Research Reactor Center
University of Missouri-Columbia

1513 Research Park Drive
Columbia, MO 65211

PHONE (573) 882-4211
FAX (573) 882-6360
WEBSITE http://web.missouri.edu/~murrwww

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

SUBJECT: University of Missouri Research Reactor
2008 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, 2008 through December 31, 2008.

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.

Sincerely,

Les P. Foyto
Reactor Manager

Enclosure

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

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NRR

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2008 – December 31, 2008

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2008 through December 31, 2008

Compiled by the Research Reactor Staff of MURR

Submitted by: _____

Leslie P. Foyto
Reactor Manager

Reviewed and Approved by: _____

Ralph A. Butler, PE
Director

UNIVERSITY OF MISSOURI – COLUMBIA
RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2008 through December 31, 2008

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 2008. 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 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 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, (3) installing a prototype flux trap switch device which senses the position of the center test hole canister, (4) replacing the two 7,000-gallon capacity demineralized water storage tanks, and (5) securing the next generation fresh and spent fuel shipping containers.

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 six individuals who received their Senior Reactor Operator and Reactor Operator certifications from the U.S. Nuclear Regulatory Commission. 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, 2008 through December 31, 2008

The following table and discussion summarize reactor operations during the period from January 1, 2008 through December 31, 2008.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled[1]
January	674.29	281.12	90.6	101.5
February	639.23	266.51	91.8	102.9
March	661.33	275.65	88.9	99.5
April	624.11	260.18	86.7	97.2
May	682.79	284.61	91.8	102.8
June	636.18	265.19	88.4	99.1
July	677.96	282.53	91.1	102.0
August	683.85	285.19	91.9	102.9
September	645.75	269.16	89.7	100.6
October	672.18	280.17	90.3	101.2
November	646.19	269.35	89.7	100.7
December	658.32	274.41	88.5	99.1
Total for the Year	**7902.18**	**3294.07**	**89.96 %**	**100.78 %**

[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 2008

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

On January 24, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was manually initiated when pressurizer water addition valve V527B "open" indication failed to energize during a routine primary coolant system make-up water addition sequence. Failure of the valve "open" indication prevented primary coolant charging pump P-533 to start as required. The immediate and subsequent actions of reactor emergency procedure REP-19, "Pressurizer Valves Fail to Operate," were performed. Investigation determined that the partial disc attached to the valve stem had rotated to a point which prevented actuation of the open indication limit switch. Following realignment and retightening, operability of the valve and the ability to add water to the primary coolant system was verified through the performance of a normal make-up water addition sequence. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

Failure of primary coolant charging pump P-533 to start during reactor operation resulted in a deviation from Technical Specification 3.10.b, which states, "*The reactor shall not be operated unless the reactor make-up water system is operable and connected to a source of at least 2,000 gallons of primary grade water.*" Licensee Event Report No. 08-01, providing a detailed description of this event and the corrective actions taken, was submitted to the U.S. Nuclear Regulatory Commission within the 30-day reporting requirement.

Major maintenance items for the month included: replacing pressurizer relief valve V537; refurbishing secondary coolant system automatic temperature control valve S-1 actuator; removing and then reinstalling Beamport 'E' vestibule box for modifications in support of the Boron Neutron Capture Therapy project; draining and back-flushing Beamport 'E' with helium; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" collecting pool coolant system single pump operational data; replacing the pneumatic tube system pre-filters; and completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor."

February 2008

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

Major maintenance items for the month included: installing and removing bismuth filter No. 1 in Beamport 'E' beamline; installing and removing bismuth filter No. 2 in Beamport 'E' beamline; installing bismuth filter No. 3 in Beamport 'E' beamline; performing three sets of filtered flux measurements on Beamport 'E' in support of the Boron Neutron Capture Therapy project; 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);" removing the lead-poly shield plate from Beamport 'E' beamline; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D);" and replacing the valve position indication disc on pressurizer water addition isolation valve V527B – this was a corrective action from Licensee Event Report No. 08-01.

March 2008

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

Major maintenance items for the month included: flooding Beamport 'E' with demineralized water; installing a silicon filter in Beamport 'E' collimator; draining and back-flushing Beamport 'E' with helium; removing bismuth filter No. 3 from Beamport 'E' beamline; installing bismuth filter No. 2 in Beamport 'E' beamline; replacing primary coolant system loop 'A' flow recorder; changing lead assignments on primary coolant flow bypass switch 2S41 contacts 2 and 6; completing Modification Record 75-1, Addendum 2, "Addition of Jumpers to Electronic Circuit Jumper Panel;" replacing pressurizer relief valve V537; completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" transferring primary de-ionization bed 'W' to pool coolant system service; loading new de-ionization bed 'G' and placing it on primary coolant system service; and replacing cooling tower fan CTF-3 motor.

April 2008

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 five 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 April 7, during a reactor startup with the control blades at approximately 17-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.

On April 12, with the reactor operating at 10 MW in the automatic control mode, a "Reactor Loop Low Pressure" reactor scram was automatically initiated when primary coolant system pressure decreased below the reactor safety system low pressure set point of 63 psig. The immediate and subsequent actions of reactor emergency procedure REP-3, "Primary Coolant System Low Pressure or Flow Scram," were completed.

Upon investigation of Mechanical Equipment Room 114, which contains a large portion of the cooling equipment for the reactor, coolant was found leaking from primary heat exchanger outlet valve V540A. The valve was isolated and that section of the primary coolant system drained in order to remove the bonnet for an internal inspection of the valve body. It was discovered that the valve diaphragm had ruptured. The diaphragm was replaced, the system re-filled and then leak tested satisfactorily. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation. Note: This type of failure had previously occurred only once at MURR (February 8, 2007). At that time, the incident was discussed with the vendor to determine if a failure of this nature had previously occurred at other facilities. To their knowledge, this type of failure had not occurred in the past. The facility will no longer purchase replacement diaphragms from this vendor and have returned the spare.

On April 15, with the reactor operating at 10 MW in the automatic control mode, a "Bldg Air Plenum and Bridge Hi Activity" reactor scram and containment building isolation were automatically initiated. The immediate and subsequent actions of emergency procedures EP-RO-012, "Reactor Isolation," and REP-2, "Reactor Scram," were performed. Remote monitoring of all containment area radiation monitors indicated normal radiation levels with the exception of the 'Reactor Pool Bridge ALARA' monitor, whose indication was erratic. After re-entry into the reactor containment building, investigation determined that bulk pool level had increased to a height sufficient enough to allow water to enter the 'Reactor Pool Bridge ALARA' monitor detector assembly during a routine manual pool filling evolution. Pool water level was lowered and the detector assembly was replaced. Proper operation was verified by performance of the applicable portions of compliance procedure CP-30, "ARMS Times and 16-Inch Valve Cabinet and Associated Horns and Lights." Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

On April 23, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was manually initiated when the outer personnel airlock door failed to open during a normal door cycling sequence. Note: The inner airlock door remained closed and sealed during the entire event; therefore, containment integrity was maintained at all times. The immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. Additionally, the reactor was placed in a 'secured' condition in accordance with the facility

Technical Specifications. Troubleshooting efforts determined that relay OTB, which energizes and causes its normally open contact to shut during a door opening sequence, was sticking and not operating consistently. The relay was replaced and the door verified operable and containment integrity restored. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

On April 29, with the reactor operating at 10 MW in the automatic control mode, a "Bldg Air Plenum and Bridge Hi Activity" reactor scram and containment building isolation were automatically initiated when radiation levels at the reactor pool surface increased above the alarm set point. Immediate actions of emergency procedures EP-RO-012, "Reactor Isolation," and REP-2, "Reactor Scram," were performed. Remote monitoring of all containment area radiation monitors indicated an elevated level by the 'Reactor Pool Bridge' monitor while all other area radiation monitor indications were normal. After re-entry into the reactor containment building, investigation discovered a personal radiation monitoring device (film badge) floating on the pool surface with a reading of approximately 8 Rem/hr. The device was removed from the pool with long sample handling manipulators and placed in shielded storage. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was subsequently restarted to 10 MW operation. Note: The film badge had been inadvertently dropped into the reactor pool by an operator a couple of days previous to this event and had landed on the graphite reflector region. The clip portion of the badge was retrieved while the reactor was shutdown on April 28; however, the remainder could not be seen or found. The section that could not be found had caused the reactor scram and isolation.

Major maintenance items for the month included: removing Beamport 'E' vestibule shutter box to perform modifications in support of the Boron Neutron Capture Therapy project; performing a zero and span procedure on reactor core outlet pressure transmitter PT-944A as part of the instrument calibration; completing the biannual cleaning of the cooling tower sump and basin; performing a reactivity worth measurement in accordance with reactor test procedure "RTP-19 - Experimental Measurement of the MURR Primary Temperature Coefficient of Reactivity;" 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);" completing the first phase of modifications to the reactor containment building 15-ton capacity overhead rectilinear crane – installation of an inspection "catwalk;" completing the biennial change-out of control blade 'B' 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)."

May 2008

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, two reactor startups and two shutdowns were performed in support of U.S. Nuclear Regulatory Commission operator licensing examinations.

Major maintenance items for the month included: replacing the valve actuator mounting bolts on anti-siphon system isolation valve V543A; performing dimensional measurements of irradiation position K2 in support of the molybdenum-99 project; replacing secondary coolant system makeup line piping from the automatic makeup valve to the sump level float control valve; repairing the amphenol connection on control rod 'D' drive mechanism; completing compliance procedure CP-26, "Containment Building Compliance Test;" performing an "end-of-life" inspection on two spent fuel elements; 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 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 2008

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

On June 12, with the reactor operating at 10 MW in the automatic control mode, the reactor was manually shutdown in order to retrieve a sample spacer. During a routine sample handling evolution, a 2-inch diameter sample spacer was inadvertently dropped on the graphite reflector region of the reactor core. The reactor was refueled and subsequently restarted to 10 MW operation.

On June 17, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was manually initiated when the personnel airlock outer door failed to fully close during a normal door cycling sequence. Failure of the outer door to fully close prevented the inner airlock door from automatically opening. The immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. Additionally, the reactor was placed in the 'secured' condition in accordance with the facility Technical Specifications. Investigation revealed that the outer airlock door failed to fully close because of an obstruction in the door's path – a "Caution Wet Floor" sign had been inadvertently bumped into the door's travel path by a janitor. The inner airlock door had remained closed and sealed the entire time the reactor was operating. The sign was removed and the door verified operable. 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: performing four 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);" collecting drain collection tank pump operational data during pool coolant system single pump operation; installing the vestibule shutter box and test fitting the shielding blocks on Beamport 'E' in support of the Boron Neutron Capture Therapy project; irradiating a "dummy" target instrumented with thermocouples in irradiation position K2 in support of the molybdenum-99 project; replacing filter cartridges in pool coolant demineralizer system inlet filter housing F-200; collecting pool coolant system single pump operational data; completing the annual facility emergency preparedness drill; and installing the bismuth filter and test fitting the lifting table on Beamport 'E' in support of the Boron Neutron Capture Therapy project.

July 2008

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 10-year preventative maintenance on the reactor instrumentation Uninterruptible Power Supply System; installing a lift table and test fitting shield blocks on Beamport 'E' in support of the Boron Neutron Capture Therapy project; performing a visual inspection of the pneumatic tube system transfer lines in Laboratory 218 with a remote camera; verifying operation of the shutter box

on Beamport 'E;' removing dry firemain cabinets at the top and bottom of the laboratory basement stairwell in support of facility security enhancements; performing four reactivity worth measurements in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11D;" replacing the air-actuator diaphragm on primary demineralizer inlet valve V527E; replacing the air-actuator diaphragm on skimmer pump outlet valve V515H; performing a voltage plateau verification on the NMC-RAK stack monitor gas channel; and replacing the mechanical seal on primary demineralizer pump P-513A.

August 2008

The reactor operated continuously in August with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one scheduled shutdown for a radiation survey. There were no unscheduled/unplanned power reductions this month. Additionally, one reactor startup and one shutdown were performed in support of U.S. Nuclear Regulatory Commission operator licensing examinations.

Major maintenance items for the month included: test fitting and installing shielding blocks on Beamport 'E;' performing neutron flux measurements in irradiation position K2 in support of the moybdenum-99 project; draining and back-flushing Beamport 'E' with helium; performing benchmark radiation surveys and operational test of the irradiation facility on Beamport 'E;' replacing the containment building supply ventilation intake damper; and performing neutron flux measurements on Beamport 'E' in support of the Boron Neutron Capture Therapy project.

September 2008

The reactor operated continuously in September 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. 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: 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);" flooding Beamport 'E' with demineralized water; burnishing rod run-in relay 2K20 contacts 5 and 6; completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" performing an underwater test fit of the prototype flux trap assembly device; completing portions of Modification Record 96-1, Addendum 2, "Removal of Nuclepore Experiment Equipment;" and completing modifications to the control room console for reactor bridge area door control.

October 2008

The reactor operated continuously in October 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: performing a zero and span procedure on reactor core outlet pressure transmitter PT-944A as part of the instrument calibration; loading new de-ionization bed 'T' and placing it on pool coolant system service; completing Modification Record 08-4, "Replacement of Demineralized Water

Storage Tanks T-300 and T-301;" completing the biannual cleaning of the cooling tower sump and basin; irradiating a 5.0 gram low-enriched uranium (LEU) foil target in irradiation position K2 in support of the molybdenum-99 project; 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);" completing the biennial change-out of control blade 'D' 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);" and completing Modification Record 05-1, Addendum 2, "Replace Pneumatic Tube System Irradiation Counter."

November 2008

The reactor operated continuously in November 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. U.S. Nuclear Regulatory Commission regional inspector arrived at the facility for a routine inspection of Reactor Operations and Emergency Preparedness.

On November 12, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was automatically initiated when an interruption in electrical 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 was corrected. The reactor was refueled and subsequently restarted to 10 MW operation..

On November 27, 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 when a sample holder inadvertently struck the offset mechanism counter balance arm during a routine sample handling evolution. The immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. The operators involved were counseled on the importance of proper sample handling techniques. Permission to restart the reactor was obtained from the Lead Senior Reactor Operator. The reactor was refueled and subsequently restarted to 10 MW operation.

Major maintenance items for the month included: replacing cooling tower fan CTF-2 timing relay; 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 detector voltage plateau calibration on the fission product monitor; performing an in-pool test fit of the prototype flux trap assembly device; and modifying the reactor pool upper bridge decking in support of the prototype flux trap assembly device.

December 2008

The reactor operated continuously in December with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and two unscheduled/unplanned power reductions.

On December 11, with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 & 6 High Power" rod run-in was automatically initiated when Channel 5 power level indication increased above the rod run-in set point. Investigation revealed an upward spike to 109% on Channel 5 chart recorder. All other power level indications were normal - between 100 and 105%. After the Reactor Manager granted permission, the rod run-in was

reset and a return to 10 MW reactor operation was initiated. Restart attempt was subsequently discontinued because of the inability to override the buildup of xenon and the reactor was manually shutdown. Troubleshooting efforts revealed a faulty high voltage power supply for nuclear instrumentation signal processor drawer No. 2 and a new power supply was installed. A full instrument channel calibration and pre-operational checks were performed satisfactorily. Permission to restart the reactor was obtained from the Reactor Manager. The reactor was refueled and subsequently restarted to 10 MW operation.

On December 19, with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 & 6 High Power" rod run-in was automatically initiated when Channel 5 power level indication increased above the rod run-in set point. Investigation revealed an upward spike to 114% on Channel 5 chart recorder. All other power level indications were normal - between 100 and 105%. The reactor was then manually shutdown. Although troubleshooting efforts could not determine a definitive cause, a section of cabling between the detector and amplifier assembly had historically caused spiking due to radiation induced insulation damage or breakdown. Nuclear instrumentation signal processor drawer No. 2 fission chamber detector and cabling were replaced. Full instrument channel calibration and pre-operational checks were performed satisfactorily. The entire 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.

On December 29, with the reactor shutdown for regularly scheduled maintenance activities, the reactor containment isolation system was being tested as part of the pre-startup checks prior to conducting a normal reactor startup. When containment isolation was manually initiated, Door 504, one of two containment building ventilation system automatically-closing doors, did not remain in the sealed condition after the door was fully closed. All other automatic features of the reactor containment isolation system operated properly, as required.

Technical Specification 3.5.a requires that reactor containment integrity be maintained at all times except when (1) the reactor is secured, and (2) irradiated fuel with a decay time of less than sixty days is not being handled. As defined by Technical Specification 1.15, six conditions must be satisfied for reactor containment integrity to exist. One of these six conditions is "*All containment building ventilation system automatically-closing doors and automatically-closing valves are operable or placed in the closed position.*" Furthermore, Technical Specification 1.12 defines "*operable*" as "*A system or component is operable when it is capable of performing its intended function in a normal manner.*"

Because Door 504 had failed to maintain a seal after it was in the fully closed position, it can be construed that the reactor may have operated during the previous week of December 22 to December 29 with reactor containment integrity in a state of reduced effectiveness due to the uncertainty in the operability of the containment building ventilation system automatically-closing door. This would have resulted in a deviation from TS 3.5.a. Door 504 valve actuator was removed and thoroughly cleaned and inspected and the gasket deflate solenoid assembly was replaced with a refurbished assembly. The containment isolation system, including operation of Door 504, was then satisfactorily tested nine (9) times. Licensee Event Report No. 08-2, providing a detailed description of this event and the corrective actions taken, was submitted to the U.S. Nuclear Regulatory Commission within the 30-day reporting requirement.

Major maintenance items for the month included: performing an in-pool test fit of the prototype flux trap assembly device; installing a new pitot tube penetration in the west tower roof in support of the installation of a new stack monitor; performing a detector voltage plateau calibration on the secondary coolant monitor; completing Modification Record 01-02, Addendum 3, "Removal and Relocation of Unused Staff Intercommunication Stations;" completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor;" testing the

control/interlock system on the Boron Neutron Capture Therapy facility; replacing the high voltage power supply for nuclear instrumentation signal processor drawer No. 2; completing Modification Record 06-3, Addendum 1, "Install Temporary Flux Trap Holder Wear Ring;" modifying the lower refuel bridge decking to facilitate the use of an in-pool irradiation position; completing Modification Record 08-05, "Install Temporary Prototype of the Flux Trap Irradiations Reactivity Safety Trip (FIRST) Device;" replacing nuclear instrumentation signal processor No. 2 fission chamber detector and cabling; and replacing the gasket deflate solenoid assembly and cleaning the valve actuator on containment ventilation isolation Door 504 three-way, dual solenoid-operated valve.

SECTION II

MURR PROCEDURES

January 1, 2008 through December 31, 2008

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-nine (69) revisions issued to the reactor operations procedures, forms and operator aids. The majority of the revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
AP-RO-110	Conduct of Operations	12	4/16/2008	Minor Editorial
AP-RO-110	Conduct of Operations	13	9/17/2008	Minor Editorial
AP-RO-115	Modification Records	4	10/29/2008	Minor Editorial
AP-RO-130	Crane Operation	2	3/19/2008	Minor Editorial
AP-RO-130	Crane Operation	3	6/25/2008	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	11	8/27/2008	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	12	12/3/2008	Minor Editorial
EX-RO-120	Beamport "A" Operation	6	8/27/2008	Minor Editorial
EX-RO-121	Beamport "B" Operation	6	8/27/2008	Minor Editorial
EX-RO-122	Beamport "C" Operation	6	8/27/2008	Minor Editorial
EX-RO-123	Beamport "D" Operation	6	8/27/2008	Minor Editorial
EX-RO-124	Beamport "E" Operation	7	8/27/2008	Minor Editorial
EX-RO-125	Beamport "F" Operation	8	8/27/2008	Minor Editorial
FM-16	Primary - Pool Coolant Water Analysis	5	3/19/2008	Cover Page
FM-19	Unscheduled Power Reduction Report	3	2/7/2008	Minor Editorial
FM-21	ARMS Trip Setpoints	6	9/17/2008	Cover Page
FM-23	MURR Tag Out Index Record	5	8/13/2008	Cover Page
FM-24	MURR Tag Out Sheet	6	8/13/2008	Cover Page
FM-25	MURR Tag Out Monthly Audit	5	8/13/2008	Cover Page
FM-43	Nuclear and Process Data	11	3/19/2008	Cover Page
FM-56	Reactor Routine Patrol	12	2/19/2008	Minor Editorial
FM-57	Long Form Startup Checksheet	12	4/16/2008	Minor Editorial
FM-57	Long Form Startup Checksheet	13	8/7/2008	Minor Editorial
FM-57	Long Form Startup Checksheet	14	10/1/2008	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
FM-58	Short Form Startup Checksheet	6	4/16/2008	Minor Editorial
FM-58	Short Form Startup Checksheet	7	10/1/2008	Minor Editorial
FM-63	DI Water Makeup Log	6	2/19/2008	Cover Page
FM-63	DI Water Makeup Log	7	10/1/2008	Minor Editorial
FM-64	DI Resin Log	4	9/3/2008	Cover Page
FM-65	Filter Status Log	4	9/3/2008	Cover Page
GS-RA-100	MURR Equipment Tag Out	7	7/30/2008	Minor Editorial
OP-RO-210	Reactor Startup - Normal	7	10/1/2008	Minor Editorial
OP-RO-211	Reactor Startup - Hot	7	10/1/2008	Minor Editorial
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	6	5/8/2008	Minor Editorial
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	7	10/1/2008	Minor Editorial
OP-RO-220	Reactor Shutdown or Power Reduction	5	7/2/2008	Minor Editorial
OP-RO-230	Changing Reactor Power Level	4	7/2/2008	Minor Editorial
OP-RO-230	Changing Reactor Power Level	5	10/1/2008	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	9	9/3/2008	Cover Page
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	5	3/19/2008	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	6	3/19/2008	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	7	2/19/2008	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	8	5/28/2008	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	5	2/19/2008	Minor Editorial
OP-RO-340	Nuclear Instrumentation Adjustment	7	2/19/2008	Minor Editorial
OP-RO-420	Primary and Pool Water Analysis	3	2/7/2008	Minor Editorial
OP-RO-461	Pool Coolant System - One Pump Operation	8	8/7/2009	Minor Editorial
OP-RO-480	Secondary Coolant System	11	7/2/2008	Minor Editorial
OP-RO-480	Secondary Coolant System	12	12/3/2008	Minor Editorial
OP-RO-520	Emergency Diesel Generator	5	3/19/2008	Cover Page
OP-RO-520	Emergency Diesel Generator	6	10/29/2008	Cover Page
OP-RO-525	Chill Water System	1	5/28/2008	Minor Editorial
OP-RO-530	Demineralized Water Supply System	7	12/3/2008	Minor Editorial
OP-RO-531	Primary and Pool Sample Station	7	7/2/2008	Cover Page
OP-RO-555	Fire Protection System	4	2/7/2008	Cover Page
OP-RO-555	Fire Protection System	5	8/7/2008	Minor Editorial
OP-RO-710	Radiation Monitoring - Area Monitors	5	8/7/2008	Cover Page
OP-RO-720	Radiation Monitoring	7	7/2/2008	Minor Editorial
OP-RO-730	Facility Exhaust System	10	6/6/2008	Minor Editorial
OP-RO-741	Waste Tank System Operation	9	8/27/2008	Minor Editorial
RM-RO-405	Reactor Demineralizer System	10	9/3/2008	Cover Page
RM-RO-470	Sulfuric Acid System	5	9/3/2008	Minor Editorial
RP-RO-100	Fuel Movement	8	6/6/2008	Minor Editorial
RP-RO-200	Measurement of Differential Worth of a Shim Blade, RTP-11D	4	9/3/2008	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
RP-RO-202	Measurement of Reactivity Worth of Movable Samples, RTP-6	1	5/8/2008	Minor Editorial
RP-RO-300	Receipt and Inspection of New Fuel	0	4/16/2008	Full Review
SM-RO-011	Beryllium Reflector Replacement	1	5/28/2008	Minor Editorial
SM-RO-300	Control Console and Instrument Panel - Securing Power	7	9/17/2008	Minor Editorial
SM-RO-620	Control Blade Leak Test	3	1/4/2008	Full Review

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 eighteen (18) 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-006	Radiological Emergency	3	1/25/2008	Minor Editorial
EP-RO-012	Reactor Isolation	2	1/25/2008	Minor Editorial
EP-RO-013	Facility Evacuation	3	1/25/2008	Minor Editorial
EP-RO-014	EPZ and Site Area Evacuations	4	7/16/2008	Minor Editorial
EP-RO-015	Emergency Notifications	4	4/8/2008	Minor Editorial
EP-RO-017	Emergency Air Sampling	3	10/2/2008	Minor Editorial
EP-RO-018	Emergency Radiation Exposure	3	4/8/2008	Minor Editorial
EP-RO-020	Emergency Equipment Maintenance	2	6/11/2008	Minor Editorial
FM-104	Emergency Call List	7	1/25/2008	Minor Editorial
FM-104	Emergency Call List	8	4/8/2008	Minor Editorial
FM-104	Emergency Call List	9	6/11/2008	Minor Editorial
FM-104	Emergency Call List	10	10/2/2008	Minor Editorial
FM-110	Fire Flowchart	2	1/25/2008	Minor Editorial
FM-118	Evacuation Flowchart	2	7/16/2008	Minor Editorial
OA-09	Combined Emergency Flowcharts	2	7/16/2008	Minor Editorial
OA-10	Fire Extinguisher Locations and Types	4	1/25/2008	Minor Editorial
OA-20	Emergency Equipment	4	6/11/2008	Minor Editorial
OA-20	Emergency Equipment	5	10/2/2008	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 fifty-five (55) revisions issued to the health physics, radioactive materials shipping, and preparation for shipping procedures and forms. 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	8	7/30/2008	Minor Editorial
AP-HP-123	Visitor Dosimetry - Reception Desk	5	1/18/2008	Cover Page
AP-HP-130	Reactor License Projects Annual Review	3	12/17/2008	Minor Editorial
BP-SH-015	Packaging and Shipment of Radioactive Material Using USA DOT 7A Model 30 Package	0	12/10/2008	Full Review
BPB-SH-002	20WC-1 Packaging and Shipment of Type B Non-waste Radioactive Material	8	12/10/2008	Minor Editorial
BPB-SH-005	DOT 6M Packaging of Type B Non-Waste Radioactive Material	6	12/10/2008	Minor Editorial
BPB-SH-008	Type B(U) F-327 Series Packaging of Type B Non-Waste Radioactive Material	5	2/7/2008	Minor Editorial
BP-SH-007	F-327 Packaging and Shipment of Type A Non-Waste Radioactive Material	4	8/7/2008	Minor Editorial
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	3	9/11/2008	Minor Editorial
BR-PSO-205	Lutetium Chloride Batch Record	4	1/18/2008	Minor Editorial
FM-17	Radiation Work Permit	7	7/30/2008	Minor Editorial
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	12	12/10/2008	Minor Editorial
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	4	5/1/2008	Minor Editorial
FM-59	Control Checksheet for Spectratek Services Reusable Type A Package Radioactive Materials Shipment	2	5/1/2008	Minor Editorial
FM-60	Control Checksheet for MURR Shipment Using DOT 7A Model 30 Package	0	8/7/2008	Full Review
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	10	5/1/2008	Minor Editorial
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	11	12/10/2008	Minor Editorial
FM-75	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	9	9/11/2008	Minor Editorial
FM-78	Lutetium Chloride Radiation Protection Data Sheet A	4	1/18/2008	Minor Editorial
FM-79	Lutetium Chloride Radiation Protection Data Sheet B	4	1/18/2008	Minor Editorial
FM-79	Lutetium Chloride Radiation Protection Data Sheet B	5	12/31/2008	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
FM-83	Concentration of Pm-149 Data Sheet	3	5/21/2008	Minor Editorial
FM-98	Control Checksheet for MURR Shipment Using USA DOT 7A MURR Model 6 or 12	4	5/1/2008	Minor Editorial
FM-99	Control Checksheet for USA DOT 7A MURR Model 1500 Series	3	2/7/2008	Minor Editorial
FM-120	Individual Type B QA Training Certification	1	2/7/2008	Cover Page
FM-130	Dissolving Ho-166 Nitrate Data Sheet	0	10/27/2008	Full Review
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	8	12/31/2008	Minor Editorial
HC-PSO-003	Glove Box Preparation of Radioactive Material for Shipment	7	12/31/2008	Minor Editorial
IC-HP-305	Calibration - Electrostatic Discharge Dosimeter	4	1/18/2008	Cover Page
IC-HP-310	Calibration - Eberline Ping 1A Stack Monitor - Particulate Channel	5	1/18/2008	Cover Page
IC-HP-311	Calibration - Eberline Ping 1A Stack Monitor - Iodine Channel	5	1/18/2008	Cover Page
IC-HP-312	Calibration - Eberline Ping 1A Stack Monitor - Gas Channel	5	1/18/2008	Cover Page
IC-HP-318	NMC Model RAK Stack Monitor Offsets/Multipliers/High Voltages Determination	5	2/15/2008	Cover Page
IC-HP-347	Calibration - Protean Model WPC 9550 Alpha-Beta Swipe Counter	8	9/12/2008	Cover Page
OP-HP-200	Air Sampling - Containment Building Tritium	3	12/17/2008	Cover Page
OP-HP-220	Tritium Bioassay	4	7/30/2008	Cover Page
OP-HP-222	Air Sampling - Containment Building Ar-41	4	1/18/2008	Minor Editorial
OP-HP-400	Gemstone Shipping Barrel Analysis	6	12/17/2008	Cover Page
OP-HP-420	Decontamination of Enclosed Processing Units	2	12/17/2008	Cover Page
POL-03	Radiation Protection Program	8	9/16/2008	Minor Editorial
POL-17	MURR Training Booklet (Security, Emergency and Health Physics)	0	10/17/2008	Full Review
PRC-PSO-213	Lutetium Chloride Processing	5	12/31/2008	Minor Editorial
PRC-RRD-108	Dissolving 166-Ho Nitrate	0	10/27/2008	Full Review
PRC-RRD-215	Supplemental Sample Dispensing	4	9/10/2008	Minor Editorial
PRC-RRD-414	Dissolution of Gd-159	3	5/21/2008	Minor Editorial
QU-RRD-253	Lu-177 Identification and Determination of Radionuclidic Purity	6	9/10/2008	Minor Editorial
RCP-PSO-004	P-33 Purification	4	2/19/2008	Minor Editorial
RP-HP-100	Contamination Monitoring - Performing a Swipe	5	1/18/2008	Cover Page
RP-HP-115	Returning Lead Pigs to Service	5	1/18/2008	Cover Page
RP-HP-137	Handling Radioactive Material in the Reactor Pool	7	5/7/2008	Minor Editorial
RP-HP-137	Handling Radioactive Material in the Reactor Pool	8	9/12/2008	Minor Editorial
SV-HP-100	Reactor Chemistry Isotope Counter Trending and Investigative Level Determination	5	1/18/2008	Cover Page
SV-HP-110	Environmental Sampling	4	2/15/2008	Cover Page
WM-SH-105	Radioactive Waste Processing	4	8/7/2008	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
WM-SH-300	Exclusive Use Shipment of LSA or SCO Radioactive Waste	6	9/11/2008	Minor Editorial

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2008 through December 31, 2008

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, page 7-14, Section 7.1.12 (as revised by the 1967-68, 1970-71 and 1973-74 Reactor Operations Annual Reports):

Delete: Both paragraphs under Section 7.1.12.

Replace with: "A closed circuit television (CCTV) system is installed in the reactor facility which allows the control room operators to monitor selected areas of the reactor containment and laboratory buildings."

Original HSR, page 7-16, Section 7.2.2, paragraph 1, sentence 1 (as revised by the 1967-68, 1969-70, 1970-71, 1981-82, 1993, and 1995 Reactor Operations Annual Reports):

Delete: The words "lined carbon steel."

Replace with: "stainless steel"

Original HSR, page 7-20, Section 7.2.9, Table 7.1 (as revised by the 1974-75, 1995, 2001, 2002, and 2007 Reactor Operations Annual Reports):

Delete: The following from Table 7.1 under Staff Stations:

"Room 210 Laboratory Building Outer Corridor"
"Room 271 Machine Shop"

Add: The following to Table 7.1 under Staff Stations:

"Room 287 Central Corridor"

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

Add: The following to Table 9.1 under (b) Controls:

"60 Bridge Door Unlock N/A Push Button"

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

Replace with: Updated Figure 9.2, Control Console Layout (dated 7/10/08)

Original HSR, Figure 10.1, Main Reactor Equipment Room (as revised by the 1994 and 1996 Reactor Operations Annual Reports):

Replace with: Updated Figure 10.1, Main Reactor Equipment Room (MURR Dwg No. 2463, Sheet 1 of 1, dated 8/8/08)

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

HSR, Addendum 3, page 23d, Figure 2.3.d, Electrical Distribution (new print added by the 2007 Reactor Operations Annual Report):

Replace with: Updated Figure 2.3.d, Electrical Distribution Reactor/Laboratory Panels-2 (MURR Dwg No. 522, Sheet 4 of 5, dated 8/4/08)

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

HSR, Addendum 4, page A-30, Figure A.3, 10 MW Process Instrumentation Control & Interlock (as revised by 1995, 1998, 2001, 2004, 2005, 2006, and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure A.3, 10 MW Process Instrumentation Control & Interlock (MURR Dwg No. 41, Sheet 3 of 4, dated 4/18/08)

HSR, Addendum 4, page A-32, Figure A.5, 10 MW Process Instrumentation Control & Interlock (as revised by 1995, 2001, 2005, and 2006 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 4/18/08)

HSR, Addendum 4, page A-34, Figure A.7, Annunciator Control 10 MW (as revised by the 1995, 2001, 2002, 2005, 2006, and 2007 Reactor Operations Annual Reports):

Replace with: Updated Figure A.7, Annunciator Control 10 MW (MURR Dwg No. 138, Sheet 1 of 1, dated 4/8/08)

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

January 1, 2008 through December 31, 2008

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 75-1, Addendum 2:

Addition of Jumpers to Electronic Circuit Jumper Panel

This addendum to modification record 75-1, "Electronic Circuits Jumper Panel," documents the addition of three jumper circuits to support the surveillance requirements of new flow detector instrument channels that were installed during the recent upgrade to the primary coolant system. The electronic circuit jumper panel provides a positive means of (1) inserting and removing circuit jumpers for maintenance, surveillance, and troubleshooting, and (2) verifying that the jumpers are removed.

Modification 01-2, Addendum 3:

Removal and Relocation of Unused Staff Intercommunication Stations

This addendum to modification record 01-2, "Installation of a New Reactor Facility Intercommunication and Paging System," documents the removal and relocation of two intercom staff stations in the Intercommunication and Paging System. One staff station, which was previously located in the laboratory building outer corridor, was relocated near the outer airlock door to aid in communication when entering the containment building. The staff station located in Room 271 was removed since it was no longer required at this location.

Modification 05-1, Addendum 2:

Replace Pneumatic Tube System Irradiation Counter

This addendum to modification record 05-1, "Pneumatic Tube System Photo Sensor Collar Upgrade," documents the installation of two new-style photo sensor collars to the pneumatic tube system which allow the light source and sensor to be removed or realigned without having to relax reactor containment integrity.

Modification 06-3, Addendum 1:

Install Temporary 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 wear ring with a temporary test design which allows the wear ring to engage a device consisting of two position sensing switches. This temporary installation is being performed in conjunction with modification record 08-5, "Install Temporary Prototype of the Flux-trap Irradiations Reactivity Safety Trip (FIRST) Device," which documents the temporary installation of a prototype switch device which senses the position of the center test hole canister.

Modification 08-2:

Addition of Service Catwalk to 15-ton Overhead Crane

This modification record documents the installation of a service catwalk to the containment building 15-ton overhead rectilinear crane. The crane requires periodic maintenance, inspection and repair to safely

perform its intended functions. Prior to the catwalk, the ability to perform these items had been severely limited by the lack of a physical access to the north-south drivetrain. The catwalk consists of two separate steel installations: (1) a fixed catwalk assembled and bolted as an auxiliary platform, and (2) a moving catwalk welded to the north box girder of the crane. The moving catwalk is designed to allow access to the north-south drive and electrical panels without limiting the north travel of the crane platform.

Modification 08-3:

Replacement of Graphite Reflector Elements 1, 2, 3, 4, 6, 7, 8, and 9

This modification record documents the replacement of eight graphite reflector elements. From April, 2005, until October, 2007, all but one of the twelve graphite reflector elements were replaced during various maintenance evolutions. Three of these were documented specifically in previous modification records. The remaining eight were documented in this modification record in order to provide consistency in documentation.

Modification 08-4:

Replacement of Demineralized Water Storage Tanks T-300 and T-301

This modification record documents the replacement of demineralized water storage tanks T-300 and T-301. Due to degradation of their phenolic liner, the original two carbon steel water storage tanks were replaced with 316L stainless steel tanks of almost identical design and capacity.

Modification 08-5:

Install Temporary Prototype of the Flux-trap Irradiations Reactivity Safety Trip (FIRST) Device

This modification record documents the temporary installation of a prototype switch device intended to positively indicate the position of the center test hole canister when it is in its secured and latched position. The current method of calculating the total experiment reactivity worth in the center test hole includes the reactivity contribution of the center test hole canister (sample holder) itself. This is a conservative approach that severely limits the total available reactivity of samples loaded into the canister. The MURR is considering an alternative methodology in which the reactivity contribution of the center test hole canister is not included, and only the reactivity contribution of the experiment samples is included in the calculation. This temporary installation is being performed in conjunction with modification record 06-3, addendum 1, "Install Temporary Flux Trap Holder Wear Ring," which documents the temporary installation of a test design wear ring on the center test hole canister.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2008 through December 31, 2008

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

RUR 430: Uranium, Natural Uranium Foil

Description: This RUR authorizes the irradiation of up to 1.0 gram of natural uranium foil for research and development activities.

RUR 431: Uranium, Low-Enriched Uranium Foil

Description: This RUR authorizes the irradiation of up to 5.0 grams of low-enriched uranium (LEU) foil, enriched to 19.75% in the isotope U-235, for research and development activities.

RUR 432: Germanium Oxide, Natural and Enriched Ge-76

Description: This RUR authorizes the irradiation of up to 0.200 grams of germanium oxide (GeO_2), natural or enriched up to 100% in the isotope Ge-76, for research and development activities.

Flux Characterization

Description: Neutron flux and gamma-dose measurements were performed on Beamport 'E' in support of the Boron Neutron Capture Therapy project.

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, 2008 through December 31, 2008

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:

Sixty-one (61) refueling evolutions were completed in 2008. Excess reactivity verifications were performed for each refueling. The largest measured excess reactivity value was 2.98%. 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.

One (1) reactivity measurement was made to characterize the reactivity worth of a 5.0 gram low-enriched uranium (LEU) foil target irradiated in the graphite reflector region.

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

Four (4) reactivity measurements were made to determine the reactivity worth of various small sample cans irradiated in the flux trap region.

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

SECTION VII

RADIOACTIVE EFFLUENT

January 1, 2008 through December 31, 2008

TABLE 1
SANITARY SEWER EFFLUENT

January 1, 2008 through December 31, 2008

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

Nuclide	Activity (Ci)
H-3	1.362E-01
S-35	6.701E-03
Co-60	4.056E-03
Lu-177	3.337E-03
Zn-65	1.641E-03
Ca-45	1.018E-03
P-32	6.677E-04
Lu-177m	4.914E-04
Mn-54	4.283E-04
Sc-46	3.906E-04
Ho-166	3.839E-04
Ag-110m	2.647E-04
Cu-67	6.546E-05
Re-186	3.213E-05
Cr-51	3.017E-05
Nb-95	2.063E-05
Fe-59	1.698E-05
Sm-153	1.436E-05
Gd-153	1.327E-05
Sb-122	1.267E-05
I-131	1.115E-05
Total H-3	1.362E-01
Total Other	1.960E-02

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

TABLE 2
STACK EFFLUENT

January 1, 2008 through December 31, 2008

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration (µCi/ml)	Total Release (Ci)	TS Limit Multiplier	% TS
Ar-41	2.71E-06	1.25E+03	350	77.3700
C-14	2.36E-11	1.07E-02	1	0.7867
Ce-144	1.70E-14	8.01E-06	1	0.0852
Co-60	3.92E-14	1.82E-05	1	0.0784
I-131	1.56E-13	7.24E-05	1	0.0782
H-3	1.84E-08	8.54E+00	350	0.0527
K-40	9.82E-14	4.55E-05	1	0.0164
Sc-46	6.61E-15	3.06E-06	1	0.0022
I-125	6.22E-15	2.88E-06	1	0.0021
Sn-113	6.83E-15	3.16E-06	1	0.0009
Zr-95	1.88E-15	8.70E-07	1	0.0005
Cs-137	6.74E-16	3.12E-07	1	0.0003
Gd-153	1.00E-15	4.64E-07	1	0.0003
Ba-140	4.93E-15	2.28E-06	1	0.0002
Ce-141	7.93E-16	3.67E-07	1	0.0001
I-133	2.48E-13	1.15E-04	350	0.0001
Hf-181	3.79E-16	1.75E-07	1	0.0001
Be-7	1.80E-14	8.33E-06	1	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, 2008 through December 31, 2008

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 2008. All doses are approximately 30 mRem/year or less, except monitor numbers 9 and 15. These monitors are located near the loading dock where packages containing radioactive material are loaded on transport vehicles. The doses recorded by these monitors are considered to be the result of exposure to packages in transit. The environmental monitoring program confirms that no environmental impact exists from the operation of the MURR facility.

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

TABLE 1

Summary of Environmental Set 73-2

Spring 2008

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.00 pCi/L	0.84 pCi/L	307 pCi/L	3.47 pCi/mL of sample
Soil	0.69 pCi/g	1.08 pCi/g	1.20 pCi/g	N/A
Vegetation	0.00 pCi/g	2.91 pCi/g	2.33 pCi/g	3.87 pCi/mL of distillate

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V73-2	0.60	20.85	< 2.33	< 3.87
2V73-2	0.60	25.73	< 2.33	< 3.87
3V73-2	0.60	12.80	< 2.33	< 3.87
4V73-2	0.00	20.95	< 2.33	< 3.87
5V73-2	0.00	29.23	6.59	< 3.87
6V73-2	0.61	17.33	< 2.33	< 3.87
7V73-2	1.21	27.95	10.44	< 3.87
10V73-2	0.30	26.01	7.39	< 3.87

TABLE 1 (Cont'd)

Summary of Environmental Set 73-2

Spring 2008

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S73-2	< 0.69	8.98	< 1.20
2S73-2	1.34	13.01	< 1.20
3S73-2	1.91	8.47	1.94
4S73-2	1.02	12.27	< 1.20
5S73-2	0.92	14.16	< 1.20
6S73-2	< 0.69	11.24	3.32
7S73-2	0.90	10.92	10.81
10S73-2	0.89	15.05	14.53

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W73-2	0.00	4.11	< 307	< 3.47
6W73-2	0.00	10.49	< 307	< 3.47
10W73-2	0.00	4.54	< 307	5.97

Note 1: Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

TABLE 2

Summary of Environmental Set 74

Fall 2008

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.12 pCi/L	3.89 pCi/L	260 pCi/L	3.55 pCi/mL of sample
Soil	0.62 pCi/g	2.20 pCi/g	0.68 pCi/g	N/A
Vegetation	0.00 pCi/g	3.16 pCi/g	2.72 pCi/g	3.41 pCi/mL of distillate

TABLE 2 (Cont'd)

Summary of Environmental Set 74

Fall 2008

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V74	0.00	< 3.16	< 2.72	< 3.41
2V74	0.00	4.86	< 2.72	< 3.41
3V74	0.27	< 3.16	< 2.72	< 3.41
4V74	0.84	4.44	< 2.72	< 3.41
5V74	0.00	8.86	< 2.72	< 3.41
6V74	0.84	5.68	< 2.72	< 3.41
7V74	0.00	14.05	< 2.72	< 3.41
10V74	0.00	9.41	< 2.72	< 3.41

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S74	0.76	11.78	2.02
2S74	0.91	10.55	2.50
3S74	1.10	12.21	3.52
4S74	0.81	9.64	3.74
5S74	0.83	10.24	3.53
6S74	< 0.62	8.50	1.84
7S74	< 0.62	10.65	3.62
10S74	< 0.62	13.29	3.46

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W74	< 1.12	< 3.89	472	< 3.55
6W74	< 1.12	< 3.89	< 260	6.95
10W74	< 1.12	9.09	< 260	< 3.55

Note 1: Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

TABLE 3
Environmental TLD Summary

January 1, 2008 through December 31, 2008

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2008 Net mR	2nd Qtr. 2008 Net mR	3rd Qtr. 2008 Net mR	4th Qtr. 2008 Net mR	Total 2008 Net mR
1	Control	N/A	0.0	3.0	0.0	2.2	5.2
2	Control	N/A	0.0	3.4	0.5	0.0	3.9
3	WSW	N/A	0.0	0.9	0.0	0.0	0.9
4*							
5*							
6	N	34	0.2	4.2	2.4	2.1	8.9
7	NE	57	0.0	3.4	2.4	2.5	8.3
8	SW	27	1.2	4.6	1.7	1.7	9.2
9	S	27	20.0	18.7	24.3	18.6	81.6
10	NE	149	0.0	1.5	0.0	0.0	1.5
11	NW	149	0.0	2.0	0.5	0.7	3.2
12	ENE	301	0.7	4.6	4.6	2.3	12.2
13	NNE	316	0.0	2.7	1.9	1.5	6.1
14	S	156	0.0	3.5	2.0	1.3	6.8
15	S	65	14.8	14.4	16.4	13.9	59.5
16	SE	107	0.0	0.0	0.0	0.0	0.0
17	E	293	0.0	0.3	0.0	0.0	0.3
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	0.0	0.1	0.0	0.0	0.1
22	ESE	168	0.0	0.0	0.0	0.0	0.0
23	NW	110	0.0	3.4	0.6	1.4	5.4
24	SSW	328	0.0	no report	0.0	0.0	0.0
25	SSW	480	0.0	2.1	1.6	0.0	3.7
26	SW	301	0.0	0.6	0.0	0.0	0.6
27	WSW	141	0.0	0.0	0.0	0.0	0.0
28	WNW	210	0.0	2.7	0.2	0.0	2.9
29	NW	255	0.0	no report	0.8	0.3	1.1
30	NNW	328	0.0	0.0	0.0	0.0	0.0
31	NNW	671	0.0	3.0	3.1	0.2	6.3
32	NNW	724	0.0	2.0	0.7	1.3	4.0
33	E	671	absent	0.0	0.0	0.0	0.0
34	ENE	587	0.0	0.0	no report	0.0	0.0
35	SSE	499	0.0	0.0	0.0	0.0	0.0
36	SE	419	0.0	0.0	0.0	0.0	0.0
37	NE	690	0.0	no report	0.0	0.0	0.0
38	NW	556	0.0	2.1	0.7	no report	2.8
39	W	491	0.0	0.0	0.0	1.8	1.8
40	N	514	0.0	-0.9	0.0	0.0	-0.9
41	NNE	137	0.0	0.3	0.0	0.0	0.3
42	In Building	N/A	7.5	6.3	9.4	8.3	31.5
43	In Building	N/A	2.7	0.2	3.3	0.0	6.2
44	Spare	N/A	0.0	2.6	0.7	0.0	3.3
45	S	65	0.0	2.4	0.4	0.0	2.8

*These badge numbers are no longer used.

TABLE 4
Number of Facility Radiation and Contamination Surveys

January 1, 2008 through December 31, 2008

	Radiation	Surface Contamination*	Air Samples**	RWP's
January	83	83	66	8
February	72	72	45	9
March	70	70	39	16
April	85	85	64	11
May	65	65	67	6
June	65	65	58	4
July	80	80	66	10
August	71	71	62	7
September	67	67	59	9
October	87	87	67	12
November	57	57	52	7
December	80	80	57	11
TOTALS	**882**	**882**	**702**	**110**

* 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

Lee Juengermann was hired as a Health Physics Technician in August 2008.

Tim Bussey resigned as a Health Physics Technician in December 2008 upon completion of his Masters Degree in Nuclear Engineering.

During calendar year 2008, MURR shipped 2,423 cubic feet of low-level radioactive waste containing 475,121 mCi of activity.

SECTION IX

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

January 1, 2008 through December 31, 2008

TOTAL PERSONNEL DOSE (MREM) BY DOSIMETRY GROUP

Month	AC	DO	FSO	HC/SH	RAG	IRR	NA	NS	OPS	PRO	RP	SIL	Total
January	111	8	135	327	199	16	59	51	1335	143	49	101	2534
February	260	61	86	346	237	12	56	118	1356	86	115	133	2866
March	137	48	85	365	415	27	31	41	1635	101	137	115	3137
April	75	52	213	314	170	11	28	68	1275	74	72	124	2476
May	24	22	56	307	189	23	19	74	1300	100	67	165	2346
June	100	99	137	432	168	27	83	63	1818	88	151	126	3292
July	116	43	103	398	213	23	99	159	1518	105	160	154	3091
August	68	26	135	445	256	15	67	89	1360	117	67	83	2728
September	41	11	107	563	348	2	64	75	1245	112	61	79	2708
October	96	23	79	496	276	3	38	35	1562	119	106	96	2929
November	94	13	71	435	288	31	50	33	1482	76	31	65	2669
December	102	37	140	426	188	16	34	34	1685	87	89	89	2927
Total to Date	**1224**	**443**	**1347**	**4854**	**2947**	**206**	**628**	**840**	**17571**	**1208**	**1105**	**2534**	**33703**
Monthly Ave	**102**	**37**	**112**	**405**	**246**	**17**	**52**	**70**	**1464**	**101**	**92**	**211**	**2809**
Highest WB	**50**	**7**	**47**	**216**	**158**	**24**	**28**	**55**	**147**	**49**	**39**	**95**	
Highest EXT	**810**	**M**	**180**	**400**	**150**	**50**	**1110**	**140**	**490**	**691**	**320**	**280**	

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
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.