UNIVERSITY *of* MISSOURI

RESEARCH REACTOR CENTER

February 25, 2011

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
2010 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, 2010 through December 31, 2010.

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) 882-5319 or FruitsJ@missouri.edu.

Sincerely,

John L. Fruits
Reactor Manager

LPF/djr

Enclosure

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

A020

1513 Research Park Drive Columbia, MO 65211 Phone: 573-882-4211 Fax: 573-882-6360 Web: www.murr.missouri.edu
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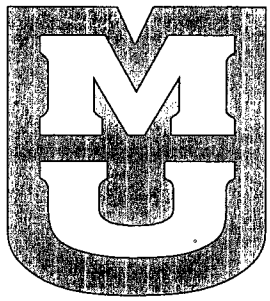

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2010 – December 31, 2010

UNIVERSITY OF MISSOURI
RESEARCH REACTOR FACILITY

REACTOR OPERATIONS
ANNUAL REPORT

January 1, 2010 through December 31, 2010

Compiled by the Research Reactor Staff of MURR

Submitted by: _____

John L. Fruits
Reactor Manager

Reviewed and approved by: _____

Ralph A. Butler, PE
Director

UNIVERSITY OF MISSOURI – COLUMBIA
RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2010 through December 31, 2010

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-operated research reactor in the United States.

The Reactor Operations Annual Report presents a summary of reactor operating experience for calendar year 2010. Included within this report are changes to MURR reactor operations and health physics 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 during this calendar year included (1) responding to the Request for Additional Information (RAI) regarding a License Amendment that was submitted to increase the flexibility and capacity in the center test hole, (2) assembling the design specifications for a new Cooling Tower that will support a power uprate to 12 MW for fuel conversion, and (3) characterizing an irradiation facility on Beamport 'E' in support of the Boron Neutron Capture Therapy project. Additionally, in August 2006 MURR submitted a request to the NRC to renew Amended Facility

Operating License R-103. Significant efforts have already been placed in responding to the Requests for Additional Information (RAI) and these efforts will continue in the upcoming year.

The facility continues to actively collaborate 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 and the individual who received his Senior Reactor Operator certification 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.

TABLE OF CONTENTS

SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2010 through December 31, 2010

The following table and discussion summarizes reactor operations during the period from January 1, 2010 through December 31, 2010.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled[1]
January	685.72	285.79	92.2	103.2
February	614.23	256.06	91.4	102.4
March	656.67	273.73	88.3	98.8
April	640.74	267.04	89.0	99.8
May	668.74	278.74	89.9	100.6
June	667.03	277.99	92.6	103.9
July	684.80	285.40	92.0	103.1
August	673.08	280.60	90.5	101.3
September	662.04	275.94	92.0	103.1
October	667.19	278.06	89.7	100.4
November	650.85	271.28	90.4	101.4
December	677.61	282.43	91.1	102.0
Total for the Year	**7948.70**	**3313.06**	**90.75 %**	**101.66 %**

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 2010

The reactor operated continuously in January 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: repairing the safety edge on inner airlock door 277.

February 2010

The reactor operated continuously in February with the following exceptions: four shutdowns for scheduled maintenance and/or refueling. There were no unscheduled/unplanned power reductions this month. One additional reactor startup was performed in support of U.S. Nuclear Regulatory Commission operator licensing examinations. U.S. Nuclear Regulatory Commission examiner arrived at facility to conduct operator licensing examinations. Received notification from the U.S. Nuclear Regulatory Commission that two new Reactor Operator licenses had been issued.

Major maintenance items for the month included: replacing the blade arm guard on the regulating blade offset mechanism; performing a zero and span procedure on reactor inlet temperature element TE-901A as part of the instrument calibration; replacing the motor on pool coolant demineralizer pump P-513B; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D)."

March 2010

The reactor operated continuously in March with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and two unscheduled/unplanned power reductions. U.S. Nuclear Regulatory Commission regional inspector arrived at the facility for a routine inspection of the Radiation Protection Program and Shipping.

On March 4, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was automatically initiated when an interruption in electric supply power from the University Power Plant to the facility occurred. All immediate and subsequent actions of reactor emergency procedure REP-11, "Momentary 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 was corrected. The reactor was refueled and subsequently restarted to 10 MW operation.

On March 9, with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 & 6 High Power Scram" was automatically initiated when Nuclear Instrumentation Power Range Channel No. 6 power level indication increased above the scram set point to full scale. The duty operator noted all other power level indications were normal - between 100 and 105%. All immediate and subsequent actions of reactor emergency procedure REP-5, "Nuclear Instrument Failure," were performed. Historically, after various periods of service, the cabling between detectors and amplifier assemblies have caused upward spiking due to radiation induced insulation damage or breakdown. The uncompensated ion chamber detector and cabling were replaced. An instrument channel calibration and pre-operational checks were performed satisfactorily. The system was response checked with a neutron source and permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

Major maintenance items for the month included: installing NEER Grant cobalt irradiation facility; collecting primary coolant system hydraulic data in support of the fuel conversion project; loading new de-ionization bed 'T' and placing it on primary coolant system service; replacing Nuclear Instrumentation Power Range Channel No. 6 uncompensated ion chamber detector and cabling; performing reactor test procedure "RTP-19 - Experimental Measurement of the MURR Primary Temperature Coefficient of Reactivity" in support of a Nuclear Engineering Department practicum; replacing reactor core differential pressure sensor DPS-929 alarm unit; completing re-alignment of annunciator alarm response switches; and completing the mechanical portion of Modification Record 09-04, "Cooling Tower Temporary Cooling."

April 2010

The reactor operated continuously in April with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and two unscheduled/unplanned power reductions. U.S. Nuclear Regulatory Commission inspectors arrived at the facility for an unannounced, non-routine inspection of Reactor Operations.

On April 5, during a reactor startup with the control blades at approximately 13-inches withdrawn (subcritical), a "Power Level Interlock" reactor scram was automatically initiated. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. The 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. It was postulated that the most likely cause was "Power Level Interlock" relay 1K26. Relay 1K26 was replaced and retested satisfactorily and permission to resume the reactor startup was obtained from the Reactor Manager.

On April 18, 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. Using various indications, the duty operator verified that no actual separation between the control rod drive mechanism electromagnets and the control blade anvils had occurred. A manual scram was subsequently initiated and all immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. Investigation of all relays and wiring associated with this portion of the rod run-in circuit revealed no abnormalities. It was postulated that "Rod Magnet Engaged and on Lower Limit" relays K49, K51, K53 and K55 were the most likely cause. The relays were replaced and retested satisfactorily and permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

Major maintenance items for the month included: replacing "Power Level Interlock" relay 1K26; adjusting the door closed/gasket inflate limit switch on containment building personnel entry Door 277; connecting an electrical outlet in the Shipping and Receiving Building to emergency power; replacing "Magnet Engaged and on Lower Limit" relays K49, K51, K53 and K55; completing the biennial change-out of Control Blade 'B' Offset Mechanism; completing the electrical portion of Modification Record 09-04, "Cooling Tower Temporary Cooling;" adjusting the door closed/gasket inflate limit switch on containment building personnel entry Door 277; performing the biannual cleaning of the cooling tower sump and basin; replacing the air seal gasket on containment building personnel entry Door 277; performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; and performing a back flush on the secondary coolant side of pool coolant system heat exchanger HX-521.

May 2010

The reactor operated continuously in May with the following exceptions: six 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 reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; burnishing Regulating Blade Automatic Control Circuit contacts on relays 1K8, 1K9, 1K10, 1K12, 2K20 and 2K21; completing compliance procedure CP-26, "Containment Building Compliance Test;" flooding Beamport 'C' with demineralized water; completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" 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 2010

The reactor operated continuously in June with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one unscheduled/unplanned power reduction.

On June 21, during a reactor startup with the control blades at approximately 6-inches withdrawn (subcritical), a "Rod Not in Contact with Magnet" rod run-in was automatically initiated when control blade 'B' anvil separated from its electro-magnet during a shimming evolution. The reactor was shutdown and the pull rod to housing alignment was checked and verified, and the anvil and magnet were cleaned. The control rod was satisfactorily withdrawn to the full out position as part of the retest using compliance procedure CP-10, "Rod Drop Times." Permission to restart the reactor was obtained from the Reactor Manager.

Major maintenance items for the month included: repairing the combination keypad for containment building personnel entry Door 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);" performing a zero and span procedure on primary coolant flow transmitter FT-912G as part of the instrument calibration; replacing the filter cartridges in pool coolant demineralizer system inlet filter housing F-200; replacing the reinforced element on pool coolant system pump P-508A pump/motor coupling; and installing sample rotator alarm system upgrade.

July 2010

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: performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor;" replacing the rotary micro-switch for the regulating blade $\leq$ 10% withdrawn rod run-in function; replacing the drive chain shock absorber on containment building personnel entry Door 276; 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; and replacing the coolant filter housing on the emergency diesel generator.

August 2010

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

Major maintenance items for the month included: repairing the air supply lines to primary coolant isolation valves 507A and 507B air actuators; installing instrumentation in order to acquire the operating times of the primary coolant isolation valves, the anti-siphon isolation valves and the in-pool heat exchanger automatic isolation valves to refine the MURR thermal-hydraulic RELAP model; loading new de-ionization bed 'F' and placing it on pool coolant system service; replacing the pressurizer surge line isolation valve 527C air actuator; replacing the wear ring on the six-tube center test hole canister; adjusting the door stop micro switch on containment building personnel entry Door 277; repairing control blade selector switch 1S3; 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);" and realigning the motor on primary coolant demineralizer pump P-513A.

September 2010

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

Major maintenance items for the month included: replacing contact cabling in controller for facility ventilation exhaust fan EF-13; replacing process instrumentation power supply 2PS5; 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\upgrading contact cabling in the controllers for facility ventilation exhaust fans EF-13 and EF-14; completing Modification Record 10-01, "Addition of Junction Box and Terminal Board for Control Rod Drive 'D' Drive Cable;" 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);" and installing modified PLC control program for containment building personnel airlock entry doors.

October 2010

The reactor operated continuously in October with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one unscheduled/unplanned power reduction.

On October 11, during a reactor startup with the control blades at approximately 13-inches withdrawn (subcritical), a "Channel 2 & 3 Short Period" rod run-in was automatically initiated when Intermediate Range Channel No. 3 period indication increased above the rod run-in set point. The duty operator noted all other power level and period indications were normal. All immediate and subsequent actions of reactor emergency procedure REP-5, "Nuclear Instrument Failure," were performed. Troubleshooting efforts lead to the replacement of the linear amplifier for Nuclear Instrumentation Signal Processor No. 2. An instrument channel calibration and pre-operational checks were performed satisfactorily. Permission to restart the reactor was obtained from the Reactor Manager.

Major maintenance items for the month included: replacing the pneumatic actuator on in-pool heat exchanger automatic isolation valve 546B; 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; completing the biennial change out of Control Blade 'D' Offset Mechanism; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D)."

November 2010

The reactor operated continuously in November 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. U.S. Nuclear Regulatory Commission regional inspector

arrived at the facility for a routine inspection of Reactor Operations and Emergency Preparedness. U.S. Nuclear Regulatory Commission examiner arrived at the facility to conduct operator licensing examinations.

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; 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);" realigning pool coolant demineralizer system pump P-513B; replacing pressurizer isolation valve V527C air actuator and valve diaphragm; rebuilding hot exhaust line ventilation valve 16B air control solenoid valves A-150, A-151, and A-153; completing Modification Record 01-09, Addendum 2, "Emergency Electrical System in North Office Addition;" and installing the monochromator on Beamport "C."

December 2010

The reactor operated continuously in December with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, three scheduled shutdowns for physics measurements, and two unscheduled/unplanned power reductions. Received notification from the U.S. Nuclear Regulatory Commission that one new Senior Reactor Operator license and one new Reactor Operator license had been issued.

On December 13, during a reactor startup with the shim blades at approximately 15-inches withdrawn (subcritical), an unannounced (no audible or visual alarm occurred) rod run-in was initiated as the duty operator noted all four shim blades moving inward. Investigation of all relays, switches and wiring associated with the rod run-in system revealed no abnormalities. It was postulated that the most likely cause was either the rod run-in system Non-Coincidence Logic Unit or the Trip Actuator Amplifier. The Non-Coincidence Logic Unit and the Trip Actuator Amplifier were replaced and operational checks of the rod run-in system were performed satisfactorily. 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.

On December 15, with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 & 6 High Power Scram" was automatically initiated when Nuclear Instrumentation Power Range Channel No. 6 power level indication increased above the scram set point to full scale. The duty operator noted all other power level indications were normal - between 100 and 105%. All immediate and subsequent actions of reactor emergency procedure REP-5, "Nuclear Instrument Failure," were performed. Troubleshooting efforts discovered a damaged pin connector on the low voltage regulator for Nuclear Instrumentation Power Range Channel No. 6. The voltage regulator was replaced and instrument channel calibration and pre-operational checks were performed satisfactorily. The reactor was refueled and subsequently restarted to 10 MW operation with permission from the Reactor Manager.

Major maintenance items for the month included: draining and back-flushing Beamport 'C' with helium; performing three 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);" realigning offset mechanism guide tube for shim control blade 'D;' performing special maintenance procedure SM-RO-625, "Measuring Control Blade Pull Weight and Blade Drop Time with the Test Magnet Assembly, RTP-21;" replacing the trip actuator amplifier and non-coincidence logic unit for the rod run-in system; replacing the low voltage regulator for Nuclear Instrumentation Power Range Channel No. 6; performing a back flush on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B; and performing a back flush on the secondary coolant side of pool coolant system heat exchanger HX-521.

SECTION II

MURR PROCEDURES

January 1, 2010 through December 31, 2010

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 fifty-five (55) revisions issued to the reactor operations procedures, forms and operator aids. Additionally, five (5) new procedures 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-115	Modification Records	6	7/1/10	Minor Editorial
AP-RR-003	10 CFR 50.59 Evaluations	6	12/7/10	Minor Editorial
AP-RR-003	10 CFR 50.59 Evaluations	5	4/26/10	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	14	12/1/10	Cover Page
EX-RO-120	Beamport "A" Operation	8	9/27/10	Minor Editorial
EX-RO-121	Beamport "B" Operation	8	9/27/10	Minor Editorial
EX-RO-122	Beamport "C" Operation	8	9/27/10	Minor Editorial
EX-RO-123	Beamport "D" Operation	8	9/27/10	Minor Editorial
EX-RO-124	Beamport "E" Operation	9	9/27/10	Minor Editorial
EX-RO-125	Beamport "F" Operation	10	9/27/10	Minor Editorial
EX-RO-126	Thermal Column Door	6	12/1/10	Cover Page
FB-SH-125	Biennial Inspection and Preventive Maintenance BMI-1 Shipping Cask	0	3/18/10	Full Review
FB-SH-130	Test and Calibration Procedure BMI-1 Shipping Cask	0	3/18/10	Full Review
FM-11	Reactor Shutdown Checksheet	4	2/16/10	Minor Editorial
FM-56	Reactor Routine Patrol	13	3/17/10	Minor Editorial
FM-57	Long Form Startup Checksheet	16	12/1/10	Minor Editorial
FM-58	Short Form Startup Checksheet	8	12/1/10	Minor Editorial
FM-66	Customer Sample Pre-Encapsulation Evaluation Worksheet	5	7/7/10	Minor Editorial
FM-68	Target Material Control Checksheet	8	9/7/10	Minor Editorial
GS-RA-100	MURR Equipment Tag Out	9	7/28/10	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
IRR-PSO-106	Target Material Control Checks	7	2/19/10	Minor Editorial
IRR-PSO-111	Customer Sample Pre-Encapsulation Evaluation	5	7/7/10	Minor Editorial
OP-RO-210	Reactor Startup-Normal	9	3/17/10	Minor Editorial
OP-RO-210	Reactor Startup-Normal	10	7/15/10	Minor Editorial
OP-RO-211	Reactor Startup - Hot	8	8/20/10	Minor Editorial
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	8	12/1/10	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	13	9/27/10	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	7	7/1/10	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	8	7/1/10	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	10	7/1/10	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	7	7/1/10	Minor Editorial
OP-RO-460	Pool Coolant System - Two Pump Operation	12	8/20/10	Minor Editorial
OP-RO-461	Pool Coolant System - One Pump Operation	10	8/20/10	Minor Editorial
OP-RO-466	Pool Level Control - Pool Coolant System	9	7/1/10	Minor Editorial
OP-RO-480	Secondary Coolant System	13	1/13/10	Minor Editorial
OP-RO-516	Valve Operation Air System	7	9/27/10	Minor Editorial
OP-RO-525	Chill Water System	3	7/1/10	Minor Editorial
OP-RO-530	Demineralized Water Supply System	10	9/27/10	Minor Editorial
OP-RO-532	Drain Collection System	7	7/28/10	Minor Editorial
OP-RO-555	Fire Protection System	8	12/30/10	Minor Editorial
OP-RO-730	Facility Exhaust System	12	7/1/10	Minor Editorial
OP-RO-741	Waste Tank System Operation	10	7/1/10	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	11	1/15/10	Minor Editorial
RM-RO-405	Reactor Demineralizer System	11	9/27/10	Minor Editorial
RP-RO-300	Receipt, Inspection and Accounting of Unirradiated Fuel	1	4/13/10	Full Review
SM-RO-200	Manual Operation of Airlock Doors 276 and 277	0	8/3/10	Full Review
SM-RO-300	Control Console And Instrument Panel-Securing Power	8	9/3/10	Minor Editorial
SM-RO-625	Measuring Control Blade Pull Weight and Blade Drop Time with the Test Magnet Assembly, RTP-21	0	8/20/10	Full Review
SM-RO-635	Retracting and Reinserting Beamport 'A' Liner	3	11/9/10	Minor Editorial
SM-RO-636	Retracting and Reinserting Beamport 'B' Liner	3	11/9/10	Minor Editorial
SM-RO-637	Retracting and Reinserting Beamport 'C' Liner	3	11/9/10	Minor Editorial
SM-RO-638	Retracting and Reinserting Beamport 'D' Liner	4	11/9/10	Minor Editorial
SM-RO-639	Retracting and Reinserting Beamport 'E' Liner	3	12/20/05	Minor Editorial
SM-RO-650	Cleaning the Acid Day Tank Sight Glass	0	2/16/10	Full Review
SM-RO-660	Replacement of Inner and Outer Pressure Vessels	2	4/2/10	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 eleven (11) 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-003	Emergency Preparedness Training	3	5/3/10	Minor Editorial
EP-RO-004	Fire	4	5/3/10	Minor Editorial
EP-RO-007	Severe Natural Phenomenon	3	5/3/10	Minor Editorial
EP-RO-014	EPZ and Site Area Evacuations	6	5/3/10	Minor Editorial
EP-RO-015	Emergency Notifications	5	5/3/10	Minor Editorial
EP-RO-017	Emergency Air Sampling	5	5/3/10	Minor Editorial
FM-104	Emergency Call List	13	2/18/10	Minor Editorial
FM-104	Emergency Call List	14	6/11/10	Minor Editorial
FM-104	Emergency Call List	15	12/21/10	Minor Editorial
OA-10	Fire Extinguisher Locations and Types	5	5/3/10	Minor Editorial
OA-20	Emergency Equipment	8	2/18/10	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 seventy-seven (77) revisions issued to the health physics, radioactive materials shipping, and preparation for shipping procedures and forms. Additionally, one (1) new form and four (4) new procedures were issued, and two (2) 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	10	11/23/2010	Cover Page
AP-HP-120	Beamport Area	5	11/23/2010	Cover Page
AP-HP-121	Isotope Closet	5	12/30/2010	Minor Editorial
AP-HP-123	Visitor Dosimetry - Reception Desk	7	2/4/2010	Cover Page
AP-HP-125	Review of Unplanned Radiation Exposure	3	11/23/2010	Cover Page
BPB-SH-002	20WC-1 Packaging and Shipment of Type B Non-Waste Radioactive Material	9	2/3/2010	Cover Page
BPB-SH-005	DOT 6M Packaging of Type B Non-Waste Radioactive Material	8	9/30/2010	Cover Page
BPB-SH-008	Type B(U) F-327 Series Packaging of Type B Non-Waste Radioactive Material	7	9/30/2010	Obsolete

Number	Name	Rev.	Revision Date	Notes
BP-SH-016	Packaging and Shipment of Radioactive Material using USA DOT 7 A Model H or I Package	1	11/16/2010	Cover Page
BPB-SH-020	Reciept Inspection of Type B Byproduct Material Shipping Containers	1	9/9/2010	Cover Page
BPB-SH-021	20 WC-1 All-Thread Rod Replacment	1	6/3/2010	Cover Page
BPB-SH-022	Painting USA DOT 20 WC-1 Overpack	1	6/3/2010	Cover Page
BPB-SH-023	Torque Wrench Calibration	1	6/3/2010	Cover Page
BPB-SH-024	Type B(U) F-458 Series Packaging of Type B Non-Waste Radioactive Material	0	9/9/2010	Full Review
BPB-SH-025	Type B(U) ZA/NNR1005 (Beatrice) Packaging of Type B Non-Waste Radioactive Material	0	9/9/2010	Full Review
BP-SH-007	F-327 Packaging and Shipment of Type A Non-Waste Radioactive Material	6	7/14/2010	Cover Page
BP-SH-007	F-327 Packaging and Shipment of Type A Radioactive Material	7	9/9/2010	Minor Editorial
BP-SH-010	Packaging and Shipment of Non-Waste Radioactive Materials in Excepted Packages	3	2/3/2010	Minor Editorial
BP-SH-011	Shipment of Non-Waste USA DOT 7A Type A 55-Gallon Radioactive Material Package	4	2/3/2010	Minor Editorial
BP-SH-012	DOT-7A Package Certification	4	11/16/2010	Cover Page
BP-SH-013	Packaging and Shipment of Radioactive Materials Using MURR Reusable Type A Package	4	11/16/2010	Cover Page
BP-SH-014	Packaging and Shipment of Radioactive Material Using an Overpack	3	11/16/2010	Cover Page
BP-SH-015	Packaging and Shipment of Radioactive Material using a USA DOT 7A Model 30	1	6/3/2010	Cover Page
BP-SH-015	Packaging and Shipment of Radioactive Material using a USA DOT 7A Model 30	2	9/9/2010	Minor Editorial
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	6	7/26/2010	Cover Page
BP-SH-059	Packaging and Shipment of Radioactive Material Using Spectratek Services Reusable DOT 7A Type A Package	2	2/3/2010	Minor Editorial
BP-SH-099	Packaging of Radioactive Material Using MURR Model 1500	2	2/3/2010	Minor Editorial
BP-SH-302	Packaging and Shipment of Radioactive Material Using MURR Models 6 and 12	3	2/3/2010	Cover Page
FM-17	Radiation Work Permit	9	11/23/2010	Cover Page
FM-27	In-House Radioactive Shipping Request Form	8	3/18/2010	Cover Page
FM-29	Dosimetry Request Packet	7	4/13/2010	Minor Editorial
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	13	8/27/2010	Cover Page
FM-39	Control Checksheet for Excepted Package Radioactive Materials Shipment	10	8/27/2010	Cover Page
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	7	7/26/2010	Cover Page
FM-53	Radioactive Material Licensing and Project Designation Change Request	4	2/4/2010	Cover Page

Number	Name	Rev.	Revision Date	Notes
FM-59	Control Checksheet for Spectratek Services Reusable Type A Package Radioactive Materials Shipment	3	4/30/2010	Minor Editorial
FM-59	Control Checksheet for Spectratek Services Reusable Type A Package Radioactive Materials Shipment	4	11/16/2010	Minor Editorial
FM-60	Control Check Sheet for MURR Shipment Using USA DOT 7A Model 30	1	6/3/2010	Cover Page
FM-69	Control Checksheet for MURR Reusable Type A Radioactive Materials Shipment	6	6/3/2010	Minor Editorial
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	12	9/30/2010	Cover Page
FM-75	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	11	9/30/2010	Obsolete
FM-89	Control Checksheet for Type A F-327 Series Radioactive Material Shipment	8	7/14/2010	Cover Page
FM-91	Declaration of Pregnancy	3	3/23/2010	Cover Page
FM-94	Exclusive Use Shipment Controls	2	4/12/2010	Cover Page
FM-98	Control Checksheet for MURR Shipment Using USA DOT 7A MURR Model 6 or 12	5	8/27/2010	Cover Page
FM-99	Control Checksheet for USA DOT 7A MURR Model 1500 Series	5	11/16/2010	Minor Editorial
FM-120	Individual Type B QA Training Certification	2	2/3/2010	Minor Editorial
FM-126	Documentation of Compliance for DOT-7A Shipping Container	1	4/30/2010	Minor Editorial
FM-128	Control Check Sheet For MURR Shipment Using USA DOT 7A MURR Model H or I	1	8/27/2010	Cover Page
FM-129	Control Checksheet for Receipt Inspection of Type B Byproduct Material Shipping Containers	1	6/3/2010	Cover Page
FM-135	Control Checksheet for Type B(U) ZA/NNR1005 (Beatrice) Radioactive Materials Shipment	0	9/9/2010	Full Review
FM-150	Statement of Training and Experience	2	2/15/2010	Minor Editorial
FM-154	Control Cheksheet for USA DOT 20 WC-1 Overpack Rod Replacment	1	6/3/2010	Cover Page
FM-155	Quality Assurance Control Checksheet Exterior Painting of USA DOT WC-1, Type B Overpack	1	6/3/2010	Cover Page
FM-157	Control Checksheet for Type B(U) F-458 Series Radioactive Materials Shipment	0	9/9/2010	Full Review
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	9	3/31/2010	Minor Editorial
HC-PSO-003	Glove Box Preparation of Radioactive Material for Shipment	8	3/24/2010	Minor Editorial
HC-PSO-005	Hot Cell Loading of Host Cans	7	3/24/2010	Minor Editorial
IC-HP-305	Calibration - Electrostatic Discharge Dosimeter	6	3/23/2010	Minor Editorial
IC-HP-341	Calibration - High Resolution Gamma Spectroscopy Systems	5	3/23/2010	Cover Page
IC-HP-349	Calibration - Lab Impex Stack Monitor-Particulate Channel	1	7/8/2010	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
IRR-PSO-112	Preparing Shipping Paperwork	4	11/9/2010	Minor Editorial
OP-HP-220	Tritium Bioassay	6	11/23/2010	Cover Page
OP-HP-223	Spent Fuel Shipping Cask Water Sample Analysis	4	12/30/2010	Cover Page
OP-HP-300	Receipt of Radioactive Material	7	2/4/2010	Minor Editorial
OP-HP-306	Daily Facility Checks	3	9/30/2010	Minor Editorial
OP-HP-353	Waste Tank Sample - Analysis	6	11/24/2010	Cover Page
OP-HP-356	Operation - Lab Impex Stack Monitor - Filter Change and Source Checks	0	7/8/2010	Full Review
OP-HP-400	Gemstone Shipping Barrel Analysis	7	1/14/2010	Minor Editorial
OP-HP-420	Decontamination of Enclosed Processing Units	3	2/4/2010	Minor Editorial
OP-HP-505	Emergency Stack Monitor Filter Analysis	4	6/9/2010	Minor Editorial
QAB-SH-005	Type B QA Personnel Training	1	6/3/2010	Minor Editorial
RM-HP-102	Stack Monitor Preventative Maintenance - Lab Impex	0	11/24/2010	Full Review
RP-HP-130	Receipt of New Fuel Elements	6	7/8/2010	Minor Editorial
RP-HP-135	Room 114 Entry - Self Monitored	5	11/23/2010	Cover Page
RP-HP-137	Handling Radioactive Material in the Reactor Pool	9	7/8/2010	Minor Editorial
RP-HP-137	Handling Radioactive Material in the Reactor Pool	10	11/23/2010	Cover Page
RP-HP-139	Beamport Radiation Level Monitoring During Reactor Startup	3	11/23/2010	Cover Page
SV-HP-119	Property Release	4	6/9/2010	Cover Page
SV-HP-121	Building Exhaust Stack Effluent - Ar-41 Monitoring	4	4/21/2010	Minor Editorial
SV-HP-130	Emergency Air Sampling of Exhaust Plume	5	11/24/2010	Cover Page
TSP-02	Transportation Security Plan	4	8/6/2010	Full Review
WM-SH-105	Radioactive Waste Processing	6	11/16/2010	Cover Page
WM-SH-300	Exclusive Use Shipment of LSA or SCO Radioactive Waste	8	7/26/2010	Minor Editorial

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2010 through December 31, 2010

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, Figure 5.1, Piping & Instrument Diagram (as revised by the 1972-73, 1973-74, 1994, 1996, 2001, 2002, 2003, 2004, 2006, 2007 and 2009 Reactor Operations Annual Reports)**:**

Replace with: Updated Figure 5.1, Piping & Instrument Diagram (MURR Dwg No. 156, Sheet 1 of 1, dated 12/15/10)

Original HSR, Section 7.1.4, paragraph 2, sentence 2, page 7-3 (as revised by the 1972-73, 1989-90, 2002, 2004 and 2009 Reactor Operations Annual Reports)**:**

Delete: The word "50%"

Replace with: "40%"

Original HSR, Section 7.1.4, paragraph 3, page 7-4 (as revised by the 1972-73, 1989-90, 2002, 2004 and 2009 Reactor Operations Annual Reports)**:**

Add:
"(17) North Office Addition Stack Monitor"
"(18) North Office Addition Fire Protection Panel"
"(19) Cyclotron Control, Processing, and Pharmacy"

ADDENDUM 1 - HAZARDS SUMMARY REPORT (FEBRUARY 1966)

HSR, Addendum 1, Section 3.8, paragraph 4, page 24, (as revised by the 1989-90, 2002 and 2004 Reactor Operations Annual Reports):

Add: "6) North Office Addition Emergency Lighting Panel (NOA ELP), which feeds through a transformer and 120/208 volt distribution panel, supplies NOA systems including facility access and security, fire protection, computer servers, NOA stack monitor, and Cyclotron control, processing and pharmacy."

HSR, Addendum 1, Figure 3.22.2, page 104, Ventilation Air Flow Diagram for the East Tower (as revised by 1995 and 2004 Reactor Operations Annual Reports)**:**

Replace with: Updated Figure 3.22.2, MURR Supply Air Schematic (MURR Dwg No. 1125, Sheet 2 of 4, dated 12/16/09)

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

HSR, Addendum 3, Figure 2.3.a, page 23a, Electrical Distribution (as revised by the 1989-90, 1990-91, 1995, 2001, 2002, 2003, 2004, 2005, 2006, 2007 and 2009 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.a, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 5/11/10)

HSR, Addendum 3, Figure 2.3.b, page 23b, Electrical Distribution (as added by the 1995 and revised by the 2001, 2002, 2003, 2004, 2005, 2007 and 2009 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 3/25/10)

HSR, Addendum 3, Figure 2.3.c, page 23c, Electrical Distribution (as added by the 2004 and revised by the 2005, 2007 and 2009 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 5/11/10)

HSR, Addendum 3, Figure 2.3.d, page 23d, Electrical Distribution (as added by the 2007 and revised by the 2008 and 2009 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, 3/25/10)

HSR, Addendum 3, Figure 2.3.e, page 23e, Electrical Distribution (as added by the 2007 and revised by the 2009 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 3/25/10)

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

HSR, Addendum 4, Figure A.11, page A-38, Schematic Diagram of Laboratory and Containment Building Ventilation Systems (as revised by the 1995, 2002, 2005 and 2009 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 1/13/10)

ADDENDUM 5 - HAZARDS SUMMARY REPORT (JANUARY 1974)

HSR, Addendum 5, Section 2.2, paragraph 7, page 5 (as revised by the 1989-90 and 2004 Reactor Operations Annual Reports):

Add: "(5) One circuit services a distribution panel, which feeds through a transformer and 120/208 volt distribution panel, to supply North Office Addition systems including facility access and security, fire protection, computer servers, NOA stack monitor, and Cyclotron control, processing and pharmacy."

HSR, Addendum 5, Section 2.4.1, page 12 (as revised by the 1989-90, 2002, 2004 and 2009 Reactor Operations Annual Reports):

Add: "(17) North Office Addition Emergency Lighting Panel (NOA ELP)

Normal supply power would be lost to the affected NOA electrical loads. However, there are no electrical loads in NOA that are required to accomplish a safe shut down of the reactor or to maintain a safe shutdown condition."

HSR, Addendum 5, Figure 2.1, page 15, Electrical Distribution (as revised by the 1989-90, 2001, 2002, 2003, 2004, 2005, 2006, 2007 and 2009 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.1, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 5/11/10)

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

January 1, 2010 through December 31, 2010

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 01-9, Addendum 2:

Emergency Electrical System in North Office Addition

This addendum to modification record 01-9, "Installation of Emergency Lighting Panel No. 1," documents the extension of the Emergency Electrical Power System to the North Office Addition (NOA). This system extension provides 120/208 VAC electrical power to key NOA systems such as facility access and security, fire protection, computing servers, stack monitor, and Cyclotron processing and pharmacy.

Modification 10-1:

Addition of Junction Box and Terminal Board for Control Rod Drive 'D' Drive Cable

This modification record documents the addition of a junction box and terminal board to the drive cable for control rod 'D' drive mechanism. The more frequent handling of control rod 'D' drive mechanism drive cable increases the likelihood of damage to the cable. Previous efforts at providing strain relief at significant flexure points have been less effective than desired. This modification record documents the addition of a junction box and terminal board near the drive mechanism. This addition reduces the magnitude of flexure and should extend the service life of the drive cable. The addition has the added advantage that when drive cable replacement is necessary; this work can be accomplished with a much shorter length of cable and can be performed entirely from the upper bridge.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2010 through December 31, 2010

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

RUR 118, as amended: Molybdenum

Description: This RUR authorizes an increase in the allowable mass of molybdenum metal, natural or enriched, based on the encapsulation style and heat load restrictions, for research and development activities.

RUR 243, as amended: Graphite

Description: This RUR authorizes the long term irradiation of natural graphite in support of research and development activities.

RUR 416, as amended: Iridium

Description: This RUR authorizes an increase in the enrichment and mass of iridium, based on the encapsulation style and heat load restrictions, in support of research and development activities.

RUR 435: Molybdenum Trioxide (Molybdenum Oxide)

Description: This RUR authorizes the irradiation of up to 270.0 grams of natural or enriched molybdenum trioxide in support of research and development activities.

RUR 436: Hydroxyapatite

Description: This RUR authorizes the irradiation of up to 1.0 g of hydroxyapatite in support of research and development activities.

Thermal Neutron Beam-Line for Neutron Capture Therapy on Beam Port E

Description: Test irradiations using the newly commissioned neutron irradiation facility designed for the development of neutron capture therapy (NCT) agents were conducted by the MU researchers during 2010. Neutron and gamma flux and dose measurements, as well as various other calibration and characterization measurements of the beam line, were completed earlier.

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.

SECTION VI

SPECIAL NUCLEAR MATERIAL AND REACTOR PHYSICS ACTIVITIES

January 1, 2010 through December 31, 2010

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-six (56) refueling evolutions were completed in 2010. Excess reactivity verifications were performed for each refueling. The largest measured excess reactivity value was 3.63%. MURR Technical Specification 3.1(f) requires excess reactivity to be less than 9.8%.

Reactivity Measurements:

Differential blade-worth measurements of three (3) 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.

Six (6) reactivity measurements were performed to determine the reactivity worth of all samples, including the sample holder, loaded in the flux trap region.

Three (3) reactivity measurements were performed to determine the reactivity worth of various sample cans irradiated in the flux trap 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, 2010 through December 31, 2010

TABLE 1
SANITARY SEWER EFFLUENT

January 1, 2010 through December 31, 2010

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

Nuclide	Activity (Ci)
H-3	7.374E-02
S-35	4.648E-03
Lu-177	4.615E-03
Co-60	1.494E-03
Ca-45	1.128E-03
P-32	7.943E-04
Lu-177m	6.512E-04
Zn-65	4.672E-04
Sc-46	1.607E-04
Cr-51	5.115E-05
Rb-86	3.950E-05
Ag-110m	3.202E-05
Mn-54	2.582E-05
Au-198	1.534E-05
Total H-3	7.374E-02
Total Other	1.412E-02

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

TABLE 2
STACK EFFLUENT

January 1, 2010 through December 31, 2010

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration (µCi/ml)	Total Release (Ci)	TS Limit Multiplier	% TS
Ar-41	2.03E-06	1.03E+03	350	58.0857
C-14	1.74E-11	8.79E-03	1	0.5800
I-131	8.29E-14	4.20E-05	1	0.0415
H-3	1.23E-08	6.25E+00	350	0.0353
Os-191	5.88E-13	2.97E-04	1	0.0294
Co-60	4.18E-15	2.12E-06	1	0.0084
S-35	1.65E-14	8.33E-06	1	0.0005
Cs-137	8.84E-16	4.48E-07	1	0.0004
Ba-140	3.38E-15	1.71E-06	1	0.0002
Co-58	1.10E-15	5.57E-07	1	0.0001
Hf-175	1.01E-15	5.12E-07	1	0.0001
Ru-103	7.35E-16	3.72E-07	1	0.0001
I-133	2.74E-13	1.39E-04	350	0.0001
As-77	1.91E-12	9.68E-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% Technical Specification limit are not listed.

Stack Flow Rate = ~34,000 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, 2010 through December 31, 2010

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 2010. All doses are approximately 17 mRem/year or less, except monitor numbers 9, 15 and 46. These monitors are located near loading dock areas 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 is provided in Table 4.

TABLE 1

Summary of Environmental Set 77

Spring 2010

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.00 pCi/L	3.21 pCi/L	204.97 pCi/L	4.95 pCi/mL of sample
Soil	0.00 pCi/g	1.85 pCi/g	0.51 pCi/g	N/A
Vegetation	1.98 pCi/g	7.75 pCi/g	1.40 pCi/g	4.17 pCi/mL of distillate

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V77	< 1.98	17.75	< 1.40	< 4.17
2V77	< 1.98	15.43	< 1.40	< 4.17
3V77	< 1.98	8.73	< 1.40	< 4.17
4V77	< 1.98	17.32	< 1.40	< 4.17
5V77	< 1.98	15.31	< 1.40	< 4.17
6V77	< 1.98	17.83	< 1.40	< 4.17
7V77	< 1.98	24.12	< 1.40	< 4.17
10V77	< 1.98	21.17	1.44	< 4.17

TABLE 1 (Cont'd)

Summary of Environmental Set 77

Spring 2010

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S77	0.42	12.37	2.57
2S77	0.64	10.23	1.94
3S77	0.94	15.20	2.01
4S77	0.91	9.94	2.66
5S77	1.12	15.72	3.41
6S77	1.23	11.00	3.15
7S77	0.54	10.05	3.06
10S77	1.11	13.58	2.82

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W77	0.16	< 3.21	< 204.97	< 4.95
6W77	0.16	3.38	< 204.97	< 4.95
10W77	0.16	5.56	< 204.97	< 4.95

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 2

Summary of Environmental Set 78

Fall 2010

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.06 pCi/L	4.30 pCi/L	203.25 pCi/L	7.39 pCi/mL of sample
Soil	0.00 pCi/g	3.83 pCi/g	0.60 pCi/g	N/A
Vegetation	0.00 pCi/g	5.54 pCi/g	1.40 pCi/g	6.15 pCi/mL of distillate

TABLE 2 (Cont'd)

Summary of Environmental Set 78

Fall 2010

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V78	0.00	12.74	< 1.40	< 6.15
2V78	0.30	12.22	< 1.40	< 6.15
3V78	0.61	10.08	2.25	< 6.15
4V78	0.31	18.94	< 1.40	< 6.15
5V78	0.00	25.47	4.68	< 6.15
6V78	0.32	15.61	< 1.40	28.09
7V78	0.00	23.17	< 1.40	< 6.15
10V78	0.93	23.37	< 1.40	< 6.15

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S78	0.61	17.26	1.63
2S78	0.78	7.73	2.53
3S78	0.64	8.30	2.91
4S78	2.26	8.22	3.16
5S78	1.39	13.40	3.25
6S78	0.30	13.87	2.54
7S78	1.70	7.55	2.92
10S78	0.60	13.97	2.26

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W78	< 1.06	< 4.30	< 203.25	< 7.39
6W78	< 1.06	< 4.30	< 203.25	< 7.39
10W78	< 1.06	6.49	< 203.25	< 7.39

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, 2010 through December 31, 2010

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2010 Net mR	2nd Qtr. 2010 Net mR	3rd Qtr. 2010 Net mR	4th Qtr. 2010 Net mR	Total 2010 Net mR
1	Control	N/A	2.5	0.0	0.8	4.9	8.2
2	Control	N/A	0.5	0.6	0.0	4.8	5.9
3	WSW	N/A	0.0	0.0	0.0	1.6	1.6
4*							
5*							
6	N	34	0.0	4.5	2.4	8.5	15.4
7	NE	57	5.5	2.5	0.1	4.5	12.6
8	SW	27	0.0	5.7	1.2	7.4	14.3
9	S	27	21.8	24.3	29.2	34.2	109.5
10	NE	149	0.0	0.0	0.0	2.0	2.0
11	NW	149	0.0	3.1	2.6	5.0	10.7
12	ENE	301	4.6	4.8	1.4	6.8	17.6
13	NNE	316	0.0	0.0	4.3	3.7	8.0
14	S	156	0.8	0.0	0.0	6.6	7.4
15	S	65	15.9	21.8	16.0	21.5	75.2
16	SE	107	0.0	0.0	0.0	4.2	4.2
17	E	293	0.0	0.0	0.0	1.1	1.1
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	1.2	0.0	0.0	3.4	4.6
22	ESE	168	0.0	0.0	0.0	0.0	0.0
23	NW	110	3.4	0.0	2.8	4.3	10.5
24	SSW	328	0.0	0.0	0.0	10.2	0.0
25	SSW	480	0.5	0.4	1.1	2.8	4.8
26	SW	301	0.0	0.7	0.0	2.1	2.8
27	WSW	141	0.0	0.0	0.0	0.0	0.0
28	WNW	210	0.0	2.0	0.0	3.6	5.6
29	NW	255	0.0	0.3	0.0	3.7	4.0
30	NNW	328	0.0	absent	0.0	2.0	2.0
31	NNW	671	0.0	2.5	0.4	4.8	7.7
32	NNW	724	0.0	0.0	1.3	3.2	4.5
33	E	671	0.0	0.0	0.0	0.0	0.0
34	ENE	587	0.0	absent	0.0	0.0	0.0
35	SSE	499	0.0	0.0	0.0	0.7	0.7
36	SE	419	0.0	0.0	0.0	0.0	0.0
37	NE	690	0.0	0.2	0.0	2.0	2.2
38	NW	556	0.2	2.0	0.0	4.4	6.6
39	W	491	0.0	0.0	0.0	1.8	1.8
40	N	514	0.0	0.0	0.0	0.0	0.0
41	NNE	137	0.0	0.0	0.0	0.0	0.0
42*							
43*							
44	Spare	N/A	1.7	0.9	0.3	6.2	9.1
45	S	65	0.0	0.0	0.0	4.2	4.2
46	E	70	New	New	10	10.2	20.2

*These badge numbers are no longer used.

TABLE 4
Number of Facility Radiation and Contamination Surveys

January 1, 2010 through December 31, 2010

	Radiation	Surface Contamination*	Air Samples**	RWP's
January	66	66	44	5
February	47	47	19	5
March	98	98	49	10
April	54	54	39	8
May	63	63	42	6
June	91	91	33	4
July	58	58	35	4
August	72	72	21	5
September	64	64	34	3
October	86	86	54	5
November	59	59	50	10
December	57	57	52	7
TOTALS	**815**	**815**	**472**	**72**

* 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

Ed Werner transferred from the Shipping/Hot Cell Group to the Health Physics Group in September 2010 to serve as a Health Physics Technician.

During calendar year 2010, MURR shipped 670 cubic feet of low-level radioactive waste containing 1,156 mCi of activity.

SECTION IX

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

January 1, 2010 through December 31, 2010

TOTAL PERSONNEL DOSE (MREM) BY DOSIMETRY GROUP

Month	AC	DO	FSO	HC/SH	RAG	IRR	NA	NS	OPS	PRO	RES	RP	SIL	Total
January	25	11	48	303	136	12	6	18	1146	115	9	47	69	1945
February	12	7	80	268	191	5	14	21	870	114	7	78	53	1720
March	5	18	38	250	160	14	29	16	1329	203	22	58	97	2239
April	43	33	167	395	184	4	40	9	1271	105	14	107	56	2428
May	26	32	97	347	126	12	29	34	1080	113	36	98	89	2119
June	29	42	70	478	218	15	39	75	1519	182	83	55	103	2908
July	59	87	134	256	171	28	56	73	1194	164	101	124	133	2580
August	57	62	165	325	296	32	71	62	1223	110	111	138	96	2748
September	36	38	135	291	183	14	66	51	954	166	116	175	96	2321
October	26	76	150	300	179	13	36	63	1279	116	88	134	123	2583
November	27	59	100	318	194	11	39	55	1171	155	99	116	104	2448
December	11	7	37	366	302	8	41	32	1487	147	30	120	118	2706
Total to Date	**356**	**472**	**1221**	**3897**	**2340**	**168**	**466**	**509**	**14523**	**1690**	**716**	**1250**	**1137**	**28745**
Monthly Ave	**30**	**39**	**102**	**325**	**195**	**14**	**39**	**42**	**1210**	**141**	**60**	**104**	**95**	**2395**
Highest WB	**101**	**32**	**312**	**1373**	**973**	**67**	**68**	**104**	**794**	**476**	**115**	**268**	**492**	
Highest EXT	**2440**	**30**	**1650**	**4300**	**1270**	**M**	**2400**	**140**	**1110**	**4890**	**320**	**2260**	**1360**	

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.