01-02 reminding them that all switch actuations are to be conscientious, deliberate actions followed immediately by verification of the expected results. The reactor was subsequently refueled and returned to normal operation.

Major maintenance items for the month included: replacing the compensating voltage power supply in the wide range nuclear instrument monitor drawer; replacing primary RTD's 980 A/B in accordance with modification package 01-3; replacing pool T_h and T_c millivolt transmitters and RTD's in accordance with modification package 01-4; replacing primary pump 501B due to a seal leak; installing a new intercom master station and some of the new staff stations.

April 2001

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

On April 6, a reactor scram and isolation occurred due to the failure of a rectifier diode in the uninterruptible power supply (UPS inverter). The diode failure caused the UPS to shift to its alternate power source which subsequently caused a fuse to blow in the alternate source circuit. This blown fuse created a loss of power to the Area Radiation Monitoring System which, in its fail-safe mode, initiated a reactor isolation. All personnel exited the containment building according to procedure. The faulty diode and blown fuse were replaced and the reactor was returned to normal operation. The electrical distribution and loads on the UPS are being evaluated to place non-reactor instrumentation loads on another UPS system.

Major maintenance items for the month included: preparing deleted pool deionization bed "w" for disposal; replacing a faulty rectifier diode in the inverter and a blown fuse in the alternate circuit of the UPS; replacing the coil and contact block on containment ventilation supply fan #2 breaker; replacing the outboard fan bearing in facility ventilation exhaust fan (EF-13); applying a synthetic metal compound (metal-tech EG) patch on a pin-hole leak on the secondary side of primary heat exchanger 503A; rebuilding the solenoid-operated air control valve for in-pool heat exchange valve 546 A; rebuilding secondary isolation valve (S-39) to heat exchanger 503A; installing an air flow meter on the main compressed air line to the containment building; replacing the valve body gaskets and valve diaphragm on valve DI-2 on the DI-202 column.

May 2001

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

On May 3, a reactor loop low flow scram occurred due to an undetermined cause. No actual low flow condition was indicated or noted on any chart recorders or any other instrumentation. Extensive troubleshooting and testing failed to duplicate the scram condition or identify a problem or failure. It is possible that air in the primary system affected the flow transmitter, producing a scram. The suspected flow transmitter (912 E) was tested and vented, the primary loop was vented, and a primary flow compliance check was completed satisfactorily. The reactor was subsequently refueled and returned to normal operation. The primary flow transmitter electronic signal was monitored with a multi-meter for the next week. No anomalies were indicated and no further problems of this type have occurred.

On May 15, a reactor scram occurred when one of the monitoring leads from the green leg of the reactor safety system monitoring circuit was inadvertently bumped and became unplugged and shorted against a nearby alarm unit chassis. This momentary short caused power supply 2PS1 to trip, which interrupted power to nuclear instrument channel #6 (power range monitor) causing a nuclear instrument anomaly scram. The 2PS1 power supply was reset and all affected electronic systems were tested satisfactorily. A Reactor Short Form Precritical Checksheet was performed and a hot reactor startup was completed. Operators were cautioned to be careful while working near sensitive equipment and the white rat was repositioned to reduce the possibility of a recurrence of this type of incident. As a corrective action, Modification 75-16 Addendum 1 will permanently mount the reactor safety system monitoring circuit in the reactor instrument panel.

On May 25, a reactor scram occurred due to the momentary loss of site electrical power during a thunderstorm. The reactor was subsequently refueled and returned to normal operation.

Major maintenance items for the month included: replacing the reactor temperature elements 980 A and 980 B with identical specification, but longer RTD units. The new seven and one-half inch RTD's should provide a more representative temperature; replacing the meter relay unit for RTD 980 B; placing a synthetic metal compound patch on the secondary side of primary heat exchanger 503 A; replacing primary pump 501 A bypass valve 538 A diaphragm; replacing nitrogen bank A solenoid valve N-22; replacing the overload, relay coil, and control transformer on secondary coolant pump #2 (SP-2) breaker; replacing the solenoid operated acid addition valve; replacing control blade D drop timer control unit and photo-electric sensor.

June 2001

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

Major maintenance items for the month included: completing the biennial change-out of control blade offset mechanism A; replacing the existing "Bailey" secondary flow transmitter with a Rosemount transmitter in accordance with modification package 01-05.

Three new reactor operators received their Operators' Licenses in June 2001.

July 2001

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

Major maintenance items for the month included: replacing the meter for pressure transmitter 917 – pool reflector differential pressure; completing Modification Record 75-16 Addendum 1 – Relocation of the Portable Reactor Safety System Monitoring Circuit (white rat); removing, rebuilding and replacing anti-siphon valve 543 B; replacing the time delay relay coil for cooling tower fan #3; replacing the four solenoid-operated air control valves for primary coolant isolation valves 507 A/B with new style solenoid-operated poppet valves as per Modification Record 01-6 (the replaced valves are designated 529F, 529H, 529S and 529T).

August 2001

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

On August 21st, a reactor scram occurred due to a spurious reactor high temperature indication on primary heat exchanger temperature instruments 980A and 980B. This occurred as a result of radio frequency (RF) interference when a portable radio was keyed in close proximity to the alarm meter units. The RF caused the meter indications to deflect, causing the scram. This situation was recreated and verified to be the cause of the scram. Operators have since been instructed to not use portable radios in close proximity to any sensitive reactor instrumentation.

Major maintenance items for the month included: completion of Addendum 2 of Modification Record 01-04, replacement of the primary T_H and T_C GE/MAC type 550 millivolt/current temperature transmitters with Moore model RBT transmitters and replacement of Bailey 100 ohm platinum RTD's with Rosemount model 68 100 ohm platinum RTD's; removing silicon sample graphite reflector wedges designated B-6, Y-5, G/Y-4 and installing a new three-hole 5-inch diameter silicon sample irradiation position; removing depleted pool de-ionization bed "V" and loading new pool de-ionization bed "T"; flooding the dry fire-main and leaving it flooded but unpressurized.

September 2001

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

Major maintenance items for the month included replacing the control blade operation "shim" switch.

October 2001

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

On October 11, a manual scram was initiated by a control room operator upon discovery that control blade "A" would not drive "out" during a routine shimming operation. The operators visually verified that blade "A" was fully inserted upon the scram. Electronics technicians discovered one broken and one frayed drive motor connecting wire. These wires were replaced and the drive mechanism was satisfactorily tested throughout its full range of travel. The connecting wires to the remaining drive mechanism motors were thoroughly inspected and found to be satisfactory. The reactor was subsequently refueled and returned to normal operation.

Major maintenance items for the month included: repairing a pin-hole leak on the fission product monitor return line; replacing two connecting wires to control blade "A" drive mechanism motor; replacing solenoid valves 529A and 529C with new style solenoid valves in accordance with modification package 01-6; completing modification package 99-4 which involved replacement of the pool and primary conductivity cells, amplifiers, and indicators; replacing the pump case and bearing covers on the pressurizer charging pump.

November 2001

The reactor operated continuously in November with the following exceptions: six shutdowns for scheduled maintenance and/or refueling. There were no unscheduled shutdowns in November.

Major maintenance items for the month included: replacing the 529 series solenoid valves for valves 527A, 527B, 515H, 524, 565A, 565B in accordance with modification package 01-6 "Replacement of All 529 Series Solenoid Valves with New Type"; replacing the regulating blade position indication encoder; completing modification package 01-8 "Re-routing Lab 218 Pneumatic Tube System Transfer Line from Row One to Row Two Terminal."

December 2001

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

Major maintenance items for the month included: performing biennial control blade offset mechanism change-out of position "C"; installing a digital run-time meter in the Control Room for the emergency diesel generator; performing flange gasket and valve diaphragm refurbishment and replacement associated with DI-200 deionization tank; replacing the door control solenoids on the inner personnel airlock door (door 277); repairing a minor leak on secondary side of primary heat exchanger 503A.

SECTION II

MURR PROCEDURES

January 1, 2001 through December 31, 2001

This section includes the summary of procedure changes required by Technical Specification 6.1.h.(4) to be included in the annual report. These procedure changes were reviewed by the Reactor Manager or Health Physics Manager and others to assure compliance with the requirements of 10CFR59. These procedure changes were also reviewed by the Procedure Review Subcommittee of the Reactor Advisory Committee to meet Technical Specification 6.1.c.(1).

A. CHANGES TO THE STANDARD OPERATING PROCEDURES

As required by the MURR Technical Specifications, the Reactor Manager reviewed the Standard Operating Procedures and found them to be adequate for the safe and reliable operation of the facility.

The MURR Standard Operating Procedures are in the final stages of a complete rewrite and reformatting effort. All MURR procedures are to be upgraded in accordance with the newly developed MURR Procedure Writers Guide. Per this guide, each procedure is stand alone, and has, as applicable, sections, *Purpose, Scope, Precautions and Limitations, Prerequisites, Procedure steps, Restoration, References and Records.*

Thus far, 42 new Standard Operating Procedures have been developed, reviewed and approved for use by Control Room personnel. All of these new procedures listed below have superseded a corresponding "old" procedure or procedure section. Given the extent of the changes to the procedures, all were reviewed and approved by the MURR Procedure Review Subcommittee.

AP-RO-100	Equipment Tag Out
EX-RO-105	Reactor Irradiation Experiments
EX-RO-120	Beamport "A" Operation
EX-RO-121	Beamport "B" Operation
EX-RO-122	Beamport "C" Operation
EX-RO-123	Beamport "D" Operation
EX-RO-124	Beamport "D" Operation
EX-RO-125	Beamport "F" Operation
EX-RO-126	Thermal Column Door
OP-RO-210	Reactor Startup-Normal
OP-RO-211	Reactor Startup-Hot
OP-RO-212	Reactor Startup-Recovery From Temporary Power Reduction
OP-RO-220	Reactor Shutdown or Power Reduction
OP-RO-230	Changing Reactor Power Level
OP-RO-250	Fuel Handling
OP-RO-310	Nuclear Instrumentation-Signal Processor #1
OP-RO-311	Nuclear Instrumentation-Signal Processor #2
OP-RO-312	Nuclear Instrumentation-Channel 6
OP-RO-330	Nuclear Instrumentation WRM
OP-RO-340	Nuclear Instrumentation Adjustment
OP-RO-410	Primary Coolant System
OP-RO-460	Pool Coolant System-Two Pump Operation
OP-RO-461	Pool Coolant System-One Pump Operation
OP-RO-465	Pool Level Control-Skimmer System
OP-RO-466	Pool Level Control-Pool Coolant System
OP-RO-480	Secondary Coolant System
OP-RO-510	Nitrogen Systems
OP-RO-515	Emergency Air System
OP-RO-516	Valve Operation Air System
OP-RO-520	Emergency Diesel Generator
OP-RO-530	Demineralized Water Supply System
OP-RO-531	Pool and Primary Sample Station
OP-RO-532	Drain Collection System
OP-RO-533	Skimmer System
OP-RO-710	Radiation Monitoring –Area Monitors
OP-RO-720	Radiation Monitoring-Stack Monitor Operational Check
OP-RO-730	Building Exhaust System Fans
OP-RO-741	Waste Tank System Operation

RM-RO-400	Waste Tank Filter Replacement	RP-RO-100	Fuel Movement
RM-RO-470	Sulfuric Acid System	SM-RO-420	Pressurizer Operation Maintenance Test

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 Plan Implementing Procedures and found them to be adequate, although in need of upgrade to be consistent with the MURR Procedure Writers Guide.

Drafts of revisions for all of the Emergency Plan Implementing Procedures are complete and have been reviewed by the Reactor Manager. Training for Operations personnel, Facility Emergency Organization members and facility staff is in progress. In conjunction with completion of this training, the newly revised procedures will be reviewed by the MURR Procedure Review Subcommittee, approved and issued.

C. HEALTH PHYSICS STANDARD OPERATING PROCEDURES

The following is a summary of new procedures or revisions to existing Health Physics Standard Operating Procedures issued in 2001. Some procedures are revisions to existing procedures, which have been placed in the new MURR procedure format and reviewed by the Procedure Review Committee. Others, which were issued prior to the committee action on new Health Physics procedures, were reviewed by various HP staff members prior to issuance.

AP-HP-123	Visitor Dosimetry-Reception Desk *Replaces old procedure HP/II-1*
AP-HP-127	Radioactive Material Licensing & Proj. Designation Change *New*
OP-HP-200	Air Sampling-Containment Building Tritium *Replaces old procedure HP/II-4*
OP-HP-222	Air Sampling-Containment Building Ar-41 *New*
OP-HP-400	Gemstone Shipping Barrel Analysis *New*
RP-HP-100	Contamination Monitoring-Performing a Swipe *Replaces old procedure HP/IV-1*
RP-HP-105	Transfer of Radioactive Material-In Facility *Replaces old procedure HP/IV-3*
HP/I-7, Rev. 3	High Radiation Area Access *Reformatted procedure and added references to controlling access to the isotope storage closet.*
HP/III-6, Rev. 2	Stack Monitor Preventative Maintenance: NMC Model RAK *Procedure revision with minor changes to increase detail of procedure.*
HP/III-8, Rev. 1	Calibration of Stack Particulate Channel: NMC Model RAK *Procedure revision with minor changes to increase detail of procedure.*

HP/III-9, Rev. 1 Calibration of Stack Iodine Channel: NMC Model RAK
Procedure revision with minor changes to increase detail of procedure.

HP/III-10, Rev 3 Calibration of Stack Gas Channel: NMC Model RAK
Procedure revision with minor changes to increase detail of procedure.

HP/III-25, Rev. 1 Calibration of Sodium Iodide Detector for Counting Air Sample Tanks containing Ar-41
Procedure revision with minor changes to increase detail of procedure.

HP/VI-8, Rev. 0 MURR Exclusive Use Shipment of Radioactive Material, Low Specific Activity or Surface Contaminated Object
New procedure to increase efficiency of waste processing shipments.

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2001 through December 31, 2001

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. These changes have all been reviewed in accordance with 10CFR50.59.

HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

Original HSR, page 1-2, Section 1.1.3, paragraph 3, sentence 1:

Delete: "...a Co-60 gamma irradiation well,..."

Original HSR, Figure 5.1, Piping & Instrument Diagram (as revised by the 1972-73, 1973-1974, 1994 and 1996 Reactor Operations Annual Reports)**:**

Replace with: Updated Figure 5.1, Piping & Instrument Diagram (MURR Dwg #156, Sheet 1 of 1, dated 9/10/01)

Original HSR, page 7-20, Section 7.2.9, paragraphs 1, 2 and 3 (as revised by the 1981-82 and 1995 Reactor Operations Annual Reports)**:**

Delete: The first three paragraphs, which state:

"A computerized telephone system has been installed in this facility. This new system incorporates a paging feature with several different phones being able to originate the page.

The intercommunication and paging system has one master station and several staff stations as shown in Table 7.1. The master station is in the reactor control room. Speakers for the paging system are located as shown in Table 7.2.

Any staff station may be called from the master control station. Any staff station may call the master control station. Voice paging may be accomplished from the master control station."

Replace with: "The reactor facility utilizes two principal communication systems: a computerized telephone system and an intercommunication system that allows two-way communication between a master station and a staff station. A paging feature, which allows several different telephones to originate a page, is incorporated into the telephone system.

Master and staff station locations for the intercommunication system are shown in Table 7.1. The master station is in the reactor control room. Speakers for the paging system are located as shown in Table 7.2. Any staff station may be called from the master control station and any staff station may call the master control station. Voice paging may be accomplished from the master control station."

Original HSR, pages 7-20 and 7-21, Section 7.2.9, Table 7.1 (as revised by the 1974-75 and 1995 Reactor Operations Annual Reports)**:**

Delete: Entire Table 7.1, which states:

"Master Stations	
Room 302	Reactor Control Console
Staff Stations	
Cooling Tower Basement	
Room 101	Beam Hole Floor
Room 105	Hot Cell Work Area
Room 114	Heat Exchanger Room
Room 115	Demineralizer Area
Room 216	Laboratory
Room 218	Laboratory
Room 227	Laboratory
Room 228	Laboratory
Room 241	Laboratory
Room 257	Laboratory
Room 286	Airlock
Rooms 282/271	ET/Machine Shops
Room 242	Health Physics Office
Room 101F	Fuel Vault
Room 278	West Mechanical Equipment Room
Fifth Level Mechanical Equipment Room"	

Replace with:

"Master Stations	
Room 302	Reactor Control Console
Staff Stations	
Cooling Tower Basement	
Cooling Tower Entrance	
Laboratory Building Roof	
Room 101	Beamport Floor
Room 105	Hot Cell Work Area
Room 114 (2)	Mechanical Equipment Room
Room 115	Demineralizer Area
Room 216	Laboratory
Room 218	Laboratory
Room 227	Laboratory
Room 242	Laboratory
Room 271	Machine Shop
Room 278	Mechanical Equipment Room
Room 282	Electronic Technician Shop
Room 286	Airlock
Room 288	Health Physics Office
Room 307	West Tower Third Level
Room 501	Containment Building Fifth Level
Room 507	West Tower Fifth Level"

Original HSR, page 7-21, Section 7.2.9, Table 7.2 (as revised by the 1995 Reactor Operations Annual Report):

Delete: Entire Table 7.2, which states:

"Room 101 (3)	Beam Hole Floor
Room 103	Below Grade Freight Area
Outside Room 215	Containment Building Third Level

Outside Room 224
Outside Room 228
Outside Room 241
Outside Room 244
Outside Room 258
Outside Room 264
Outside Room 288
Outside Room 292
In Reactor Lobby
Containment Building Fourth Level
Containment Building Fifth Level"
Room 231A
Room 231B
Room 231C
Room 251

Replace with:

"Room 101 (3)
Containment Building Grade Level (2)
Containment Building Third Level
Containment Building Fourth Level
Cooling Tower Grade Level
Room 103
Room 111
Main Lobby
Outside Room 114
Outside Room 214A
Outside Room 224
Outside Room 228
Outside Room 241
Outside Room 244
Outside Room 258
Outside Room 264
Outside Room 288
Outside Room 293
Room 212
Room 215A
Room 216
Room 218
Room 224
Room 227
Room 232B
Room 238
Room 231
Room 231A
Room 231B
Room 231C
Room 241
Room 251
Room 251
Room 257
Room 259
Room 262
Room 267A
Room 271
Room 278
Room 288"

Original HSR, page 8-10, Section 8.5, paragraph 1 (as revised by 1996 Reactor Operations Annual Report)**:**

Delete: Fourth sentence, which states: "Currently only two reactor terminals and four sending-receiving stations are used."

Replace with: "Currently, only two reactor terminals and three sending-receiving stations are in use."

Original HSR, page 8-11, Section 8.5, paragraph 3 (as revised by 1996 Reactor Operations Annual Report)**:**

Delete: Second and third sentences, which state: "First, each of the pneumatic tubes are equipped with double send-receive stations such that each tube services two laboratories adjacent one to the other. The control panels of the sending receiving stations for these adjacent laboratories are electrically interlocked such that when a rabbit is dispatched from one station it is impossible to utilize the remaining station for an irradiation."

Replace with: "First, each of the pneumatic tubes may be equipped with double send-receive stations such that each tube can service two laboratories adjacent one to the other. The control panels of the sending-receiving stations for these laboratories are electrically interlocked such that when a rabbit is

dispatched from one station it is impossible to utilize the remaining station for an irradiation."

Original HSR, page 9-13, Section 9.3.4 (as revised by 1968-69 and 1995 Reactor Operations Annual Reports):

Delete: Entire section, which states:

"Two of the three power range channels are identical and monitor reactor power from shutdown condition to full power in a single range. The detectors for these two channels are mounted in the pool near core center line elevation in water tight containers and are adjustable radially and vertically. The output of a power range level monitor is delivered to local and remote indicators, to a power level recorder, and to two independently adjustable trip circuits. The power level remote indicators are mounted on the control console.

The third power level channel is the Wide Range Monitor. It monitors reactor power from shutdown to full power in eighteen linear ranges. The detector for this power level channel is a compensated ion chamber.

The output of the Wide Range Monitor is delivered to two independently adjustable trip circuits, remote and local level indicators, and to the power level recorder. The remote power level indicator is mounted on the control console.

Power level, as measured and indicated by any one of the three power level monitors is continuously recorded. Power level indication from the power range monitor units is recorded on a dual unit recorder located in an auxiliary panel next to the instrument cubicle. The wide range monitor power level indication is recorded on a recorder located on the instrument cubicle in front of the control console.

The output of the Wide Range Monitor is delivered to the servo amplifier system and provides the controlling signal when the reactor is operating under automatic control."

Replace with:

"Three power range channels are required to be operable and provide scram and rod run-in trips during all phases of reactor operation. The power range neutron detectors may be either compensated or uncompensated ion chambers or fission chambers mounted in the pool outside the reflector region at approximately core centerline elevation in water-tight drywells. The power range detector drywells are designed to allow both vertical and radial adjustment, if necessary.

One power range channel will monitor reactor power from shutdown to full power in discrete linear ranges. The output of the Wide Range Monitor is delivered to the servo amplifier system and provides the controlling signal for the regulating blade when the reactor is operating under automatic control. This channel may be one of the three power range channels required to provide scram trips. If this channel does not provide scram trips, a total of four power range channels will be required (three others with scram trips).

The output of the power range level monitors is delivered to local and remote meters, power level recorders, and for three of the monitors to two adjustable trip circuits (scram and rod run-in). The power level remote meters are located on the reactor control console."

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

Delete: Second sentence, which states: "If the temperatures exceed 125% of normal a scram is initiated."

Replace with: "If reactor outlet temperature exceeds 125% of normal, a scram is initiated."

Original HSR, pages 9-5 through 9-7, Table 9.1 (as revised by 1981-82 and 1995 Reactor Operations Annual Reports):

Delete: Entire Table 9.1, "Control Console Displays and Controls"

Replace with:

(a) Displays

No.	Function	Type
1	Control Rod Position Indication	Digital
2	Control Rod Drive Mechanism "Power On" (4)	Light
3	Control Rod Drive Mechanism "Drive Full In" (4)	Light
4	Control Rod Drive Mechanism "Drive Full Out" (4)	Light
5	Control Rod Drive Mechanism "Magnet Engaged" (4)	Light
6	Control Rod Drive Mechanism "Blade Full In" (4)	Light
7	Regulating Rod Full In	Light
8	Regulating Rod Full Out	Light
9	Regulating Rod 10% Withdrawn	Light
10	Regulating Rod 20% Withdrawn	Light
11	Regulating Rod 60% Withdrawn	Light
12	Source Range Level - Channel 1	Meter
13	Source Range Period - Channel 1	Meter
14	Intermediate Range Level - Channel 2	Meter
15	Intermediate Range Period - Channel 2	Meter
16	Intermediate Range Level - Channel 3	Meter
17	Intermediate Range Period - Channel 3	Meter
18	Power Range Level - Channel 4	Meter
19	Power Range Level - Channel 5	Meter
20	Power Range Level - Channel 6	Meter
21	Wide Range Level	Meter
22	Power Level Set	Meter
23	Pneumatic Tube System Blowers "On" Indication	Light
24	Regulating Rod Position Indication	Digital
25	Temperature Readout	Digital
26	High Power "Warning"	Light

(b) Controls

No.	Function	Positions	Type of Switch
27	Rod Control Mode	"Manual"	Push Button
28	Rod Control Mode	"Auto"	Push Button
29	Power Schedule Selector	"Raise-Off-Lower"	3 Pos. Spring Ret.
30	Regulating Rod Operate	"Jog In"	Push Button
31	Regulating Rod Operate	"Jog Out"	Push Button
32	Master Control	"Off-Test-On"	3 Pos. Key Lock
33	Power Level Selector	"50kW-5MW-10MW"	3 Position
34	Control Rod Selector	"A-B-C-D-Gang"	5 Position
35	Control Rod Operate	"In-Normal-Out"	3 Pos. Spring Ret.
36	Regulating Rod Operate	"In-Normal-Out"	3 Pos. Spring Ret.

37	Annunciator Acknowledge	N/A	Push Button
38	Annunciator Reset	N/A	Push Button
39	Annunciator Test	N/A	Push Button
40	Scram	N/A	Push Button
41	Scram Reset	N/A	Push Button
42	Rod Run-In	N/A	Push Button
43	Rod Run-In Reset	N/A	Push Button
44	Magnet Current	"Off-On"	2 Position
45	Reactor Isolation	"Off-On"	2 Position
46	Facility Evacuation	"Off-On"	2 Position
47	Hi/Low Reflector ΔP	"Off-Bypass"	2 Pos. Key Lock
48	Low Pressurizer Pressure	"Off-Bypass"	2 Pos. Key Lock
49	Low Primary Pressure	"Off-Bypass"	2 Pos. Key Lock
50	Vent Tank Low Level	"Off-Bypass"	2 Pos. Key Lock
51	Rod Magnet Contact	"Off-Bypass"	2 Pos. Key Lock
52	Ant-Siphon High Level	"Off-Bypass"	2 Pos. Key Lock
53	Intrusion Alarm	"Off-On"	2 Position
54	Airlock Door Security	"Closed-Open"	2 Position
55	Thermal Column Shutter	"Off-On"	2 Position
56	Pneumatic Tube Blowers	"Off-On"	2 Position
57	Airlock Door Open	N/A	Push Button
58	Range Switch	N/A	18 Position
59	Automatic Shim Circuit	N/A	N/A
60	Temperature Readout	N/A	24 position

Original HSR, pages 9-7 through 9-10, Table 9.2 (as revised by 1981-82, 1986-87, 1995 and 2000 Reactor Operations Annual Reports)**:**

Delete: Entire Table 9.2, "Instrument Cubicle Devices"

Replace with: "1 Annunciator
2 Source Range Monitor Level Recorder
3 Intermediate Range Monitor Level Recorder - 2 Pen
4 Wide Range Monitor Level Recorder - 2 Pen
5 Power Range Monitor Level Recorder - 3 Pen
6 Multiscaler
7 Neutron Flux Monitor - Signal Processor Drawer No. 1
8 Neutron Flux Monitor - Signal Processor Drawer No. 2
9 Neutron Flux Monitor - Channel No. 6 Drawer
10 Neutron Flux Monitor - Wide Range Monitor Drawer
11 Annunciator & Interlock Relay Drawer
12 Servo Amplifier Drawer
13 Auxiliary Annunciator - Panalarm
14 Non-Coincidence Logic Unit - Reactor Safety System "Yellow Leg"
15 Trip Actuator Amplifier - Reactor Safety System "Yellow Leg"
16 Non-Coincidence Logic Unit - Rod Run-In System
17 Trip Actuator Amplifier - Rod Run-In System
18 Non-Coincidence Logic Unit - Reactor Safety System "Green Leg"
19 Trip Actuator Amplifier - Reactor Safety System "Green Leg"
20 20 VDC Regulated Power Supply Drawer (2PS1)
21 20 VDC Regulated Power Supply Drawer (2PS2)
22 Control Blade Drop Timer Circuit
23 Rod Position Indication Drawer
24 Reactor Safety System Relay Drawer
25 Primary Coolant System Pressure Meter - PT 943
26 Primary Coolant HX503A Outlet Temperature Meter - TE 980A

27 Primary Coolant HX503B Outlet Temperature Meter - TE 980B
28 Dual Alarm Unit (EP 953A/B) - Primary Coolant High Temperature Scram
29 RTD Transmitter (EP 903B) - Primary Coolant T_h
30 Isolated Power Supply (EP 911A) - Reactor Safety System "Yellow Leg"
31 Square Root Converter (EP 919A) - Primary Flow "A" Loop
32 Dual Alarm Unit (EP 920A/B) - Primary & Pool Low Flow Scrams
33 Square Root Converter (EP 919F) - Pool Flow "B" Loop
34 RTD Transmitter (EP 903A) - Primary Coolant T_c
35 Summer (EP 954) - Primary Coolant Differential Temperature
36 MV/I Transmitter (EP 955) - In-Pool Heat Exchanger Differential Temp.
37 RTD Transmitter (EP 903C) - Pool Coolant T_c
38 Summer (EP 952) - Pool Coolant Differential Temperature
39 RTD Transmitter (EP 903D) - Pool Coolant T_h
40 Square Root Transmitter (EP 919C) - Primary Demineralizer Flow
41 Square Root Transmitter (EP 919D) - Pool Demineralizer Flow
42 Isolated Power Supply (EP 911B) - Reactor Safety System "Green Leg"
43 Square Root Converter (EP 919E) - Primary Flow "B" Loop
44 Dual Alarm Unit (EP 920C/D) - Primary & Pool Low Flow Scrams
45 Square Root Converter (EP 919B) - Pool Flow "A" Loop
46 Alarm Unit - Pressurizer Water Level
47 Power Mode I, II, & III Indication Lights
48 Clock
49 "REACTOR ON" Light
50 Annunciator Alarm Power Switch - 3 Position
51 Area Radiation Monitor - Beamport Floor North Wall
52 Area Radiation Monitor - Beamport Floor West Wall
53 Area Radiation Monitor - Beamport Floor South Wall
54 Area Radiation Monitor - Containment Building Exhaust No. 1
55 Secondary Coolant System Radiation Monitor
56 Area Radiation Monitor - Reactor Pool Bridge ALARA
57 Area Radiation Monitor - Reactor Pool Bridge
58 Area Radiation Monitor - Beamport Floor East Wall
59 Area Radiation Monitor - Fuel Vault
60 Area Radiation Monitor - Mechanical Equipment Room (Room 114)
61 Area Radiation Monitor - Containment Building Exhaust No. 2
62 Fuel Element Failure Radiation Monitor
63 Circuit Fuses (7)
64 Reactor Pool Bridge Radiation Monitor Upscale Switch & Light
65 Containment Ventilation Isolation Door 504 Stop Push Button
66 Containment Ventilation Isolation Door 504 Close Light
67 Containment Ventilation Isolation Door 504 Open Push Button & Light
68 Containment Ventilation Isolation Door 505 Stop Push Button
69 Containment Ventilation Isolation Door 505 Close Light
70 Containment Ventilation Isolation Door 505 Open Push Button & Light
71 Valve 552A Open Indication Light
72 Valve 552A Closed Indication Light
73 Valve 552B Open Indication Light
74 Valve 552B Closed Indication Light
75 Valve 552B Control Switch - 2 Position – "Open-Normal"
76 Valve 527D Open Indication Light
77 Valve 527D Closed Indication Light
78 Valve 527D Control Switch - 2 Position - "Open-Normal"
79 Valve Control Switches[a] - 2 Position - "Auto-Man"
80 Valve Control Switches[b] - 2 Position - "Open-Close"
81 Pump Control Switches[c] - 2 Position - "Off-On"
82 Cooling Tower Fan Control Switches - 3 Position - "Fast-Off-Slow"

83 Valve 547 Position Indication Light
84 Heavy Equipment Entry (Door 101) Door Ajar Indication Light
85 Primary Coolant T_h - T_c Recorder - 2 Pen
86 Primary Coolant System Temperature Controller (S-1)
87 Pool Coolant T_h - T_c Recorder - 2 Pen
88 Pool Coolant System Temperature Controller (S-2)
89 Primary Coolant System Flow Recorder - 2 Pen
90 Pool Coolant System Flow Recorder - 2 Pen
91 Primary & Pool Coolant Demineralizer Flow Recorder - 2 Pen
92 Closed Circuit Television Monitor
93 Pool Coolant System Differential Temperature Meter
94 Primary Coolant System Differential Temperature Meter
95 Pressurizer Water Level Indication Meter
96 In-Pool Heat Exchanger Differential Temperature Meter
97 Reactor Pool Reflector Region Differential Pressure Meter - PT 917
98 Reactor Core Outlet Pressure Meter - PT 944A
99 Reactor Core Outlet Pressure Meter - PT 944B
100 Primary Coolant HX503A Differential Pressure Meter - DPS 928A
101 Primary Coolant HX503B Differential Pressure Meter - DPS 928B
102 Reactor Core Differential Pressure Meter - DPS 929
103 Valve 16A Closed Indication Light
104 Valve 16A Open Indication Light
105 Valve 16B Closed Indication Light
106 Valve 16B Open Indication Light
107 Fan Failure Alarm Panel
108 Secondary Coolant System Recorder - 3 Pen (Temperatures & Flow)
109 Secondary Coolant System High Temperature Alarm Light
110 Drain Collection System Control Panel
111 Digital Temperature Readout (TE 980/990)
112 Emergency Diesel Generator Alarm Panel
113 Hot Cell Isolation Valve Position Indication & Remote Operator
114 Reactor Power Calculator
115 Reactor Safety System Monitoring Circuit
116 Pool Coolant Flow Bypass Switch (2S40) - 4 Position
117 Primary Coolant Flow Bypass Switch (2S41) - 4 Position
118 Primary Coolant System Conductivity Meter - Demineralizer Inlet
119 Primary Coolant System Conductivity Meter - Demineralizer Outlet
120 Pool Coolant System Conductivity Meter - Demineralizer Inlet
121 Pool Coolant System Conductivity Meter - Demineralizer Outlet
122 Fire Main Low Pressure Alarm Light
123 Door Open Alarm (Room 114, Cooling Tower, Demineralizer Area)
124 Alarm Cutout Switches - Door, Firemain, Secondary pH
125 Domestic Cold Water (DCW) Low Pressure Alarm Light
126 Fire Main Low Pressure Alarm Panel
127 Pneumatic Tube System Irradiation Counter
128 Off-Gas Radiation Monitor Recorder - 3 Pen
129 Off-Gas Radiation Monitor Flow Alarms & Cutout Switch
130 Off-Gas Radiation Monitor Recorder - 3 Pen
131 Secondary Coolant Transmitter Selector Switch
132 Emergency Diesel Generator Elapsed Time Run Meter

---

[a]Auto/Manual control switches for the following valves: V546A/B, V507A/B, V509, V545, V526, V527A, and V527B.

[b]Open/Close control switches and indication lights for the following valves: V546A/B, V507A/B, V509, V543A/B, V527E, V527F, V545, V526, V527A, V527B, and V527C.

°Off/On control switches and indication lights for the following pumps: SP-1, SP-2, SP-3, P501A/B, P508A/B, P513A/B, and P533 (Off/Auto).

Original HSR, Figure 9.1, Control Room Layout

Replace with: Updated Figure 9.1, Control Room Layout

Original HSR, Figure 9.2, Control Console Layout (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure 9.2, Control Console Layout (dated 2/1/02)

Original HSR, Figure 9.3, Instrument Cabinet (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure 9.3, Instrument Cabinet (MURR Dwg #74, Sheet 12 of 12, dated 2/4/02)

Original HSR, Figure 9.4, Safety System 10 MW (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure 9.4, Safety System (MURR Dwg #139, Sheet 1 of 1, dated 4/5/01)

Original HSR, Figure 9.5, Rod Run-In System (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure 9.5, Rod Run-In System (MURR Dwg #140, Sheet 1 of 1, dated 4/6/98)

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

HSR, Addendum 3, Figure 2.2, Secondary Cooling System (as revised by 1989-90, 1990-91, 1994 and 1995 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.2, Secondary Cooling System (MURR Dwg #502, Sheet 1 of 1, dated 8/9/01)

HSR, Addendum 3, Figure 2.3.a, Electrical Distribution (as revised by 1990-91 and 1995 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.a, Electrical Distribution (MURR Dwg #522, Sheet 1 of 2, dated 12/21/01)

HSR, Addendum 3, Figure 2.3.b, Electrical Distribution (as revised by 1990-91 and 1995 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.b, Electrical Distribution (MURR Dwg #522, Sheet 2 of 2, dated 12/21/01)

HSR, Addendum 3, page 29, Section 2.5.2:

Add the following new section after Section 2.5.2.2:

"2.5.2.3 Gamma-Metrics Power Range Monitors

Gamma-Metrics power range channels do not have interchangeable Test and Feedback modules designed to create full scale power range meter deflection for two separate modes of reactor operation, Mode I (10 MW) and Mode II (5 MW). Because there is no possibility of having the wrong test and feedback module installed for either mode of operation, this power range channel does not require an electrical interlock."

HSR, Addendum 3, page 29, Section 2.5.3.1, paragraph 1:

Delete: Entire paragraph, which states: "Eight temperature assemblies are to be added for heat exchanger outlet temperature monitoring. These will be identified as EP No. 980A, B, C and D; EP 990A, B, C and D."

Replace with: "Eight temperature assemblies provide heat exchanger outlet temperature monitoring. These assemblies are identified as EP No. 980A, B, C and D; EP No. 990A, B, C and D."

HSR, Addendum 3, page 29, Section 2.5.3.1, paragraph 2:

Delete: Entire paragraph, which states: "The power supply unit will be in series with the eight temperature assemblies and readout selection switch."

Replace with: "Specifications for temperature assemblies 980A and B are as follows:

1. Output: 4-20 MADC
2. Range: 75-175 °F
3. Accuracy: ± 0.2% of span
4. Power requirements: 12-45 VDC

HSR, Addendum 3, page 29, Section 2.5.3.1, paragraph 3:

Delete: First sentence, which states: "Specifications for the temperature units:"

Replace with: "Specifications for temperature assemblies 980C and D, and 990A, B, C, and D are as follows:"

HSR, Addendum 3, Figure 2.8.a, Gamma-Metrics Neutron Flux Monitor Block Diagram:

Add new figure: Figure 2.8.a – Gamma-Metrics Neutron Flux Monitor Block Diagram

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

HSR, Addendum 4, Figure A.1, Safety System (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.1, Safety System (MURR Dwg #139, Sheet 1 of 1, dated 4/5/01)

HSR, Addendum 4, Figure A.2, Piping & Instrument Diagram (as revised by 1995 Reactor operations Annual Report):

Replace with: Updated Figure A.2, Piping & Instrument Diagram (MURR Dwg #156, Sheet 1 of 1, dated 9/10/01)

HSR, Addendum 4, Figure A.3, 10 MW Process Instrumentation Control & Interlock (as revised by 1995 and 1998 Reactor Operations Annual Reports):

Replace with: Updated Figure A.3, Process Instrumentation Control & Interlock (MURR Dwg #41, Sheet 3 of 4, dated 6/18/01)

HSR, Addendum 4, Figure A.4.a, Reactor Control System (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.4.a, Reactor Control System (MURR Dwg #42, Sheet 1 of 2, dated 10/17/01)

HSR, Addendum 4, Figure A.4.b, Reactor Control System (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.4.b, Reactor Control System (MURR Dwg #42, Sheet 2 of 2, dated 6/25/01)

HSR, Addendum 4, Figure A.5, 10 MW Process Instrumentation Control & Interlock (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.5, Process Instrumentation Control & Interlock (MURR Dwg #41, Sheet 1 of 4, dated 9/21/01)

HSR, Addendum 4, Figure A.6, 10 MW Process Instrumentation Control & Interlock (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.6, Process Instrumentation Control & Interlock (MURR Dwg #41, Sheet 2 of 4, dated 6/18/01)

HSR, Addendum 4, Figure A.6.a, 10 MW Process Instrumentation Control & Interlock:

Add new figure: Figure A.6.a, Process Instrumentation Control & Interlock (MURR Dwg #41, Sheet 4 of 4, dated 11/07/01)

HSR, Addendum 4, Figure A.7, Annunciator Control 10 MW (as revised by 1995 Reactor Operations Annual Report):

Replace with: Updated Figure A.7, Annunciator Control 10 MW (MURR Dwg #138, Sheet 1 of 2, dated 11/7/01)

HSR, Addendum 4, pages A-19 and A-20, Section A.3.8:

Delete: Entire section, which states:

"Two parts of the MURR protection system need to be considered under this criterion; the wide range monitor channel and the core inlet temperature channel. Both of these channels are presently classified as part of the protection system.

Neither of these channels can be said to have an isolation device between the protection system and the control system. The output from the wide range monitor to the power control servo-amplifier is in parallel with the output to the scram trip module. The dc temperature signal to TC 909 is presently in series with the signal to the dual alarm unit that initiates a scram.

If the wide range monitor fails downscale, it would not be able to initiate a scram and at the same time the servo-amplifier would call for increased power. However, overpower protection is still available even if one of the two remaining power range monitors should have also failed. Thus, the first paragraph under IEEE 279 Section 4.7.3 is satisfied (but not the second paragraph) by the power range nuclear instrumentation. Since no provision has been made to enable a power range channel to be removed from service during operation, the second paragraph of 4.7.3 does not apply. The reactor operating schedule permits shutdowns sufficiently frequent for adequate testing and maintenance. Two additional temperature channels, 980A and 980B, will be added to provide high core inlet temperature protection. The temperature signal controller, TC 909, will be removed from the protective system to provide compliance with criteria 4.7 (Figure A.6)."

Replace with: "The MURR protection system satisfies the intent of IEEE 279 with regard to control and protection system interaction. No instrument channel provides both safety and control functions."

ADDENDUM 5 - HAZARDS SUMMARY REPORT (JANUARY 1974)

HSR, Addendum 5, Figure 2.1, Electrical Distribution:

Replace with: Updated Figure 2.1, Electrical Distribution (MURR Dwg #522, Sheet 1 of 2, dated 12/21/01)

SECTION IV

PLANT AND SYSTEM MODIFICATION

January 1, 2001 through December 31, 2001

For each modification described below, MURR has on file the safety evaluation as well as documentation of review in accordance with 10 CFR 50.59.

Modification 75-16, Addendum 1:
Relocation of the Portable Reactor Safety System Monitoring Circuit ("White Rat")
This addendum to modification record 75-16, "Portable White Rat for Safety System," documents the permanent mounting of the fourteen (14) individual safety system monitoring circuits, which were previously housed in two portable units, on the reactor control room Instrument Panel. This modification provides the operators with the ability to survey the Safety System Monitoring Circuit from the control console without having to go behind the Instrument Panel.

Modification 88-6, Addendum 1:
Installation of a Digital Elapsed Time Run Meter for the 275 kW Emergency Diesel Generator
This addendum to modification record 88-6, "Emergency Electrical Power Upgrade," documents the installation of a Digital Elapsed Time Run Meter on the reactor control room Instrument Panel for the Emergency Diesel Generator. The run meter provides the operators with an indication of when the Diesel Generator is running and the length of time it has run.

Modification 94-6, Addendum 1:
Installation of Privacy Panels to the 4-Level Costar Tower Structure
This addendum to modification record 94-6, "Costar Tower Construction in Containment; Documentation of Architectural/Engineering Evaluations," documents the installation of privacy panels to the Costar Tower.

Modification 95-1, Addendum 1E:
Replacing the Nuclear Instrumentation Wide Range Monitor Recorder with a Two-Pen Yokogawa Recorder
This addendum to modification record 95-1, "Replacement of Nuclear Instruments," documents the replacement of the Speedomax H, Model S wide range monitor chart recorder, manufactured by the Leeds and Northrup Company, with a new Yokogawa Model 4370 recorder. Because of its age and the inability to purchase replacement parts, the Speedomax H, Model S chart recorder had become obsolete.

Modification 99-4:
Replace Conductivity Cells, Amplifiers, and Indicators
This modification record documents the replacement of the General Electric conductivity cells, amplifiers, and indicating units for the pool and primary coolant systems with new GLI International conductivity/resistivity sensors, GLI International Model 53 conductivity analyzers, and Dwyer Model D 100 process indicators. Because of its age and the inability to purchase replacement parts, the pool and primary coolant conductivity measurement system had become obsolete.

Modification 00-2:
Installation of Roll Pins on the Input, Output, and Secondary Gear Shafts of the Regulating Rod Drive Mechanism Gearbox
This modification record documents the changes performed to the regulating rod drive mechanism gearbox. The gearbox consists of three gear shafts positioned within an aluminum housing with bearings installed on both ends of each shaft. The gears are mounted to their respective shafts by setscrews coated with medium loc-tite. To prevent a gear from slipping on its shaft should a setscrew loosen, 1/16-inch holes were drilled through each gear and shaft, approximately 90° from the setscrews, and a roll pin was inserted into each hole.

Modification 01-1:
Replace Pool T_C General Electric Type 550 Millivolt Temperature Transmitter with a Moore Industries Model RBT Transmitter
This modification record documents the replacement of the General Electric Measurement and Control (GE/MAC) Type 550 millivolt temperature transmitter for the pool coolant system temperature element 901C with a new Moore Industries Model RBT transmitter. Because of its age and the inability to purchase replacement parts, the GE/MAC temperature transmitter had become obsolete.

Modification 01-2:
Installation of a New Reactor Facility Intercommunication and Paging System
This modification record documents the replacement of the facility intercommunication system with a new system manufactured by Rauland. The original intercommunication system was manufactured by Executone Inc., Long Island City, New York and installed in the 1960's during initial construction of the facility. Because of its age and the inability to purchase replacement parts, the intercommunication system had become obsolete.

Modification 01-3:
Replacement of the 980A/B Temperature Transmitters, Meter Relay Units, and RTDs
This modification record documents the replacement of the temperature transmitters, alarm meter units, and the resistance temperature detectors (RTDs) for the primary coolant system temperature elements (TEs) 980A and 980B with new Simpson Meter Relay units and Rosemount temperature transmitters and RTDs. Because of its age and the inability to purchase replacement parts, the temperature monitoring system for TE 980A and 980B had become obsolete.

Modification 01-4, Addendum 1:
Replace Pool T_H and T_C General Electric Measurement and Control (GE/MAC) Type 550 Millivolt/Current (MV/I) Temperature Transmitters with Moore Industries Model RBT Transmitters
This addendum to modification record 01-4, "Replacement of the General Electric Measurement and Control (GE/MAC) Process Instrumentation MV/I Transmitters, Differential Temperature Summers, Square Root Converters, and Dual Alarm Units," documents the replacement of the GE/MAC Type 550 temperature transmitters for the pool coolant system temperature elements 901C and 901D. Because of its age and the inability to purchase replacement parts, the GE/MAC temperature transmitters had become obsolete.

Modification 01-4, Addendum 2:
Replace Primary T_H and T_C General Electric Measurement and Control (GE/MAC) Type 550 Millivolt/Current (MV/I) Temperature Transmitters with Moore Industries Model RBT Transmitters
This addendum to modification record 01-4, "Replacement of the General Electric Measurement and Control (GE/MAC) Process Instrumentation MV/I Transmitters, Differential Temperature Summers, Square Root Converters, and Dual Alarm Units," documents the replacement of the GE/MAC Type 550 temperature transmitters for the primary coolant system temperature elements 901A and 901B. Because of its age and the inability to purchase replacement parts, the GE/MAC temperature transmitters had become obsolete.

Modification 01-4, Addendum 4:
Replace the General Electric Measurement and Control (GE/MAC) Type 565 Primary and Pool Coolant Demineralizer Flow Square Root Converters with Moore Industries Square Root Converters
This addendum to modification record 01-4, "Replacement of the General Electric Measurement and Control (GE/MAC) Process Instrumentation MV/I Transmitters, Differential Temperature Summers, Square Root Converters, and Dual Alarm Units," documents the replacement of the GE/MAC Type 565 square root converters for the pool and primary coolant demineralizer systems. Because of its age and the inability to purchase replacement parts, the GE/MAC square root converters had become obsolete.

Modification 01-5:

Upgrade Secondary Coolant System Flow and Temperature Measurement System

This modification record documents the replacement of the resistance temperature detectors, differential pressure transmitter, and three-pen chart recorder for the secondary coolant system. The replacement was necessitated by the age of the flow and temperature measurement system and the unavailability of replacement parts for the flow transmitter and chart recorder.

Modification 01-7:

Installation of the 5-Inch Silicon Irradiation Facility

This modification record documents the removal of the 4-inch (Yellow and Green), 5-inch (Yellow), and 6-inch (Blue) Silicon Irradiation Facilities, which were mounted adjacent to the upper reflector tank in the bulk pool, and the subsequent replacement with a three position, 5-inch Silicon Irradiation Facility. This modification was performed to satisfy the programming needs of Product and Service Operations.

Modification 01-8:

Reroute Room 218 Pneumatic Tube System Transfer Line From Row One to Row Two Terminal

This modification record documents placing Room 218 pneumatic transfer system on Row 2 of the graphite reflector region. This modification was performed to satisfy the programming needs of the Analytical Chemistry Group.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2001 through December 31, 2001

No new experimental procedures were developed during this period.

SECTION VI

SPECIAL NUCLEAR MATERIAL AND REACTOR PHYSICS ACTIVITIES

January 1, 2001 through December 31, 2001

Inspections: There was one NRC inspection reviewing SNM activities. All records and activities were found to be in compliance with NRC rules and regulations. No violations were noted.

Reactor Characteristic Measurements: Sixty-one refueling evolutions were completed in 2001. Excess reactivity verification was performed for each refueling. The largest excess measured reactivity was 3.44% MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

Nine (9) reactivity measurements were made to measure the sample loading worth of all samples loaded in the flux trap region.

Nineteen (19) measurements were made to determine the reactivity worth of several samples that are irradiated either in the flux trap region or in the graphite irradiation positions.

Two Differential Blade worth measurements, one Regulating Blade worth measurement and one Primary Temperature Coefficient measurement were also performed.

SECTION VII

RADIOACTIVE EFFLUENT

January 1, 2001 through December 31, 2001

Table 1

SANITARY SEWER EFFLUENT

January 1, 2001 through December 31, 2001

Descending Order of Activity Released for Nuclide Totals >1.000E-5 Ci

Nuclide	Activity (Ci)
H-3	1.642E-01
S-35	5.008E-03
Co-60	2.589E-03
Ag-110	6.445E-04
Zn-65	2.660E-04
Ca-45	2.597E-04
Mn-54	2.576E-04
P-32	2.115E-04
As-77	1.195E-04
Tb-160	9.392E-05
Ho-166	6.290E-05
Lu-177	4.460E-05
Cr-51	4.206E-05
Re-186	3.095E-05
Total H-3	1.642E-01
Total Other	9.630E-03

Sanitary Sewer Effluents are in compliance with 10 CFR 20.2003, "Disposal by release into sanitary sewerage."

TABLE 2
STACK EFFLUENT

January 1, 2001 through December 31, 2001

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration mCi/ml	Total Release 1/01 - 12/01 Ci	TS Limit Multiplier	%TS
Ar-41	2.55375E-09	1.18E+03	350	72.9643
Co-60	4.86857E-17	2.25E-05	1	0.0974
Cd-109	6.2197E-17	2.88E-05	1	0.0889
Ce-144	1.44018E-17	6.66E-06	1	0.0720
W-188	1.2327E-15	5.70E-04	1	0.0616
H-3	1.99364E-11	9.22E+00	350	0.0570
I-131	1.12832E-16	5.22E-05	1	0.0564
I-125	7.42698E-17	3.43E-05	1	0.0248
Cs-137	7.74856E-18	3.58E-06	1	0.0039
Eu-155	4.14375E-18	1.92E-06	1	0.0021
Zr-95	7.52769E-18	3.48E-06	1	0.0019
Zn-65	6.98918E-18	3.23E-06	1	0.0017
Gd-153	2.89771E-18	1.34E-06	1	0.0010
Se-75	7.01837E-18	3.24E-06	1	0.0009
Pa-233	6.09254E-18	2.82E-06	1	0.0008
Os-191	1.13428E-17	5.24E-06	1	0.0006
Mn-54	5.1199E-18	2.37E-06	1	0.0005
Au-196	1.74329E-18	8.06E-07	350	0.0005
Ba-140	8.23895E-18	3.81E-06	1	0.0004
Hg-203	3.21998E-18	1.49E-06	1	0.0003
Co-57	2.87572E-18	1.33E-06	1	0.0003
Ce-139	2.6274E-18	1.21E-06	1	0.0003
Ru-163	2.27169E-18	1.05E-06	1	0.0003
As-77	5.18041E-15	2.39E-03	350	0.0002
Na-22	1.37916E-18	6.38E-07	1	0.0002
Ce-141	9.82241E-19	4.54E-07	1	0.0001
Sn-85	2.16305E-18	1.00E-06	1	0.0001
I-133	3.71369E-16	1.72E-04	350	0.0001
Hf-181	5.54467E-19	2.56E-07	1	0.0001
Br-82	9.08323E-16	4.20E-04	350	0.0001
Total				73.4

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

Stack Flow Rate = 30,000 cfm

Stack effluent releases are in compliance with University of Missouri-Columbia Research Reactor License R-103 Technical Specifications.

SECTION VIII
ENVIRONMENTAL MONITORING AND HEALTH PHYSICS SURVEYS

January 1, 2001 through December 31, 2001

Environmental samples are collected two times per year at eight locations and analyzed for radioactivity. 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 the environmental monitors deployed around MURR in 2001. 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 environmental monitoring program confirms that no environmental impact exists from the operation of the MURR facility.

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

Table 1
Summary of Environmental Set 59
April 2001

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.62 pCi/L	2.51 pCi/L	173.36 pCi/L	1.44 pCi/mL of sample
Soil	0.62 pCi/g	2.51 pCi/g	1.48 pCi/g	N / A
Vegetation	1.23 pCi/g	5.02 pCi/g	3.93 pCi/g	1.44 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)
10V59	< 1.23	15.74	< 3.93	< 1.44
1V59	< 1.23	< 5.02	< 3.93	< 1.44
2V59	< 1.23	13.67	< 3.93	< 1.44
3V59	< 1.23	6.97	< 3.93	< 1.44
4V59	< 1.23	9.29	4.59	< 1.44
5V59	< 1.23	9.55	< 3.93	< 1.44
6V59	< 1.23	18.32	< 3.93	< 1.44
7V59	< 1.23	14.96	< 3.93	< 1.44

Activity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S59	< 0.62	9.76	16.43
1S589	< 0.62	7.44	5.46
2S59	< 0.62	7.83	1.27
3S59	0.84	9.25	3.32
4S59	< 0.62	9.12	4.56
5S59	< 0.69	10.15	2.35
6S59	< 0.62	5.25	2.10
7S59	0.84	8.22	4.05

Activity Levels -- Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
10W59	< 0.62	14.77	< 173.36	< 1.44
4W59	< 0.62	4.32	< 173.36	< 1.44
6W59	< 0.62	3.68	< 173.36	< 1.44

Sample 4V59 > MDA on NaI well detector. The sample was analyzed by HRGRS in an attempt to determine specific radionuclides. No nuclides were identified at greater than background levels.

Table 2
Summary of Environmental Set 60
September 2001

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.68 pCi/L	2.55 pCi/L	204.88 pCi/L	1.20 pCi/mL of sample
Soil	0.68 pCi/g	2.55 pCi/g	1.44 pCi/g	N / A
Vegetation	1.36 pCi/g	5.09 pCi/g	3.47 pCi/g	1.20 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)
10V60	< 1.36	6.46	< 3.47	1.90
1V60	< 1.36	5.89	< 3.47	7.53
2V60	< 1.36	8.98	< 3.47	2.32
3V60	< 1.36	8.98	< 3.47	< 1.20
4V60	< 1.36	< 5.09	< 3.47	2.68
5V60	< 1.36	8.98	< 3.47	1.76
6V60	< 1.36	7.86	< 3.47	2.29
7V60	< 1.36	9.26	< 3.47	1.64

Activity Levels – Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S60	0.77	13.19	8.62
1S60	0.77	12.63	9.38
2S60	0.77	9.68	11.07
3S60	< 0.68	13.47	7.06
4S60	< 0.68	8.28	6.03
5S60	< 0.68	6.60	6.71
6S60	1.08	15.44	9.60
7S60	0.77	12.49	9.54

Activity Levels -- Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
10W60	< 0.68	10.10	< 204.88	< 1.20
4W60	< 0.68	< 2.55	< 204.88	< 1.20
6W60	< 0.68	2.81	< 204.88	< 1.20

Table 3
Environmental TLD Summary
January 2001 through December 2001

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2001 Net mR	2nd Qtr. 2001 Net mR	3rd Qtr. 2001 Net mR	4th Qtr. 2001 Net mR	Total Net mR
1	Control	N/A	2.8	0.2	6.0	0.5	9.5
2	Control	N/A	2.4	1.0	3.5	-0.6	6.3
3	WSW	N/A	0.3	0.0	2.5	-1.6	1.2
4	Spare	N/A	2.2	1.0	14.5	12.1	29.8
5	Spare	N/A	1.1	-2.3	16.2	10.2	25.2
6	N	34	5.9	4.1	5.1	2.2	17.3
7	NE	57	8.2	5.4	10.4	3.8	27.8
8	SW	27	4.9	3.8	8.5	2.9	20.1
9	S	27	53.6	51.9	32.1	25.2	162.8
10	NE	149	1.5	-2.7	1.8	-1.6	-1.0
11	NW	149	1.0	1.0	2.4	-1.3	3.1
12	ENE	301	4.5	0.6	8.3	absent	13.4
13	NNE	316	2.0	-1.8	7.1	0.8	8.1
14	S	156	6.0	2.5	6.8	2.3	17.6
15	S	65	15.2	14.0	20.7	14.8	64.7
16	SE	107	3.5	-0.5	1.9	-4.0	0.9
17	E	293	-1.8	-1.2	1.8	0.1	-1.1
18	NE	476	3.0	-1.9	absent	-0.6	0.5
19	NNE	606	-0.3	-7.8	-3.9	-6.7	-18.7
20	NE	907	-1.8	-9.8	2.9	-7.5	-16.2
21	SE	236	absent	-3.9	2.9	1.7	0.7
22	ESE	168	1.8	-7.0	-0.4	-4.0	-9.6
23	NW	110	1.6	-0.7	6.3	0.9	8.1
24	SSW	328	-1.1	-3.5	0.8	-1.7	-5.5
25	SSW	480	3.3	1.1	4.5	0.0	8.9
26	SW	301	2.2	absent	2.7	-2.4	2.5
27	WSW	141	-2.3	-6.2	-0.8	-6.5	-15.8
28	WNW	210	3.8	-3.4	6.8	1.3	8.5
29	NW	255	absent	1.7	7.2	3.3	12.2
30	NNW	328	1.6	-1.1	4.4	-3.7	1.2
31	NNW	671	3.0	1.4	6.5	2.8	13.7
32	NNW	724	3.9	-0.5	5.1	-0.3	8.2
33	E	671	5.3	0.2	7.0	0.3	12.8
34	ENE	587	-0.5	-5.0	0.0	-2.9	-8.4
35	SSE	499	-1.0	-2.3	-0.1	-5.9	-9.3
36	SE	419	absent	-3.3	1.9	-1.6	-3.0
37	NE	690	2.1	-3.8	absent	-2.8	-4.5
38	NW	556	absent	1.6	3.9	-0.1	5.4
39	W	491	-1.9	-2.1	3.3	-2.4	-3.1
40	N	514	3.9	-1.0	2.4	-0.7	4.6
41	NNE	137	-1.4	-3.5	-0.6	-1.8	-7.3
42	In Building	N/A	10.2	8.7	15.3	9.6	43.8
43	In Building	N/A	10.3	8.2	10.3	5.2	34.0
44	Spare	N/A	3.0	-0.4	21.9	14.8	39.3
45	S	65	4.3	1.8	8.2	2.8	17.1

Table 4

Number of Facility Radiation and Contamination Surveys

2001	Radiation	Surface Contamination*	Air Samples	RWP
January	40	40	12	12
February	22	22	12	12
March	38	38	12	14
April	90	82	12	6
May	73	70	15	11
June	61	56	9	6
July	52	52	11	8
August	68	67	17	8
September	71	67	12	6
October	52	52	14	9
November	62	59	15	9
December	53	54	12	14
TOTALS	**682**	**659**	**153**	**115**

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

Miscellaneous Notes

The Health Physics office hired three Health Physics Technicians during 2001:
Jessie Quichocho, January 2001; Matt Ballew, February 2001; and Rob Taylor, March 2001.

John Ernst, CHP, was promoted to Associate Director-Regulatory Assurance Group, October 2001.

Ron Dobey, CHP, was promoted to Acting Health Physics Manager, October 2001.

During 2001, MURR shipped 1073 cubic feet low level radioactive waste.

SECTION IX

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

January 1, 2001 through December 31, 2001

1. Largest single exposure and average exposure are expressed in millirem.
2. Minimal exposure for "C" and "U" Badges is defined to be gamma <10 mrem; beta < 40 mrem; neutron < 20 mrem.
3. Minimal exposure for "P" Badges is defined to be gamma <1 mrem; beta <10 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; "P" - 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	77	75	85	89	85	88	98	79	98	94	94	93
AME	57	59	54	45	52	53	48	54	47	47	47	48
AE	57.7	55.4	83.0	58.0	51.9	57.0	72.1	55.2	50.7	51.1	50.8	66.0
HE	230	200	220	160	180	220	280	170	190	140	140	290

"P" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	34	40	42	35	39	42	43	57	56	61	59	47
AME	28	20	23	23	20	13	15	8	14	6	3	15
AE	17.9	27.4	35.2	12.3	11.5	21.7	27.0	23.0	16.4	19.3	21.7	6.4
HE	109	148	160	179	89	129	168	116	65	48	34	31

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	108	92	87	115	102	102	68	127	115	113	108	121
AME	73	86	102	64	84	82	126	68	94	86	91	79
AE	155.3	162.4	163.0	136.1	105.4	122.6	121.7	140.9	108.3	113.3	112.5	138.9
HE	970	750	1200	580	470	990	600	1970	510	1010	450	590

Self Reading Dosimeters:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	4	2	0	12	3	10	4	7	7	10	11	5
AME	95	89	66	53	64	62	73	78	78	71	68	75
AE	52.2	69.9	84	75.2	65.8	86.7	63.4	68.9	47.8	59.2	58.2	57
HE	245	254	235	150	163	245	225	272	183	176	192	291

SPARE ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	47	51	31	37	34	26	25	22	10	7	11	7
A M E	5	5	4	4	7	3	1	1	2	0	2	0
A E	38.0	58.0	65.0	52.5	41.6	106.7	130.0	110.0	40.0	0.0	90.0	0.0
H E	90	120	230	90	140	130	130	110	70	0	160	0

"P" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	56	47	53	41	59	67	63	58	22	84	83	91
A M E	9	23	12	19	15	11	17	2	5	0	0	1
A E	3.0	6.0	13.2	14.8	3.1	25.6	7.5	4.0	3.2	0.0	0.0	1.0
H E	11	34	30	109	23	181	19	5	7	0	0	1

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	13	8	7	5	11	6	32	22	14	35	30	33
A M E	6	8	5	6	7	4	6	6	4	4	10	5
A E	95.0	85.0	164.0	125.0	70.0	92.5	83.3	86.7	60.0	155.0	75.0	64.0
H E	150	170	310	230	180	200	180	230	90	280	170	160

Analysis of personnel exposure levels indicates that exposures are significantly below the limits of 10 CFR 20.1201 and are generally maintained ALARA. Radiation workers who are not full time staff members have radiation exposures which are generally lower than full time staff radiation workers.