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February 24, 2010

U.S. Nuclear Regulatory Commission  
Attention: Document Control Desk  
Mail Station P1-37  
Washington, DC 20555-0001

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

SUBJECT: University of Missouri Research Reactor  
2009 Reactor Operations Annual Report

I have enclosed one copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers January 1, 2009 through December 31, 2009.

This document is submitted to the U.S. Nuclear Regulatory Commission in accordance with the University of Missouri Research Reactor Technical Specification 6.1.h(4).

If you have any questions regarding the contents of this report, please contact me at (573) 882-5276 or [FoytoL@missouri.edu](mailto:FoytoL@missouri.edu).

Sincerely,

Les P. Foyto  
Reactor Manager

LPF/djr

Enclosure

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

A020  
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UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI  
RESEARCH REACTOR

REACTOR OPERATIONS  
ANNUAL REPORT

January 1, 2009 – December 31, 2009

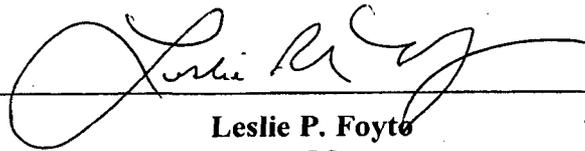
**UNIVERSITY OF MISSOURI  
RESEARCH REACTOR FACILITY**

**REACTOR OPERATIONS  
ANNUAL REPORT**

**January 1, 2009 through December 31, 2009**

**Compiled by the Research Reactor Staff of MURR**

**Submitted by:**



**Leslie P. Foyte  
Reactor Manager**

**Reviewed and  
approved by:**



**Ralph A. Butler, PE  
Director**

**UNIVERSITY OF MISSOURI – COLUMBIA  
RESEARCH REACTOR**

**REACTOR OPERATIONS ANNUAL REPORT**

January 1, 2009 through December 31, 2009

**INTRODUCTION**

The University of Missouri Research Reactor (MURR) is a multi-disciplinary research and education facility providing a broad range of analytical, materials science, and irradiation services to the research community and the commercial sector. Scientific programs include research in archaeometry, epidemiology, health physics, human and animal nutrition, nuclear medicine, radiation effects, radioisotope studies, radiotherapy, and nuclear engineering; and research techniques including neutron activation analysis, neutron and gamma-ray scattering, and neutron interferometry. The heart of this facility is a pressurized, reflected, open pool-type, light water moderated and cooled, heterogenous reactor designed for operation at a maximum steady state power level of 10 Megawatts thermal – the highest powered University-owned research reactor in the United States.

The Reactor Operations Annual Report presents a summary of reactor operating experience for calendar year 2009. Included within this report are changes to MURR procedures, revisions to the Hazards Summary Report, facility modifications, new tests and experiments, reactor physics activities, and environmental and health physics data.

This Report is being submitted to the U.S. Nuclear Regulatory Commission (NRC) to meet the administrative requirements of MURR Technical Specification 6.1.h (4).

**ACKNOWLEDGMENTS**

The success of MURR and these scientific programs is due to the dedication and hard work of many individuals and organizations. Included within this group are: the University administration; the governing officials of the State of Missouri; the Missouri State Highway Patrol; the City of Columbia Police Department; the Missouri University Police Department (MUPD); the Federal Bureau of Investigation (FBI); our Regulators; those who have provided funding including the Department of Energy (DOE) and the Department of Homeland Security (DHS); Argonne National Laboratory (ANL); Idaho National Laboratory (INL); Sandia National Laboratories (SNL); the Researchers; the Students; the Columbia Fire Department; the Campus Facilities organization; members of the National Organization of Test, Research, and Training Reactors (TRTR); and many others who have made, and will continue to make, key contributions to our overall success. To these individuals and organizations, the staff of MURR wishes to extend its fondest appreciation.

Some of the major facility projects that were supported by Reactor Operations this calendar year included (1) establishing and characterizing an irradiation facility on Beamport 'E' in support of the Boron Neutron Capture Therapy project, (2) irradiating and processing a 5-gram low-enriched uranium (LEU) target to determine the feasibility of producing fission product molybdenum-99 from LEU, and (3) securing the next generation fresh and spent fuel shipping containers. Additionally, in August 2006 MURR submitted a request to the NRC to renew Amended Facility Operating License R-103. This year the NRC began the

review process of our submittal. Significant efforts have already been placed in responding to the Requests for Additional Information (RAIs) and these efforts will continue in the upcoming year.

The facility is also actively collaborating with the US-RERTR (Reduced Enrichment for Research and Test Reactors) Program and four other U.S. high-performance research reactor facilities that use highly-enriched uranium (HEU) fuel to find a suitable low-enriched uranium (LEU) fuel replacement. Although each one of the five high-performance research reactors is responsible for its own feasibility and safety studies, regulatory interactions, fuel procurement, and conversion, there are common interests and activities among all five reactors that will benefit from a coordinated, working-group effort.

Reactor Operations Management also wishes to commend the three individuals who received their Reactor Operator certifications from the NRC. These individuals participated in a rigorous training program of classroom seminars, self-study, and on-the-job training. The results of this training are confident, well-versed, decisive individuals capable of performing the duties of licensed operators during normal and abnormal situations.

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## SECTION I

### REACTOR OPERATIONS SUMMARY

January 1, 2009 through December 31, 2009

The following table and discussion summarizes reactor operations during the period from January 1, 2009 through December 31, 2009.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled <sup>(1)</sup>
January	683.79	284.97	91.9	102.9
February	607.11	253.02	90.3	101.2
March	674.91	281.29	90.7	101.6
April	646.52	269.50	89.8	100.7
May	671.42	279.82	90.2	101.0
June	637.30	265.65	88.5	99.3
July	681.25	283.91	91.6	102.5
August	668.24	278.52	89.8	100.6
September	659.64	274.90	91.6	102.7
October	669.26	278.95	90.0	100.7
November	648.55	270.33	90.1	101.0
December	687.63	286.59	92.4	103.5
<b>Total for the Year</b>	<b>7935.62</b>	<b>3307.45</b>	<b>90.58 %</b>	<b>101.48 %</b>

Note 1: MURR is scheduled to average at least 150 hours of full power operation per week. Total time is the number of hours in the month listed or the year.

#### January 2009

The reactor operated continuously in January with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one scheduled shutdown for a physics measurement. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: replacing the pump-end of primary coolant system circulation pump P-501B; adjusting the scram set point on reflector differential pressure transmitter PT-917; refurbishing and cleaning the gasket inflate and deflate solenoid assemblies and valve actuators on containment ventilation isolation Doors 504 and 505 three-way, dual solenoid-operated valves; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" refurbishing and cleaning the gasket inflate and deflate solenoid assemblies and valve actuators on containment personnel airlock Doors 276 and 277 three-way, dual solenoid-operated valves; replacing rod control power unavailable relay 1K30; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" draining and back-flushing Beampoint 'E' with helium for flux measurements in support of the Boron Neutron Capture Therapy

project; replacing the west pneumatic tube system blower and motor; replacing cooling tower fan CTF-3 gearbox; and completing Modification Record 96-1, Addendum 2, "Removal of the Nuclepore Experiment Equipment."

### **February 2009**

The reactor operated continuously in February with the following exceptions: four shutdowns for scheduled maintenance. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; performing a back flush on the secondary coolant side of pool coolant system heat exchanger HX-521; refurbishing air control valve A-146; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" replacing the Eberline stack monitor blower motor; refurbishing and cleaning the gasket inflate and deflate solenoid assemblies and valve actuator on containment truck entry Door 101 three-way, dual solenoid-operated valve; replacing containment exhaust ventilation isolation valve 16B; replacing the electrical supply breaker for the valve operating system air compressor; and performing flux measurements on Beamport 'E' in support of the Boron Neutron Capture Therapy project.

### **March 2009**

The reactor operated continuously in March with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and two scheduled shutdowns for physics measurements. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: replacing the pump casing gasket on primary demineralizer system pump P-513A; sealing the containment sump abandoned underground gravity drain lines; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" performing three (3) sets of flux measurements on Beamport 'E' in support of the Boron Neutron Capture Therapy project; performing a zero and span procedure on primary coolant system flow transmitter FT-912E chart recorder; completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" replacing the springs in the gasket inflate and deflate solenoid assemblies and valve actuator on containment personnel entry Doors 276 and 277 three-way, dual solenoid-operated valves; replacing cooling tower fan CTF-3 gear box shaft oil seal; performing a reactivity worth measurement in accordance with reactor test procedure "RTP-19 - Experimental Measurement of the MURR Primary Temperature Coefficient of Reactivity;" replacing the springs in the gasket inflate and deflate solenoid assemblies and valve actuators on containment ventilation isolation Doors 504 and 505 three-way, dual solenoid-operated valves; and flooding Beamport 'E' with demineralized water.

### **April 2009**

The reactor operated continuously in April with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, one scheduled shutdown for a physics measurement, and two unscheduled/unplanned power reductions.

On April 25, with the reactor operating at 10 MW in the automatic control mode, a "Power Level Interlock" reactor scram was automatically initiated. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. Control room operators noted that the scram annunciation failed to "lock in" and had reset immediately. Investigation of all relays, switches and wiring associated with the power level interlock circuit revealed no abnormalities. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

On April 26, with the reactor operating at 10 MW in the automatic control mode, a "Power Level Interlock" reactor scram was automatically initiated. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. Control room operators noted that the scram annunciation failed to "lock in" and had reset immediately. Once again, investigation of all relays, switches and wiring associated with the power level interlock circuit revealed no abnormalities. Temporary monitoring equipment was attached to the circuit to monitor certain input signals to aid in any future troubleshooting efforts. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was subsequently restarted to 10 MW operation.

Major maintenance items for the month included: loading new de-ionization bed 'R' and placing it on pool coolant system service; replacing the drive chain attachment mounting plates on containment building personnel entry Doors 276 and 277; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)" in support of the natural metal molybdenum-99 project; irradiating a low-enriched uranium (LEU) foil annular target in the K-2 irradiation position in support of the fission product molybdenum-99 project; completing the biennial change-out of control blade 'A' offset mechanism; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" replacing power level interlock relay 2K9; draining and back-flushing Beamport 'E' with helium for flux measurements in support of the Boron Neutron Capture Therapy project; and performing the biannual cleaning of the cooling tower sump and basin.

Note: Replacement of power level interlock relay 2K9 was performed as a troubleshooting action in response to the two unscheduled power reductions that occurred this month. In September, reactor core differential pressure alarm unit EP-929 was also replaced. After bench top testing of both components, the most likely cause of the power reductions was determined to be alarm unit EP-929. Although neither component had failed, the reset set point of alarm unit EP-929 was not always repeatable.

### **May 2009**

The reactor operated continuously in May with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one scheduled shutdown for a physics measurement. There were no unscheduled/unplanned power reductions this month. Additionally, U.S. Nuclear Regulatory Commission regional inspectors conducted a routine inspection of the Radiation Protection Program and Shipping.

Major maintenance items for the month included: installing the NEER Grant cobalt irradiation facility; performing an "end-of-life" inspection on two spent fuel elements; completing portions of Modification Record 01-09, Addendum 2, "Emergency Electrical System in North Office Addition;" repairing the amphenol connection on control rod 'D' drive mechanism; completing compliance procedure CP-26, "Containment Building Compliance Test;" replacing cooling tower fan CTF-2 gearbox; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)."

## June 2009

The reactor operated continuously in June with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and one unscheduled/unplanned power reduction. Additionally, three reactor startups and two shutdowns were performed in support of U.S. Nuclear Regulatory Commission operator licensing examinations. U.S. Nuclear Regulatory Commission examiner conducted operator licensing examinations.

On June 15, with the reactor operating at 10 MW in the automatic control mode, a "Rod Not in Contact with Magnet" rod run-in was automatically initiated when control blade 'D' anvil separated from its electro-magnet during a routine sample handling evolution. The immediate actions of REP-2, "Reactor Scram," were performed. The operators involved were counseled on the importance of proper sample handling techniques. The reactor was refueled and remained shutdown for previously scheduled maintenance activities. After completion of maintenance activities, the reactor was restarted to 10 MW operation.

Major maintenance items for the month included: replacing Nuclear Instrumentation signal processor No. 2 power range monitor (PRM-5) isolator; replacing primary coolant isolation valve V507A/B position interlock relay 2K11; performing a back flush on the secondary coolant side of pool coolant system heat exchanger HX-521; performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; replacing the north shock absorber on containment building personnel entry Door 276; replacing Nuclear Instrumentation signal processor No. 2 intermediate range monitor (IRM-3) isolator; completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor;" collecting reflector differential pressure data in support of the fission product molybdenum-99 project; performing a zero and span procedure on primary coolant system flow transmitter FT-912G and square root converter EP-919G as part of the instrument calibration; performing a zero and span procedure on primary coolant system flow transmitter FT-912H as part of the instrument calibration; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)."

## July 2009

The reactor operated continuously in July with the following exceptions: four shutdowns for scheduled maintenance and/or refueling. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: replacing the valve bonnet on containment truck entry Door 101 three-way, dual solenoid-operated valve; placing the Lab Impex stack monitor on line for testing; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" replacing a latch finger on the flux trap hold down device; performing a zero and span procedure and adjusting the scram set points on reflector differential pressure transmitter PT-917 as part of the instrument calibration; replacing the motor and gearbox assembly on containment building personnel entry Door 276; and replacing the trip set point adjustment switch on containment building ventilation exhaust Air Plenum No. 2 radiation monitor.

## August 2009

The reactor operated continuously in August with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and two scheduled shutdowns for physics measurements. There were no

unscheduled/unplanned power reductions this month. Received notification from the U.S. Nuclear Regulatory Commission that three (3) new Reactor Operator licenses had been issued.

Major maintenance items for the month included: performing two reactivity worth measurements in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" performing troubleshooting maintenance on the Uninterruptible Power Supply (UPS); replacing Nuclear Instrumentation wide range pico-ammeter with a refurbished unit; replacing Nuclear Instrumentation signal processor No. 1 fission chamber detector and cabling; and connecting normal electrical power to the shipping and receiving building as part of Modification Record 04-05, Addendum 7, "Extension of Normal Electrical Service from MCC-1 to the Shipping and Receiving Building."

### **September 2009**

The reactor operated continuously in September with the following exceptions: four shutdowns for scheduled maintenance and/or refueling. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: performing a zero and span procedure on primary coolant system flow transmitter FT-912A as part of the instrument calibration; completing Modification Record 06-03, Addendum 2, "Replace Flux Trap Holder Wear Ring;" removing the NEER grant cobalt irradiation facility; completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" replacing reactor core differential pressure alarm unit EP-929; and placing three "spent" graphite reflector wedges in the wedge storage cask.

### **October 2009**

The reactor operated continuously in October with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and two unscheduled/unplanned power reductions. U.S. Nuclear Regulatory Commission regional inspector conducted a routine inspection of Reactor Operations and Emergency Preparedness.

On October 7, with the reactor operating at 10 MW in the automatic control mode, a "Rod Not in Contact with Magnet" rod run-in was automatically initiated when control blade 'D' anvil separated from its electro-magnet during a routine sample handling evolution. The immediate actions of REP-2, "Reactor Scram," were performed. The operators involved were counseled on the importance of proper sample handling techniques near the offset mechanisms. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

On October 28, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was automatically initiated when an interruption in normal electric supply power from the University Power Plant to the facility occurred. All immediate and subsequent actions of reactor emergency procedure REP-10, "Sustained Loss of Normal Electrical Power," were performed. Permission to restart the reactor was obtained from the Reactor Manager after confirmation from the power plant that the cause of the interruption in electrical power had been corrected. The reactor was refueled and subsequently restarted to 10 MW operation.

Major maintenance items for the month included: adjusting the scram set point on reactor core outlet pressure transmitter PT-944A; replacing laboratory building ventilation exhaust plenum pressure controller; completing the

biennial change-out of control blade 'C' offset mechanism; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" loading new de-ionization bed 'B' and placing it on pool coolant system service; installing the NEER grant cobalt irradiation facility; completing Modification Record 90-1, Addendum 2, "Evacuation System Changes in Support of the Shipping and Receiving Building;" completing Modification Record 01-2, Addendum 4, "Intercommunication and Paging System Changes in Support of the Shipping and Receiving Building;" and completing Modification Record 09-1, "Interfacing MURR Systems with the Shipping and Receiving Building."

#### **November 2009**

The reactor operated continuously in November with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and one scheduled shutdown for a physics measurement. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" replacing a section of the make-up water supply line on the secondary coolant system; repairing primary coolant demineralizer outlet valve V527F air actuator; performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; performing a back flush on the secondary coolant side of pool coolant system heat exchanger HX-521; installing a split screen monitor in the control room as part of Modification Record 09-02, "Airlock Door Control;" replacing the drive motor on containment building personnel entry Door 276; replacing the mechanical seal water supply line on primary coolant system circulation pump P-501B; and installing a proxy card reader as part of Modification Record 09-02, "Airlock Door Control."

#### **December 2009**

The reactor operated continuously in December with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, one scheduled shutdown for a physics measurement, and one scheduled shutdown for training. There were no unscheduled/unplanned power reductions this month.

Major maintenance items for the month included: completing Modification Record 09-02, "Airlock Door Control;" completing Modification Record 01-09, Addendum 3, "Emergency Electrical System in the Shipping and Receiving Building;" and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)."

**SECTION II**  
**MURR PROCEDURES**

January 1, 2009 through December 31, 2009

As required by administrative Technical Specification 6.1.h (4), this section of the Annual Report includes a summary of procedure changes. These procedure changes were reviewed by the Reactor Manager or Reactor Health Physics Manager and others to assure compliance with the requirements of 10 CFR 50.59. These procedure changes were also reviewed by the Reactor Procedure Review Subcommittee of the Reactor Advisory Committee to meet the requirements of Technical Specification 6.1.c (1).

**A. CHANGES TO REACTOR OPERATIONS PROCEDURES**

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

There were sixty-six (66) revisions issued to the reactor operations procedures, forms and operator aids. Additionally, one (1) new form and one (1) new procedure were issued. The majority of the revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the new and revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
AP-RO-110	Conduct of Operations	14	2/13/2009	Minor Editorial
AP-RO-110	Conduct of Operations	15	10/27/2009	Minor Editorial
AP-RO-115	Modification Records	5	10/27/2009	Minor Editorial
AP-RO-130	Crane Operation	4	3/17/2009	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	13	12/29/2009	Cover Page
EX-RO-120	Beamport "A" Operation	7	2/13/2009	Minor Editorial
EX-RO-121	Beamport "B" Operation	7	2/13/2009	Minor Editorial
EX-RO-122	Beamport "C" Operation	7	2/13/2009	Minor Editorial
EX-RO-123	Beamport "D" Operation	7	3/17/2009	Minor Editorial
EX-RO-124	Beamport "E" Operation	8	2/13/2009	Minor Editorial
EX-RO-125	Beamport "F" Operation	9	2/13/2009	Minor Editorial
EX-RO-126	Thermal Column Door	5	12/29/2009	Cover page
FB-SH-130	Test and Calibration Procedure BMI-1 Shipping Cask	0	3/26/2009	Full Review
FM-11	Reactor Shutdown Checksheet	3	2/13/2009	Cover Page
FM-20	Waste Tank Sample Report	8	8/18/2009	Minor Editorial
FM-43	Nuclear and Process Data	12	1/16/2009	Minor Editorial
FM-43	Nuclear and Process Data	13	5/22/2009	Minor Editorial
FM-57	Long Form Startup Checksheet	15	3/17/2009	Minor Editorial
FM-66	Customer Sample Pre-Encapsulation Evaluation Worksheet	4	6/16/2009	Minor Editorial
FM-71	Pneumatic Tube User Approval	2	8/18/2009	Minor Editorial
FM-127	MURR Irradiations Encapsulation Evaluation	0	4/1/2009	Full Review

Number	Name	Rev.	Revision Date	Notes
GS-RA-100	MURR Equipment Tag Out	8	8/19/2009	Minor Editorial
IRR-PSO-100	Scheduling Flux Trap Tubes	5	12/16/2009	Minor Editorial
IRR-PSO-106	Target Material Control Checks	6	2/2/2009	Minor Editorial
IRR-PSO-111	Customer Sample Pre-Encapsulation Evaluation	4	6/16/2009	Minor Editorial
OA-1	Facility Exhaust Fans EF-13 and EF-14, EF-13 Running	5	12/29/2009	Cover Page
OA-2	Facility Exhaust Fans EF-13 and EF-14, EF-14 Running	5	12/29/2009	Cover Page
OA-3	Beamport and Pool Overflow Loop Seals	5	1/16/2009	Cover Page
OA-7	Receiving Bulk Chemicals	3	10/12/2009	Minor Editorial
OP-RO-101	Instrument Air System	7	5/22/2009	Minor Editorial
OP-RO-210	Reactor Startup - Normal	8	10/27/2009	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	10	1/16/2009	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	11	2/13/2009	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	12	10/12/2009	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	6	6/17/2009	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	7	6/17/2009	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	9	6/17/2009	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	6	6/17/2009	Minor Editorial
OP-RO-410	Primary Coolant System	7	5/22/2009	Minor Editorial
OP-RO-410	Primary Coolant System	8	12/29/2009	Minor Editorial
OP-RO-420	Primary and Pool Water Analysis	4	9/3/2009	Minor Editorial
OP-RO-460	Pool Coolant System - Two Pump Operation	11	8/18/2009	Cover Page
OP-RO-461	Pool Coolant System - One Pump Operation	9	8/18/2009	Minor Editorial
OP-RO-465	Pool Level Control - Skimmer System	6	1/16/2009	Minor Editorial
OP-RO-466	Pool Level Control - Pool Coolant System	7	3/4/2009	Minor Editorial
OP-RO-466	Pool Level Control - Pool Coolant System	8	6/5/2009	Minor Editorial
OP-RO-520	Emergency Diesel Generator	7	3/17/2009	Minor Editorial
OP-RO-520	Emergency Diesel Generator	8	10/12/2009	Minor Editorial
OP-RO-525	Chill Water System	2	5/22/2009	Minor Editorial
OP-RO-530	Dem mineralized Water Supply System	8	8/18/2009	Minor Editorial
OP-RO-530	Dem mineralized Water Supply System	9	10/27/2009	Minor Editorial
OP-RO-531	Primary and Pool Sample Station	8	8/18/2009	Cover Page
OP-RO-532	Drain Collection System	6	8/18/2009	Cover Page
OP-RO-533	Skimmer System	5	10/12/2009	Cover Page
OP-RO-555	Fire Protection System	6	1/16/2009	Cover Page
OP-RO-555	Fire Protection System	7	10/27/2009	Minor Editorial
OP-RO-730	Facility Exhaust System	11	3/17/2009	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	9	3/4/2009	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	10	11/10/2009	Minor Editorial
RM-RO-400	Waste Tank System Filter Replacement	5	3/17/2009	Minor Editorial
RP-RO-201	Measurement of Total Reactivity Worth of Flux Trap Loadings, RTP-17(B)	3	10/29/2009	Minor Editorial
SM-RO-420	Pressurizer Operation - Maintenance & Test	3	9/11/2009	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
SM-RO-635	Retracting and Reinserting Beamport 'A' Liner	2	2/27/2009	Minor Editorial.
SM-RO-636	Retracting and Reinserting Beamport 'B' Liner	2	2/27/2009	Minor Editorial
SM-RO-637	Retracting and Reinserting Beamport 'C' Liner	2	2/27/2009	Minor Editorial
SM-RO-638	Retracting and Reinserting Beamport 'D' Liner	3	2/27/2009	Minor Editorial
SM-RO-639	Retracting and Reinserting Beamport 'E' Liner	3	2/27/2009	Minor Editorial
SM-RO-640	Retracting and Reinserting Beamport 'F' Liner	4	2/27/2009	Minor Editorial

## 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 for the safe and reliable operation of the facility.

There were ten (10) revisions issued to the emergency procedures, forms and operator aids. The majority of the revisions were strictly format or editorial in nature. The following is a list of the revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
EP-RO-004	Fire	3	7/23/2009	Minor Editorial
EP-RO-014	EPZ and Site Area Evacuations	5	2/18/2009	Minor Editorial
EP-RO-017	Emergency Air Sampling	4	2/18/2009	Minor Editorial
EP-RO-020	Emergency Equipment Maintenance	4	2/18/2009	Minor Editorial
FM-104	Emergency Call List	11	3/24/2009	Minor Editorial
FM-104	Emergency Call List	12	10/29/2009	Minor Editorial
FM-118	Evacuation Flowchart	2	2/18/2009	Minor Editorial
OA-09	Combined Emergency Flowcharts	2	2/18/2009	Minor Editorial
OA-20	Emergency Equipment	4	3/24/2009	Minor Editorial
OA-20	Emergency Equipment	5	7/23/2009	Minor Editorial

## C. CHANGES TO HEALTH PHYSICS PROCEDURES, BYPRODUCT MATERIAL SHIPPING PROCEDURES, and PREPARATION OF BYPRODUCT MATERIAL FOR SHIPPING PROCEDURES

As required by the MURR Technical Specifications, the Reactor Health Physics Manager reviewed the procedures for radioactive materials handling, shipping, and preparation for shipping of byproduct materials.

There were sixty-eight (68) revisions issued to the health physics, radioactive materials shipping, and preparation for shipping procedures and forms. Additionally, six (6) new forms and fifteen (15) new procedures were issued, and five (5) procedures were obsoleted. The majority of the revisions were strictly format or editorial in nature. The following is a list of the revised procedures and forms:

Number	Name	Rev.	Revision Date	Notes
AP-HP-105	Radiation Work Permit	9	9/23/2009	Minor Editorial
AP-HP-119	High Radiation Area Access	2	2/13/2009	Cover Page
AP-HP-120	Beamport Area	4	6/2/2009	Cover Page

Number	Name	Rev.	Revision Date	Notes
AP-HP-121	Isotope Closet	4	6/2/2009	Cover Page
AP-HP-123	Visitor Dosimetry - Reception Desk	6	3/11/2009	Minor Editorial
AP-HP-127	Radioactive Material Licensing and Project Designation Change Request	4	2/13/2009	Cover Page
AP-HP-129	Hot Cell Control	6	6/2/2009	Minor Editorial
AP-HP-150	Source Calibration	4	8/13/2009	Cover Page
AP-SH-001	Administrative Procedure, Radioactive Materials Shipping	6	12/22/2009	Minor Editorial
BPB-SH-001	2R Shipping Container Leak Check	6	3/2/2009	Obsolete
BPB-SH-005	DOT 6M Packaging of Type B Non-Waste Radioactive Material	7	4/8/2009	Minor Editorial
BPB-SH-008	Type B(U) F-327 Series Packaging of Type B Non-Waste Radioactive Material	6	4/8/2009	Minor Editorial
BPB-SH-020	Receipt Inspection of Type B Byproduct Material Shipping Containers	0	3/26/2009	Full Review
BPB-SH-021	20 WC-1 All-Thread Rod Replacement	0	3/26/2009	Full Review
BPB-SH-022	Painting USA DOT 20 WC-1 Overpack	0	3/26/2009	Full Review
BPB-SH-023	Torque Wrench Calibration	0	3/26/2009	Full Review
BP-SH-007	F-327 Packaging and Shipment of Type A Non-Waste Radioactive Material	5	12/22/2009	Minor Editorial
BP-SH-012	DOT-7A Package Certification	3	3/2/2009	Minor Editorial
BP-SH-013	Packaging and Shipment of Radioactive Materials Using MURR Reusable Type A Package	3	4/8/2009	Minor Editorial
BP-SH-014	Packaging and Shipment of Radioactive Material Using an Overpack	2	4/8/2009	Minor Editorial
BP-SH-016	Packaging and Shipment of Radioactive Material Using USA DOT-7A Model H or I Package	0	8/13/2009	Full Review
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	4	4/8/2009	Minor Editorial
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	5	11/5/2009	Minor Editorial
BP-SH-302	Packaging and Shipment of Radioactive Material Using MURR Models 6 and 12	2	3/2/2009	Minor Editorial
FB-SH-125	Biennial Inspection and Preventive Maintenance BMI-1 Shipping Cask	0	3/26/2009	Full Review
FM-13	Receipt of Radioactive Material	4	7/14/2009	Cover Page
FM-13	Receipt of Radioactive Material	5	10/14/2009	Minor Editorial
FM-17	Radiation Work Permit	8	9/23/2009	Minor Editorial
FM-29	Initial Radiation Worker Training Packet	6	8/19/2009	Cover Page
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	5	4/28/2009	Minor Editorial
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	6	11/5/2009	Minor Editorial
FM-53	Radioactive Material Licensing and Project Designation Change Request	3	7/14/2009	Cover Page
FM-54	Report of Personnel Contamination	6	7/14/2009	Cover Page

Number	Name	Rev.	Revision Date	Notes
FM-62	Radiation Instrument Certificate of Calibration	5	3/18/2009	Cover Page
FM-67	Receipt of Radioactive Gemstone Shipping Containers	5	7/14/2009	Cover Page
FM-75	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	10	12/22/2009	Minor Editorial
FM-91	Declaration of Pregnancy	2	3/2/2009	Cover Page
FM-99	Control Checksheet for USA DOT 7A MURR Model 1500 Series	4	3/26/2009	Minor Editorial
FM-107	Control Check Sheet for Overpack Shipment	3	12/22/2009	Minor Editorial
FM-108	2R Container Leak Check Data Sheet	1	3/26/2009	Obsolete
FM-126	Certificate of Compliance for DOT-7A Shipping Container	0	3/2/2009	Full Review
FM-128	Control Check Sheet For MURR Shipment Using USA DOT-7A MURR Model H or I	0	8/13/2009	Full Review
FM-129	Control Checksheet for Receipt Inspection of Type B Byproduct Material Shipping Containers	0	3/26/2009	Full Review
FM-154	Control Checksheet for USA DOT 20 WC-1 Overpack Rod Replacement	0	3/26/2009	Full Review
FM-155	Quality Assurance Control Checksheet Exterior Painting of USA DOT WC-1, Type B Overpack	0	3/26/2009	Full Review
FM-156	Required Documentation for Non-MURR Owned Type B Shipping Containers	0	6/5/2009	Full Review
HC-PSO-005	Hot Cell Loading of Host Can	6	2/9/2009	Minor Editorial
IC-HP-300	Calibration - Radiation Survey Instruments	5	3/18/2009	Cover Page
IC-HP-305	Calibration - Electrostatic Discharge Dosimeter	5	2/13/2009	Cover Page
IC-HP-331	Calibration - Tennelec LB-5100 Alpha/Beta	6	6/2/2009	Cover Page
IC-HP-333	Eberline BC-4 Beta Swipe Counter - Calibration	5	2/13/2009	Cover Page
IC-HP-335	Calibration - Portal Monitor Gamma-60 - S/N 900644	7	4/29/2009	Cover Page
IC-HP-337	Calibration - Portal Monitor Gamma-60 - S/N 1010 and 1011	6	8/13/2009	Cover Page
IC-HP-348	Calibration - Canberra S5XLB-G & Tennelec Series 4 with Gamma	4	6/2/2009	Cover Page
IC-HP-349	Calibration - Lab Impex Stack Monitor-Particulate Channel	0	12/3/2009	Full Review
IC-HP-350	Calibration - Lab Impex Stack Monitor Iodine Channel	0	12/3/2009	Full Review
IC-HP-351	Calibration - Lab Impex Stack Monitor - Gas Channel	0	12/3/2009	Full Review
IC-HP-352	Calibration - Lab Impex Stack Monitor-Flow Calibration	0	12/3/2009	Full Review
IRR-PSO-112	Preparing Shipping Paperwork	2	2/2/2009	Minor Editorial
IRR-PSO-112	Preparing Shipping Paperwork	3	9/15/2009	Minor Editorial
OP-HP-220	Tritium Bioassay	5	7/14/2009	Cover Page
OP-HP-227	Tennelec LB-5100 Alpha/Beta - Operation	4	6/2/2009	Cover Page
OP-HP-230	Eberline BC-4 Beta Swipe Counter - Operation	4	2/13/2009	Cover Page
OP-HP-300	Receipt of Radioactive Material	6	2/13/2009	Cover Page

Number	Name	Rev.	Revision Date	Notes
OP-HP-306	Daily Facility Checks	2	10/14/2009	Minor Editorial
OP-HP-348	Operation - Protean WPC-9550 Swipe Counter	3	2/13/2009	Cover Page
OP-HP-350	Eberline Model Ping 1A - Filter Change	4	4/29/2009	Cover Page
OP-HP-351	NMC Model RAK - Filter Change	4	2/13/2009	Cover Page
OP-HP-352	Particulate and Iodine Filter - Analysis	3	2/13/2009	Cover Page
OP-HP-353	Waste Tank Sample - Analysis	5	3/18/2009	Cover Page
PRC-RRD-001	Preparing and Submitting a Radioactive Sample for Packaging	0	12/30/2009	Full Review
QAB-SH-002	Procurement of Type B Packages	0	3/2/2009	Full Review
QAB-SH-003	Material Control for Type B Shipping Program	0	3/2/2009	Full Review
QAB-SH-004	Type B Program Vendor Qualification	0	3/2/2009	Full Review
QAB-SH-005	Type B QA Personnel Training	0	3/2/2009	Full Review
QA-HP-005	Use of 13-G Shipping Cask	0	3/26/2009	Obsolete
QA-SH-002	Sodium Iodide Spectral Analysis for Excepted, Exempt, License-to-License, Type A, or Type B Radioactive Materials Shipments	3	3/2/2009	Minor Editorial
QA-SH-002	Sodium Iodide Spectral Analysis for Excepted, Exempt, License-to-License, Type A, or Type B Radioactive Materials Shipments	4	12/22/2009	Minor Editorial
RP-HP-120	Personnel Radioactive Contamination	6	4/29/2009	Minor Editorial
RP-HP-130	Receipt of New Fuel Elements	5	4/29/2009	Cover Page
RP-HP-135	Room 114 Entry - Self Monitored	4	4/29/2009	Cover Page
SP-SH-001	NeoRx 2 R Shipping Container Leak Check	1	3/2/2009	Obsolete
SV-HP-105	Sealed Calibration Source - Leak Check	7	2/13/2009	Cover Page
SV-HP-115	Building Exhaust Stack Effluent - Tritium Monitoring	4	10/14/2009	Minor Editorial
SV-HP-119	Property Release	3	4/29/2009	Cover Page
SV-HP-121	Building Exhaust Stack Effluent - Ar-41 Monitoring	3	8/13/2009	Cover Page
SV-HP-130	Emergency Air Sampling of Exhaust Plume	4	7/14/2009	Cover Page
TPZ-PSO-001	Receiving Gemstone Irradiation Shipping Drums	5	10/5/2009	Minor Editorial
TPZ-PSO-002	Irradiation of Gemstone Irradiation Containers	4	6/16/2009	Minor Editorial
TSP-02	Transportation Security Plan	3	2/2/2009	Minor Editorial
WMB-SH-005	Shipment of Type B Radioactive Waste Using Chem-Nuclear System 1-13G Cask	6	3/26/2009	Obsolete
WM-SH-100	Radioactive Waste - Preparation and Storage	5	6/5/2009	Minor Editorial
WM-SH-105	Radioactive Waste Processing	5	6/5/2009	Minor Editorial
WM-SH-300	Exclusive Use Shipment of LSA or SCO Radioactive Waste	5	9/24/2009	Minor Editorial

### SECTION III

#### REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2009 through December 31, 2009

These changes were approved by the Reactor Manager and reviewed by licensed staff and members of the Reactor Safety Subcommittee and have been determined not to involve a change to the Technical Specifications. These changes have all been reviewed in accordance with 10 CFR 50.59.

#### HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

**Original HSR, Section 3.2.1, paragraph 4, page 3-3** (as revised by 1967-68, 1973-74 and 1981-82 Reactor Operations Annual Reports):

Delete:           “(12) 3/4" pvc Film irradiator helium supply”

Replace with:   “(12) 3/4" pvc (blanked)”

**Original HSR, Figure 5.1, Piping & Instrument Diagram** (as revised by the 1972-73, 1973-74, 1994, 1996, 2001, 2002, 2003, 2004, 2006 and 2007 Reactor Operations Annual Reports):

Replace with:   Updated Figure 5.1, Piping & Instrument Diagram (MURR Dwg No. 156, Sheet 1 of 1, dated 11/17/09)

**Original HSR, Section 7.1.4, paragraph 3, page 7-4** (as revised by the 1972-73, 1989-90, 2002 and 2004 Reactor Operations Annual Reports):

Add:             “(16) Shipping and Receiving Building Fire Protection Panel”

**Original HSR, Section 7.2.9, Table 7.2, page 7-21** (as revised by the 1995, 2001 and 2007 Reactor Operations Annual Reports):

Add:             “Shipping and Receiving Building  
Room 101 (2)”

**Original HSR, Figure 8.4, MURR 3 Tube Flux Trap** (as added by the 1972-73 and revised by the 2007 Reactor Operations Annual Reports):

Replace with:   Updated Figure 8.4, Flux Trap: 3-Barrel Assembly View (MURR Dwg No. 2505, Sheet 1 of 3, dated 3/18/09)

**Original HSR, Figure 8.5, Flux Trap: 6-Barrel Assembly View** (as added by the 2000 and revised by the 2007 Reactor Operations Annual Reports):

Replace with:   Updated Figure 8.5, Flux Trap: 6-Barrel Assembly View (MURR Dwg No. 2528, Sheet 1 of 3, dated 3/18/09)

**Original HSR, Section 8.6, paragraph 2, page 8-13** (as revised by the 1969-70 and 1981-82 Reactor Operations Annual Reports):

Delete: "The graphite stack incorporates a bismuth filter, neutron radiographic variable aperture, and a slot for the irradiator case for the film irradiator experiment. The original thermal column door has been with a new door that incorporates a film irradiator experiment. Figure 8.3 is a cross sectional view of the thermal column door, and the film irradiator experiment."

Replace with: "The graphite stack incorporates a bismuth filter, neutron radiographic variable aperture, and a slot that at one time was occupied by the irradiator case of a film irradiator experiment. Figure 8.3 is a cross sectional view of the thermal column door."

**Original HSR, Section 9.2, Table 9.1, pages 9-5 through 9-7** (as revised by 1981-82, 1995, 2001, 2004 and 2008 Reactor Operations Annual Reports):

Delete: "54 Airlock Door Security "Closed-Open" 2 Position"

Replace with: "54 Airlock Door Security "Normal-Closed-Outer Open" 3 Position"

Delete: "57 Airlock Door Open N/A Push Button"

Replace with: "57 Airlock Door Open "Outer-Inner" 3 Pos. Spring Ret."

**Original HSR, Figure 9.2, Control Console Layout** (as revised by the 1995, 2001, 2004 and 2009 Reactor Operations Annual Reports):

Replace with: Updated Figure 9.2, Control Console Layout (dated 12/21/09)

**Original HSR, Figure 9.4, Safety System 10 MW** (as revised by the 1995, 2001, 2002, 2003, 2006 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure 9.4, Safety System (MURR Dwg No. 139, Sheet 1 of 1, dated 8/10/09)

#### **ADDENDUM 1 - HAZARDS SUMMARY REPORT (FEBRUARY 1966)**

**HSR, Addendum 1, Section 3.22, paragraph 8, page 102**, (as revised by the 1989-90 and 1995 Reactor Operations Annual Reports):

Delete: The following words from the second sentence: "the Nuclepore film shield box,"

#### **ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)**

**HSR, Addendum 3, page 23a, Figure 2.3.a, Electrical Distribution** (as revised by the 1989-90, 1990-91, 1995, 2001, 2002, 2003, 2004, 2005, 2006 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.a, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 8/10/09)

**HSR, Addendum 3, page 23b, Figure 2.3.b, Electrical Distribution** (as added by the 1995 and revised by the 2001, 2002, 2003, 2004, 2005 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.b, Electrical Distribution North Office Addition (MURR Dwg No. 522, Sheet 2 of 5, dated 8/10/09)

**HSR, Addendum 3, page 23c, Figure 2.3.c, Electrical Distribution** (as added by the 2004 and revised by the 2005 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.c, Electrical Distribution Reactor/Laboratory Panels (MURR Dwg No. 522, Sheet 3 of 5, dated 8/10/09)

**HSR, Addendum 3, page 23d, Figure 2.3.d, Electrical Distribution** (as added by the 2007 and revised by 2008 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.d, Electrical Distribution Reactor/Laboratory Panels-2 (MURR Dwg No. 522, Sheet 4 of 5, 8/10/09)

**HSR, Addendum 3, page 23e, Figure 2.3.e, Electrical Distribution** (as added by the 2007 Reactor Operations Annual Report):

Replace with: Updated Figure 2.3.e, Electrical Distribution North Office Addition Panels (MURR Dwg No. 522, Sheet 5 of 5, dated 8/10/09)

#### **ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)**

**HSR, Addendum 4, page A-28, Figure A.1, Safety System 10 MW** (as revised by the 1995, 2001, 2002, 2003, 2006 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure A.1, Safety System (MURR Dwg No. 139, Sheet 1 of 1, dated 8/10/09)

**HSR, Addendum 4, page A-29, Figure A.2, Piping & Instrument Diagram** (as revised by the 1995, 2001, 2002, 2003, 2004, 2006 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure A.2, Piping & Instrument Diagram (MURR Dwg No. 156, Sheet 1 of 1, dated 11/17/09)

**HSR, Addendum 4, page A-32, Figure A.5, 10 MW Process Instrumentation Control & Interlock** (as revised by 1995, 2001, 2005, 2006 and 2008 Reactor Operations Annual Reports):

Replace with: Updated Figure A.5, 10 MW Process Instrumentation Control & Interlock (MURR Dwg No. 41, Sheet 1 of 4, dated 11/18/09)

**HSR, Addendum 4, page A-38, Figure A.11, Schematic Diagram of Laboratory and Containment Building Ventilation Systems** (as revised by the 1995, 2002 and 2005 Reactor Operations Annual Reports):

Replace with: Updated Figure A.11, Schematic Diagram of Laboratory and Containment Building Ventilation Systems (MURR Dwg No. 1125, Sheet 1 of 4, dated 12/16/09)

**ADDENDUM 5 - HAZARDS SUMMARY REPORT (JANUARY 1974)**

**HSR, Addendum 5, page 15, Figure 2.1, Electrical Distribution** (as revised by the 1989-90, 2001, 2002, 2003, 2004, 2005, 2006 and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.1, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 8/10/09)

**HSR, Addendum 5, Section 2.4.1, page 12** (as revised by the 1989-90, 2002 and 2004 Reactor Operations Annual Reports):

Add: “(16) Shipping and Receiving Building

Normal supply power would be lost to Shipping and Receiving Building (SaRB). However, there are no electrical loads in the SaRB that are required to accomplish a safe shut down of the reactor or to maintain a safe shutdown condition.”

## SECTION IV

### PLANT AND SYSTEM MODIFICATIONS

January 1, 2009 through December 31, 2009

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

#### **Modification 90-1, Addendum 2:**

##### Evacuation System Changes in Support of the Shipping and Receiving Building

This addendum to modification record 90-1, "Evac Horn," documents changes to the facility evacuation system that were necessary in order to safely occupy the new shipping and receiving building (SaRB). To ensure a prompt and effective response from facility staff to an emergency or abnormal condition, the facility evacuation system was extended into the SaRB. One (1) horn was installed in the open space of this building.

#### **Modification 96-1, Addendum 2:**

##### Removal of the Nuclepore Experiment Equipment

This addendum to modification record 96-1, "Removal of Nuclepore Gas Lines, Isolation Valves, and Valve Control Wiring," documents the removal of the remaining utility connections and abandoned components associated with the nuclepore facility not removed under modification record 96-1 and modification record 96-1, addendum 1. The nuclepore facility was installed in 1977 to provide a means of producing finely controlled porosity in an irradiated plastic film. To accommodate the required equipment a redesigned thermal column door was installed. Within this door, a removable set of uranium-bearing 'fission plates' was exposed to thermal neutron flux in the thermal column facility. As the target film slid across these fission plates, the fission products released penetrated the film, thus producing finely distributed perforations, which were later acid-etched to produce the desired porosity. After the nuclepore facility was decommissioned and abandoned in place in 1993, modification record 96-1 documented the removal of gas lines, isolation valves and valve controls. The irradiator case (that part of the experiment that was moved into and out of the neutron flux) was removed using reactor test procedure RTP-16D. Addendum 1 to modification record 96-1 documented the removal and disposal of the shield box ventilation exhaust filter housing and associated duct work.

#### **Modification 01-2, Addendum 4:**

##### Intercommunication and Paging System Changes in Support of the Shipping and Receiving Building

This addendum to modification record 01-2, "Installation of a New Reactor Facility Intercommunication and Paging System," documents changes to the facility intercommunication and paging system that were necessary in order to safely occupy the new Shipping and Receiving Building (SaRB). To ensure a prompt and effective response from facility staff to an emergency or abnormal condition, the intercommunication and paging system was extended into the SaRB. Two (2) paging speakers were installed in this building.

#### **Modification 01-9, Addendum 3:**

##### Emergency Electrical System in the Shipping and Receiving Building

This addendum to modification record 01-9, "Installation of Emergency Lighting Panel No. 1," documents the addition of loads to the emergency electrical power system in the new shipping and receiving building

(SaRB). This addition provides two (2) 120 volt emergency power circuits to the SaRB for key systems such as fire protection and building access control.

**Modification 06-3, Addendum 2:**

Replace Flux Trap Holder Wear Ring

This addendum to modification record 06-3, "Replace Flux Trap Holder Wear Ring," documents the replacement of the center test hole canister temporary wear ring with a different design. The new ring covers a larger circumference of the flux trap holder; thus ensuring rotation will not disengage the position sensing switches of the flux-trap irradiations reactivity safety trip (FIRST) instrument channel. This installation was done in support of preliminary long form modification record, "Flux-Trap Irradiations Reactivity Safety Trip (FIRST) Instrument Channel." The prototype FIRST rig was installed under modification record 08-5, and subsequent details of the FIRST device and its function are provided in this modification record.

**Modification 09-1:**

Interfacing MURR Systems with the Shipping and Receiving Building

This modification record was used as the initiating document to ensure all systems related to emergency response and routine operation have been identified and modified prior to safely occupying the facility's new shipping and receiving building. Actual modifications to these systems – facility evacuation, fire protection, intercommunication and paging, and normal and emergency electrical power – were performed under addendums to previously approved modification records.

**Modification 09-2:**

Airlock Door Control

This modification record documents the replacement of the existing pedestrian entry (airlock) door analog control system with a Programmable Logic Controller (PLC)-driven system. In addition, the control scheme was modified to maintain both airlock doors closed and sealed when in an idle condition. All existing interlocks and protective functions were preserved, with the addition of controls necessary to open and close both doors. This modification record is classified as "Safeguards Information" due to the inclusion of security-sensitive information.

## SECTION V

### NEW TESTS AND EXPERIMENTS

January 1, 2009 through December 31, 2009

New tests or experiments developed during this period under a Reactor Utilization Request (RUR) or reactor Project are as follows:

#### **RUR 118, as amended: Molybdenum Metal**

Description: This RUR authorizes the irradiation of up to 375.0 grams of molybdenum metal, natural or enriched up to 100 % in the isotope Mo-98, for research and development activities.

#### **RUR 219, as amended: Epithermal Neutron Irradiation Facility**

Description: This RUR authorizes the use of a cadmium-lined epithermal neutron irradiation container for research and development activities.

#### **RUR 269, as amended: Platinum**

Description: This RUR authorizes the irradiation of up to 0.50 grams of platinum, natural or enriched up to 100% in the isotope Pt-192, Pt-194 or Pt-198, for research and development activities.

#### **RUR 433: Lanthanum Nitrate**

Description: This RUR authorizes the irradiation of up to 0.023 grams of lanthanum nitrate ( $\text{La}(\text{NO}_3)_3$ ) for research and development activities.

#### **Project RL-70: Thermal Neutron Beam-Line for Neutron Capture Therapy on Beam Port E**

Description: This Project authorizes the use of a neutron irradiation facility in support of the development of neutron capture therapy (NCT) agents. The NCT facility will enable experimenters to measure the efficacy of capture therapy agents in animal models and cell cultures.

Each of these tests or experiments has a written safety evaluation on file, and a 10 CFR 50.59 Screen if applicable, to assure that the test or experiment is safe and within the limits of the Technical Specifications. The safety evaluations have been reviewed by the Reactor Manager, Reactor Health Physics Manager, Assistant Reactor Manager-Physics, and the Reactor Safety Subcommittee, as applicable. In the case of RL-70, the Isotope Use Subcommittee also reviewed this project.

## SECTION VI

### SPECIAL NUCLEAR MATERIAL AND REACTOR PHYSICS ACTIVITIES

January 1, 2009 through December 31, 2009

#### **Inspections:**

There was one NRC inspection which reviewed Special Nuclear Material activities. All records and activities were found to be in compliance with NRC rules and regulations. No violations were noted.

#### **Reactor Characteristic Measurements:**

Fifty-five (55) refueling evolutions were completed in 2009. Excess reactivity verifications were performed for each refueling. The largest measured excess reactivity value was 2.86%. MURR Technical Specification 3.1(f) requires excess reactivity to be less than 9.8%.

#### **Reactivity Measurements:**

Differential blade-worth measurements of four (4) shim control blades were performed following either a planned replacement of a control blade or characterization of the burn-in effect of a new control blade.

Three (3) reactivity measurements were performed to determine the reactivity worth of all samples, including the sample holder, loaded in the flux trap region.

Six (6) reactivity measurements were performed to determine the reactivity worth of various sample cans irradiated in the flux trap region.

One (1) reactivity measurement was performed to characterize the reactivity worth of a cadmium-lined epithermal neutron irradiation container in the graphite reflector region.

In support of the Nuclear Engineering student labs, one (1) differential blade-worth measurement and one (1) primary coolant temperature coefficient measurement were also performed.

## SECTION VII

### RADIOACTIVE EFFLUENT

January 1, 2009 through December 31, 2009

TABLE 1  
SANITARY SEWER EFFLUENT

January 1, 2009 through December 31, 2009

Descending Order of Activity Released for Nuclide Totals > 1.000E-05 Ci

<u>Nuclide</u>	<u>Activity (Ci)</u>
H-3	5.123E-02
S-35	6.449E-03
Lu-177	4.726E-03
Co-60	3.261E-03
P-32	2.866E-03
Ca-45	2.510E-03
Lu-177m	1.633E-03
Zn-65	1.004E-03
Cr-51	2.580E-04
Mn-54	1.994E-04
Sc-46	1.915E-04
Ru-105	1.295E-04
Ag-100m	1.193E-04
Rh-105	6.020E-05
Gd-159	4.906E-05
Na-22	1.472E-05
Cu-67	1.284E-05
Total H-3	5.123E-02
Total Other	2.350E-02

Sanitary Sewer Effluents are in compliance with 10 CFR 20.2003, "Disposal By Release Into Sanitary Sewerage."

TABLE 2  
STACK EFFLUENT

January 1, 2009 through December 31, 2009

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration ( $\mu\text{Ci/ml}$ )	Total Release (Ci)	TS Limit Multiplier	% TS
Ar-41	1.92E-06	9.78E+02	350	70.3004
Os-191	8.35E-11	4.05E-02	1	4.1739
C-14	1.84E-11	8.34E-03	1	0.6130
I-131	1.21E-12	5.86E-04	1	0.6035
H-3	1.15E-08	5.58E+00	350	0.0328
I-125	2.20E-14	1.07E-05	1	0.0073
Se-75	4.55E-14	2.21E-05	1	0.0057
Hg-203	1.26E-14	6.13E-06	1	0.0013
I-133	1.21E-12	5.85E-04	350	0.0003
Ba-140	2.91E-15	1.41E-06	1	0.0001
Co-58	1.35E-15	6.57E-07	1	0.0001
Co-57	9.22E-16	4.48E-07	1	0.0001
S-35	2.28E-15	1.11E-06	1	0.0001
Br-82	1.21E-12	5.88E-04	350	0.0001
Ce-139	6.22E-16	3.02E-07	1	0.0001
Nb-95	1.33E-15	6.45E-07	1	0.0001
As-77	1.29E-12	6.27E-04	350	0.0001

Note: C-14 activity is calculated based on the ratio of argon to nitrogen in the air and the (n,p) reaction cross sections for the activation of N-14 to C-14.

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

Stack Flow Rate = 30,500 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, 2009 through December 31, 2009

Environmental samples are collected two times per year at eight (8) locations and analyzed for radioactivity. Soil and vegetation samples are taken at each location. Water samples are taken at three (3) of the eight (8) 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 2009. All doses are approximately 16 mRem/year or less, except monitor numbers 9, 15 and 42. Monitors 9 and 15 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. Monitor 42 is located in the Health Physics Office, which is in close proximity to the reactor. 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 is provided in Table 4.

TABLE 1  
Summary of Environmental Set 75  
Spring 2009

<u>Matrix</u>	<u>Alpha</u>	<u>Beta</u>	<u>Gamma</u>	<u>Tritium</u>
Water	0.73 pCi/L	3.26 pCi/L	200.41 pCi/L	3.76 pCi/mL of sample
Soil	0.71 pCi/g	4.35 pCi/g	0.56 pCi/g	N/A
Vegetation	2.47 pCi/g	7.68 pCi/g	1.72 pCi/g	3.82 pCi/mL of distillate

#### Activity Levels - Vegetation

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>	<u>H-3 (pCi/mL)</u>
1V75	< 2.47	20.57	< 1.72	< 3.82
2V75	< 2.47	9.14	< 1.72	< 3.82
3V75	< 2.47	13.15	< 1.72	< 3.82
4V75	< 2.47	16.62	< 1.72	< 3.82
5V75	< 2.47	18.90	< 1.72	< 3.82
6V75	< 2.47	19.75	< 1.72	< 3.82
7V75	< 2.47	19.76	< 1.72	< 3.82
10V75	< 2.47	15.90	< 1.72	< 3.82

TABLE 1 (Cont'd)  
Summary of Environmental Set 75  
Spring 2009

Activity Levels - Soil

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>
1S75	< 0.71	10.16	3.77
2S75	0.95	11.13	3.16
3S75	< 0.71	10.37	3.03
4S75	< 0.71	9.37	2.77
5S75	0.95	10.26	3.53
6S75	0.92	< 4.35	2.17
7S75	< 0.71	6.32	3.31
10S75	0.79	7.67	2.93

Activity Levels - Water

<u>Sample</u>	<u>Alpha (pCi/L)</u>	<u>Beta (pCi/L)</u>	<u>Gamma (pCi/L)</u>	<u>H-3 (pCi/mL)</u>
4W75	< 0.73	< 3.26	< 200.41	< 3.76
6W75	< 0.73	3.46	< 200.41	< 3.76
10W75	< 0.73	9.29	618.29 <sup>2</sup>	< 3.76

Note 1: Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights. HPGE spectral analysis was performed on any sample with a gamma activity greater than Minimum Detectable Activity.

Note 2: HPGE spectral analysis indicates high gamma activity as a result of a known medical isotope (Tc-99m) not produced at MURR.

TABLE 2  
Summary of Environmental Set 76  
Fall 2009

Detection Limits<sup>1</sup>

<u>Matrix</u>	<u>Alpha</u>	<u>Beta</u>	<u>Gamma</u>	<u>Tritium</u>
Water	0.00 pCi/L	2.65 pCi/L	198.75 pCi/L	3.62 pCi/mL of sample
Soil	0.00 pCi/g	2.23 pCi/g	1.48 pCi/g	N/A
Vegetation	1.90 pCi/g	6.78 pCi/g	1.45 pCi/g	4.17 pCi/mL of distillate

TABLE 2 (Cont'd)  
 Summary of Environmental Set 76  
 Fall 2009

Activity Levels - Vegetation

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>	<u>H-3 (pCi/mL)</u>
1V76	< 1.90	9.74	< 1.45	< 4.17
2V76	< 1.90	11.37	< 1.45	< 4.17
3V76	< 1.90	7.94	< 1.45	< 4.17
4V76	< 1.90	12.14	< 1.45	< 4.17
5V76	< 1.90	< 6.78	< 1.45	< 4.17
6V76	< 1.90	8.02	< 1.45	< 4.17
7V76	< 1.90	10.13	< 1.45	< 4.17
10V76	< 1.90	18.33	< 1.45	< 4.17

Activity Levels - Soil

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>
1S76	0.71	12.48	9.47
2S76	0.56	6.50	9.50
3S76	0.94	8.63	5.85
4S76	0.89	8.80	10.36
5S76	0.44	13.34	8.54
6S76	0.75	10.99	11.69
7S76	0.63	12.04	10.93
10S76	0.63	12.44	11.63

Activity Levels - Water

<u>Sample</u>	<u>Alpha (pCi/L)</u>	<u>Beta (pCi/L)</u>	<u>Gamma (pCi/L)</u>	<u>H-3 (pCi/mL)</u>
4W76	0.62	< 2.65	< 198.75	< 3.62
6W76	0.00	3.58	< 198.75	< 3.62
10W76	0.00	4.07	< 198.75	< 3.62

Note 1: Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights. HPGE spectral analysis was performed on any sample with a gamma activity greater than Minimum Detectable Activity.

TABLE 3  
Environmental TLD Summary

January 1, 2009 through December 31, 2009

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2009 Net mR	2nd Qtr. 2009 Net mR	3rd Qtr. 2009 Net mR	4th Qtr. 2009 Net mR	Total 2009 Net mR
1	Control	N/A	0.0	2.2	0.0	0.0	2.2
2	Control	N/A	5.1	1.5	0.0	0.0	6.6
3	WSW	N/A	2.6	1.5	0.0	0.1	4.2
4*							
5*							
6	N	34	3.9	3.2	3.9	1.3	12.3
7	NE	57	3.6	6.4	0.1	5.9	16.0
8	SW	27	0.8	4.3	0.0	1.0	6.1
9	S	27	23.9	20.5	28.7	35.5	108.6
10	NE	149	0.8	0.0	0.0	0.0	0.8
11	NW	149	3.1	1.7	0.5	0.0	5.3
12	ENE	301	2.7	5.8	1.7	2.0	12.2
13	NNE	316	4.2	3.8	0.1	0.0	8.1
14	S	156	0.1	3.1	0.0	0.0	3.2
15	S	65	19.3	22.1	13.9	16.4	71.7
16	SE	107	0.0	0.0	0.0	0.0	0.0
17	E	293	0.0	0.0	0.0	0.0	0.0
18	NE	476	0.0	0.0	0.0	0.0	0.0
19	NNE	606	0.0	0.0	0.0	0.0	0.0
20	NE	907	0.0	0.0	0.0	0.0	0.0
21	SE	236	0.9	0.0	0.0	0.0	0.9
22	ESE	168	0.8	0.0	0.0	0.0	0.8
23	NW	110	0.3	1.1	0.7	1.4	3.5
24	SSW	328	1.9	0.0	0.0	0.0	0.0
25	SSW	480	3.7	0.7	0.0	0.0	4.4
26	SW	301	2.9	0.0	0.0	0.0	2.9
27	WSW	141	0.0	0.0	0.0	0.0	0.0
28	WNW	210	1.9	0.0	0.0	0.0	1.9
29	NW	255	3.2	0.9	0.0	0.0	4.1
30	NNW	328	0.0	0.0	0.0	0.0	0.0
31	NNW	671	2.9	0.8	0.0	0.0	3.7
32	NNW	724	no report	0.0	0.0	0.0	0.0
33	E	671	0.0	0.0	0.0	0.0	0.0
34	ENE	587	0.0	0.0	0.0	0.0	0.0
35	SSE	499	0.4	0.0	0.0	0.0	0.4
36	SE	419	1.7	0.0	0.0	0.0	1.7
37	NE	690	0.0	0.0	0.0	0.0	0.0
38	NW	556	2.1	1.1	0.0	0.0	3.2
39	W	491	0.0	0.0	0.0	0.0	0.0
40	N	514	0.0	0.0	0.0	0.0	0.0
41	NNE	137	0.6	0.0	0.0	0.0	0.6
42	In Building	N/A	8.0	8.7	8.9	8.6	34.2
43	In Building	N/A	3.2	1.0	0.0	0.0	4.2
44	Spare	N/A	2.4	1.2	0.1	0.6	4.3
45	S	65	3.6	0.0	0.0	0.0	3.6

\*These badge numbers are no longer used.

TABLE 4  
Number of Facility Radiation and Contamination Surveys

January 1, 2009 through December 31, 2009

	<u>Radiation</u>	<u>Surface Contamination*</u>	<u>Air Samples**</u>	<u>RWP's</u>
January	66	66	64	12
February	62	62	55	5
March	69	69	59	9
April	73	73	73	16
May	63	63	62	4
June	91	91	58	0
July	72	72	71	6
August	53	53	57	2
September	78	78	61	5
October	73	73	57	10
November	52	52	62	14
December	<u>78</u>	<u>78</u>	<u>60</u>	<u>4</u>
<b>TOTALS</b>	<b>830</b>	<b>830</b>	<b>739</b>	<b>87</b>

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

\*\* Air samples include exhaust stack Ar-41, containment building Ar-41, sump entries, and hot cell entries.

**Miscellaneous Notes**

Nathan Hogue was hired as a Health Physics Technician in May 2009.

Lee Juengermann was promoted from his position as a Health Physics Technician to the MURR Shipping Manager in November 2009.

During calendar year 2009, MURR shipped 785 cubic feet of low-level radioactive waste containing 5,692.1 mCi of activity.

**SECTION IX**

**SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF,  
EXPERIMENTERS AND VISITORS**

January 1, 2009 through December 31, 2009

**TOTAL PERSONNEL DOSE (MREM) BY DOSIMETRY GROUP**

<b>Month</b>	<b>AC</b>	<b>DO</b>	<b>FSO</b>	<b>HC/SH</b>	<b>RAG</b>	<b>IRR</b>	<b>NA</b>	<b>NS</b>	<b>OPS</b>	<b>PRO</b>	<b>RES</b>	<b>RP</b>	<b>SIL</b>	<b>Total</b>
January	68	12	146	322	251	2	9	29	1412	81	0	58	77	2467
February	91	11	80	354	145	12	12	25	962	83	0	81	67	1923
March	26	25	54	404	251	5	34	14	1333	117	34	88	45	2430
April	37	47	305	305	143	3	24	44	1070	55	9	123	19	2184
May	28	29	76	287	119	7	28	65	953	52	43	60	33	1780
June	32	28	185	215	154	0	34	78	1347	114	39	101	79	2406
July	32	8	116	289	228	9	47	44	1449	88	47	136	56	2549
August	69	37	76	351	173	14	68	31	1519	90	9	145	89	2671
September	68	12	43	303	216	12	6	92	1327	111	20	96	110	2416
October	71	6	182	343	410	11	16	49	1398	150	3	176	92	2907
November	22	28	64	320	157	14	71	24	1071	112	53	128	77	2141
December	8	13	37	349	164	10	15	12	1087	88	25	102	95	2005
<b>Total to Date</b>	<b>552</b>	<b>256</b>	<b>1364</b>	<b>3842</b>	<b>2411</b>	<b>99</b>	<b>364</b>	<b>507</b>	<b>14928</b>	<b>1141</b>	<b>282</b>	<b>1294</b>	<b>839</b>	<b>27879</b>
<b>Monthly Ave</b>	<b>46</b>	<b>21</b>	<b>114</b>	<b>320</b>	<b>201</b>	<b>8</b>	<b>30</b>	<b>42</b>	<b>1244</b>	<b>95</b>	<b>28</b>	<b>108</b>	<b>70</b>	<b>2323</b>
<b>Highest WB</b>	<b>173</b>	<b>42</b>	<b>339</b>	<b>887</b>	<b>772</b>	<b>68</b>	<b>89</b>	<b>128</b>	<b>870</b>	<b>379</b>	<b>45</b>	<b>210</b>	<b>413</b>	
<b>Highest EXT</b>	<b>2720</b>	<b>M</b>	<b>820</b>	<b>3290</b>	<b>810</b>	<b>M</b>	<b>1670</b>	<b>220</b>	<b>2930</b>	<b>5080</b>	<b>1280</b>	<b>1460</b>	<b>1450</b>	

**AC** - Analytical Chemistry  
**DO** - Director's Office  
**FSO** - Facility Support Organization  
**HC/SH** - Hot Cell/Shipping  
**RAG** - Regulatory Assurance Group

**IRR** - Irradiations  
**NA** - Nuclear Analysis  
**NS** - Neutron Scattering  
**OPS** - Operations  
**PRO** - Isotope Production

**RES** - Research  
**RP** - Radiopharmaceutical  
**SIL** - Silicon

**WB** = Whole Body      **EXT** = Extremities      **M** = Minimal

Dosimetry services are provided by R.S. Landauer Jr. & Company (except self-reading dosimetry).

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 radiation workers.

Note: Analytical Chemistry group was split into the Analytical Chemistry and Research groups.