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RESEARCH REACTOR CENTER

February 27, 2012

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
2011 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, 2011 through December 31, 2011.

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

JLF/djr

Enclosure

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

A020
NRR

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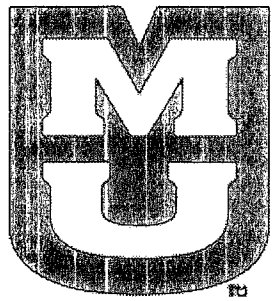

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2011 – December 31, 2011

UNIVERSITY OF MISSOURI
RESEARCH REACTOR FACILITY

REACTOR OPERATIONS
ANNUAL REPORT

January 1, 2011 through December 31, 2011

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, 2011 through December 31, 2011

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 2011. 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 regarding a License Amendment that was submitted to increase the flexibility and capacity in the center test hole, (2) preparation and installation of a new Cooling Tower that will support a power uprate to 12 MW, which is required for fuel conversion, (3) development of the necessary controls and procedures for usage of the BEA Research Reactor (BRR) spent fuel shipping package and (4) submission of a request to the NRC to amend MURR Technical Specification 2.1, "Reactor Core Safety Limit," because of an error that was discovered in the MURR

Safety Limit Analysis. 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 Request for Additional Information 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 one individual who received his Reactor Operator certification from the NRC. This individual participated in a rigorous training program of classroom seminars, self-study, and on-the-job training. The results of this training is a confident, well-versed, decisive individual capable of performing the duties of a licensed operator during normal and abnormal situations.

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SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2011 through December 31, 2011

The following table and discussion summarizes reactor operations during the period from January 1, 2011 through December 31, 2011.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled[1]
January	669.29	278.98	90.0	100.7
February	614.47	256.11	91.4	102.4
March	679.31	283.16	91.3	102.2
April	655.27	273.12	91.0	102.1
May	652.70	272.08	87.7	98.2
June	652.20	271.85	90.6	101.6
July	682.73	284.53	91.8	102.7
August	648.93	270.51	87.2	97.7
September	640.57	266.19	89.0	99.8
October	651.29	271.96	87.5	98.0
November	650.82	271.66	90.4	101.4
December	536.24	267.69	72.1	80.7
Total for the Year	**7733.82**	**3267.84**	**88.33 %**	**98.96 %**

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 2011

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

Major maintenance items for the month included: performing two reactivity worth measurements in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11 (D);" completing compliance procedure CP-29, "Calibration of the NMC RAK Radiation Stack Monitor;" 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);" and completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor."

February 2011

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

On February 14, during a reactor startup to 10 MW operation, criticality was achieved prior to the pre-calculated Estimated Critical Position (ECP). The manual 1/M calculation and graph indicated that the reactor would become critical at a rod height slightly lower than the one predicted by the pre-generated ECP. The Assistant Reactor Manager – Physics was contacted and permission was given by the Reactor Manager to continue the reactor startup to criticality. Once critical rod height data was obtained at 50 kW, the reactor was shut down for further investigation. The correct core fuel loading was confirmed by map check of the fuel storage facilities. Two of the fuel elements (out of the eight) that were loaded in the core had only one week of operational history; however, there was no correction used in the calculated ECP for the partial buildup of Samarium in these two elements. The sample loading in the center test hole canister was re-verified and the center test hole strainer was installed. The reactivity worth of the loaded center test hole canister was verified by performing reactor procedure RP-RO-201, "Measurement of Total Reactivity Worth of Flux Trap Loadings, RTP-17(B)." It was determined that although the deviations in core reactivity and center test hole reactivity worth were independently within normal tolerances, the two combined deviations were sufficient enough to cause the overall calculated ECP to be outside the limits listed in operating procedure OP-RO-210, "Reactor Startup - Normal." 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: completing Modification Record 01-02, Addendum 5, "Intercommunication and Paging System Changes in Support of the North Office Addition Lab Space;" installing an additional facility evacuation horn in the North Office Addition in accordance with Modification Record 90-01, "Evacuation System Changes in Support of the New North Office Addition;" loading new de-ionization bed 'K' and placing it on pool coolant system service; 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 performing two reactivity worth measurements in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D)," in support of a Nuclear Engineering Department practicum.

March 2011

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

On March 21, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was manually initiated when the control room operators observed a faster than normal lowering of pressurizer liquid level soon after startup. Upon investigation, it was discovered that the water loss was through the reactor pressure vessel head flange and into the reactor pool. The pressure vessel head is required to be unbolted and removed during the weekly core refueling. It was determined that the pressure vessel head flange had been improperly tightened after it was reinstalled following a core refueling. The pressure vessel head was removed, a new flexitallic gasket was installed

and the vessel head was reinstalled and tightened. The reactor returned to 10 MW operation with permission from the Reactor Manager.

Major maintenance items for the month included: replacing the +15 volt power supply for Nuclear Instrumentation Signal Processor No. 1; performing two reactor test procedures "RTP-19 - Experimental Measurement of the MURR Primary Temperature Coefficient of Reactivity" in support of a Nuclear Engineering Department practicum; replacing the rotary limit switch and cam follower for Regulating Blade 60% Withdrawn indication; installing the facility exhaust ventilation system isolation damper for laboratory 251; and collecting primary coolant system hydraulic data for benchmarking.

April 2011

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

On April 7, 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 a momentary upward spike to 109% on Channel 5 chart recorder. All other power level indications were normal - between 100 and 105%. The specific cause of the rod run-in could not be determined. The Reactor Manager granted permission to reset the rod run-in and the reactor was returned to 10 MW operation.

During the following scheduled maintenance day activities (April 11), extensive troubleshooting did not reveal a definitive cause. 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 fission chamber detector and associated cabling were replaced. An instrument channel calibration and pre-operational check were performed satisfactorily. The system was then response checked with a neutron source. No further instances of indication spiking have occurred.

On April 21, with the reactor operating at 10 MW in automatic control mode, a "Reactor Loop Low Flow" reactor scram was automatically initiated when primary coolant system flow decreased below the reactor safety system low flow scram set point of 1725 gpm. The immediate and subsequent actions of reactor emergency procedure REP-3, "Primary Coolant System Low Pressure or Flow Scram," were completed. Subsequent investigation revealed primary coolant circulation pump P-501B thermal overloads had tripped due to a failure of relay K2 in the pump controller. The relay was replaced; the pump controller was inspected and retested satisfactorily. 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: performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" refurbishing Regulating Blade 60% Withdrawn relay 1K10; replacing the fission chamber detector for Nuclear Instrumentation Signal Processor No. 2; replacing pump control relay K2 for primary coolant circulation pump P-501B; and completing the biennial change-out of Control Blade 'A' Offset Mechanism and associated retesting.

May 2011

The reactor operated continuously in May with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, one shutdown for physics measurements and one unscheduled/unplanned power reduction.

On May 13, with the reactor operating at 10 MW in the automatic control mode, a "Nuclear Instrument Anomaly" scram was automatically initiated when Nuclear Instrumentation Power Range Channel No. 6 self-diagnostic operation monitoring system generated a malfunction (inoperative) signal. The duty operator noted that the other two power level indications were normal - between 100 and 105% - prior to the scram. All immediate and subsequent actions of reactor emergency procedure REP-5, "Nuclear Instrument Failure," were performed. Subsequent investigation revealed that the uncompensated ion chamber detector and associated cabling were causing excessive loading of the high voltage power supply. The uncompensated ion chamber detector and cabling and the high voltage power supply 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: performing back flushes on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B and pool coolant system heat exchanger HX-521; completing compliance procedure CP-26, "Containment Building Compliance Test;" replacing the trolleys for Personnel Airlock Door 276; completing compliance procedure CP-29, "LAB IMPEX 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 2011

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

On June 6, during a reactor startup with the reactor operating at 5 MW in the manual control mode, a "Reactor Loop Hi Temp Scram" was automatically initiated when primary coolant heat exchanger outlet temperature increased above the scram set point of 148 °F. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were performed. An insufficient configuration of the secondary coolant circulation pumps and cooling tower fans to provide adequate cooling was the cause of the scram. After verification that no Safety Limits or Limiting Safety System Settings had been exceeded, permission to restart the reactor was obtained from the Reactor Manager. The control room staff was reminded of the need to provide greater cooling prior to reaching "the point of adding heat" when outside temperature and humidity conditions are higher than normal.

On June 13, with the reactor operating at 10 MW in the automatic control mode, an unannounced (no audible or visual alarm occurred) rod run-in was initiated when the control room operator noted all four shim control blades moving inward. A brief initial investigation was unable to determine the cause of the rod run-in and the reactor was manually shutdown. Subsequent investigation of all relays, switches and wiring associated with the rod run-in system revealed no abnormalities. This instance was similar to Unscheduled Shutdown No. 1242 at which time the Non-Coincidence Logic Unit and the Trip Actuator Amplifiers were replaced. Temporary monitoring equipment was reattached to the circuit to monitor certain input signals to aid in any future troubleshooting efforts. Operational checks of the rod run-in system were performed satisfactorily and permission to restart the reactor was obtained from the Reactor Manager.

On June 13, with the reactor operating at 10 MW in the automatic control mode, an unannounced (no audible or visual alarm occurred) rod run-in was initiated as the control room operator noted all four shim control blades moving inward. A brief initial investigation was unable to determine the cause of the rod run-in and the reactor was manually shutdown. The temporary monitoring equipment did not indicate that an input signal generated the rod run-in. Additional troubleshooting and investigation were unable to reproduce this system response. The Non-Coincidence Logic Unit and the Trip Actuator Amplifiers were replaced and operational checks of the rod run-in system were performed satisfactorily. Permission to restart the reactor was obtained from the Reactor Manager.

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 and pool coolant system heat exchanger HX-521; 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 compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor;" and adjusting the timing sequence between seal deflation and door actuation for Personnel Airlock Doors 276 and 277.

July 2011

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);" performing a zero and span procedure on Differential Pressure across the Reactor Pool Reflector Transmitter PT-917; replacing the trolley blocks on Personnel Airlock Door 276; performing back flushes 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 repairing the wire harness on control rod 'A' drive mechanism.

August 2011

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: performing back flushes on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B and pool coolant system heat exchanger HX-521; loading new de-ionization bed 'S' and placing it on pool coolant system service; repairing the Fission Product Monitor; removing pneumatic tube system service from laboratory 227; and completing the biennial change-out of Control Blade 'D' Offset Mechanism and associated retesting.

September 2011

The reactor operated continuously in September with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, one scheduled shutdown for physics measurements and two unscheduled/unplanned power reductions. U.S. Nuclear Regulatory Commission examiner arrived at the facility to conduct operator licensing examinations.

On September 1, with the reactor operating at 10 MW in the automatic control mode, a manual reactor shutdown was initiated in order to investigate an abnormal lowering in Reactor Make-Up Water Storage Tank T-300 water level. Upon investigation, it was discovered that Charging Pump Gland Cooling Solenoid Valve 515AF apparently had not fully seated following a routine charging evolution. Valve 515AF automatically opens when Primary Coolant Charging Pump P-533 starts in order to provide packing gland cooling and lubrication. The water source for both the coolant charging pump and gland cooling and lubrication is from T-300. The valve was disassembled and a small amount of debris was found on the valve disc and seating surface. The debris was removed, the valve reassembled and operationally tested satisfactorily. Inspection of the remainder of the system revealed no additional foreign material. The reactor was refueled and permission to restart the reactor was obtained from the Reactor Manager.

On September 2, 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 'B' anvil separated from its electro-magnet following the completion of a routine shimming evolution. The reactor was shut down, and an inspection of the offset mechanism and a pull rod to housing alignment were performed. Satisfactory operation of the shim rod was verified through performance of the applicable portions of compliance procedure CP-25, "Offset Removal, Installation and Control Blade Inspection;" special maintenance procedure SM-RO-625, "Measuring Control Blade Pull Weight and Blade Drop Time with the Test Magnet Assembly, RTP-21;" and compliance procedure CP-10, "Rod Drop Times." The reactor was refueled and permission to restart the reactor was obtained from the Reactor Manager.

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);" updating the PLC control program for containment building Personnel Airlock Doors 276 and 277 as part of Modification Record 09-2, "Airlock Door Control;" and modifying the secondary coolant chemical addition piping and secondary coolant pH and conductivity sensing lines as part of Modification Record 09-4, "Cooling Tower Temporary Cooling."

October 2011

The reactor operated continuously in October with the following exceptions: five shutdowns for scheduled maintenance and/or refueling and one unscheduled/unplanned power reduction. U.S. Nuclear Regulatory Commission regional inspector arrived at the facility for a routine inspection of Reactor Operations and Emergency Preparedness.

On October 7, with the reactor operating at 10 MW in the automatic control mode, a reactor scram was automatically initiated when a momentary interruption in electrical 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 University Power Plant that the cause of the interruption in electrical power was corrected. The reactor was refueled and subsequently restarted to 10 MW operation.

Major maintenance items for the month included: replacing detector cabling on the Reactor Bridge ALARA module of the Area Radiation Monitoring System; completing Modification Record 09-04, "Cooling Tower Temporary Cooling;" completing Modification Record 01-02, Addendum 6, "Intercommunication and Paging System Changes in Support of the North Office Addition Classroom Space, Laboratory Break Room and Laboratory Basement;" repairing rod drop timer contacts on "Loss of Voltage to Magnet C and D Scram" relay; performing back flushes on

the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B and pool coolant system heat exchanger HX-521; and replacing the suction piping expansion boot for secondary coolant circulation pump SP-2.

November 2011

The reactor operated continuously in November with the following exceptions: four shutdowns for scheduled maintenance and/or refueling and one shutdown for physics measurements. There were no unscheduled/unplanned power reductions this month. Received notification from the U.S. Nuclear Regulatory Commission that one new Reactor Operator license had been issued.

Major maintenance items for the month included: performing back flushes on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B and pool coolant system heat exchanger HX-521; performing a reactivity worth measurement in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" replacing the suction piping expansion boot for secondary coolant circulation pump SP-1; and refurbishing the ventilation exhaust isolation valve 16B solenoid-operated air control valve A-150.

December 2011

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

On December 3, with the reactor operating at 10 MW in the automatic control mode, a "Rod Not in Contact with Magnet" rod run-in was automatically initiated when control blade 'D' anvil separated from its electro-magnet during a routine sample handling evolution. The immediate actions of REP-2, "Reactor Scram," were performed. The operators involved were counseled on the importance of proper sample handling techniques near the offset mechanisms. The reactor was refueled and permission to restart the reactor was obtained from the Lead Senior Reactor Operator.

On December 6, with the reactor operating at 10 MW in the automatic control mode, the reactor was manually shut down. Following routine scheduled calibration activities on the iodine channel of the Eberline PING stack monitor, the control room operators observed a higher than normal indication on the chart recorder when returning the monitor to service. Confidence in the monitor's performance was in question and the reactor was immediately shut down as required by Technical Specification 3.4.a. Investigation revealed some Iodine-131 contamination on or in the iodine detector area which had most likely occurred during the calibration procedure. Decontamination efforts proved successful with an iodine indication slightly higher than pre-calibration levels. After consultation with the Reactor Health Physics Manager, the Reactor Manager determined that the reactor could be refueled and restarted.

On December 13, with the reactor operating at 10 MW in the automatic control mode, the reactor was manually shut down because of difficulties in maintaining primary coolant system temperatures in their normal operating bands. While operating on the temporary cooling towers during installation of the new cooling towers, efficiency of the secondary coolant side of the primary coolant heat exchangers had declined due to difficulties in maintaining secondary coolant water chemistry and the buildup of foreign material from the temporary cooling towers. The unseasonably high outside temperatures coupled with the reduced performance of the heat exchangers precluded 10

MW operation. Following back flushes on the secondary coolant side of the primary coolant heat exchangers, the Reactor Manager directed control room personnel to operate the reactor at a reduced power level, as necessary, in order to maintain proper primary coolant system temperatures. The reactor was refueled and permission to restart the reactor was obtained from the Reactor Manager.

On December 20, 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. The duty operator noted all reactor power level 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 fission chamber detector and associated cabling for Nuclear Instrumentation Signal Processor No. 2. An instrument channel calibration, nuclear instrument response check and pre-operational checks were performed satisfactorily. The reactor was refueled and permission to restart the reactor was obtained from the Reactor Manager.

On December 25, with the reactor operating at 9.5 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-11, "Momentary Loss of Normal Electrical Power," were performed. After the cause of the momentary loss of electrical power was confirmed and corrected by the University Power Plant, permission to refuel and restart the reactor was obtained from the Reactor Manager.

Major maintenance items for the month included: performing back flushes on the secondary coolant side of primary coolant system heat exchangers HX-503A and HX-503B and pool coolant system heat exchanger HX-521; completing compliance procedure CP-31, "Calibration of the Eberline Radiation Stack Monitor;" refurbishing control blade selector switch 1S3; electrically connecting the new cooling tower fans to Motor Control Center No. 1; and completing the biennial change-out of Control Blade 'C' Offset Mechanism and associated retesting.

SECTION II

MURR PROCEDURES

January 1, 2011 through December 31, 2011

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 one hundred and one (101) revisions issued to the reactor operations procedures, forms and operator aids. Additionally, two (2) new procedures were issued and six (6) outdated procedures were obsoleted. The majority of the revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the new and revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
AP-RO-110	Conduct of Operations	16	12/9/2011	Minor Editorial
AP-RO-115	Modification Records	7	11/17/2011	Minor Editorial
AP-RO-130	Crane Operation	5	6/14/2011	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	15	11/17/2011	Minor Editorial
EX-RO-120	Beamport "A" Operation	9	10/13/2011	Minor Editorial
EX-RO-121	Beamport "B" Operation	9	10/13/2011	Minor Editorial
EX-RO-122	Beamport "C" Operation	9	10/13/2011	Minor Editorial
EX-RO-123	Beamport "D" Operation	9	10/13/2011	Minor Editorial
EX-RO-124	Beamport "E" Operation	10	10/13/2011	Minor Editorial
EX-RO-125	Beamport "F" Operation	11	10/13/2011	Minor Editorial
EX-RO-126	Thermal Column Door	7	11/17/2011	Minor Editorial
FB-SH-001	Unirradiated Fuel Shipment Using the 110-Gallon USA DOT 6M Type B Package	0	8/11/2011	Obsoleted
FB-SH-005	Type B Shipment of Spent Fuel Using the BMI-1 Shipping Cask	1	8/11/2011	Obsoleted
FB-SH-110	Type B Shipment of Spent Fuel Using the BEA Research Reactor (BRR) Package	0	8/17/2011	New Procedure
FB-SH-120	Annual Inspection and Preventive Maintenance BMI-1 Shipping Cask	0	5/11/2011	Obsoleted
FB-SH-125	Biennial Inspection and Preventive Maintenance BMI-1 Shipping Cask	0	3/11/2011	Obsoleted
FB-SH-130	Test and Calibration Procedure BMI-1 Shipping Cask	0	3/11/2011	Obsoleted
FB-SH-200	O-Ring Fabrication BMI-1 Shipping Cask	0	5/11/2011	Obsoleted
FM-08	Fuel Movement Sheet	7	11/17/2011	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
FM-16	Primary-Pool Coolant Water Analysis	6	3/15/2011	Minor Editorial
FM-18	Deviation From Procedure Report	5	11/17/2011	Minor Editorial
FM-20	Waste Tank Sample Report	9	4/14/2011	Minor Editorial
FM-20	Waste Tank Sample Report	10	6/14/2011	Minor Editorial
FM-21	ARMS Trip Setpoints	7	7/26/2011	Cover Page
FM-21	ARMS Trip Setpoints	8	11/17/2011	Minor Editorial
FM-43	Nuclear and Process Data	14	7/26/2011	Cover Page
FM-43	Nuclear and Process Data	15	11/17/2011	Minor Editorial
FM-55	Startup Nuclear Data	5	3/31/2011	Cover Page
FM-55	Startup Nuclear Data	6	11/17/2011	Cover Page
FM-56	Reactor Routine Patrol	14	3/31/2011	Cover Page
FM-57	Long Form Startup Checksheet	17	11/17/2011	Cover Page
FM-58	Short Form Startup Checksheet	9	11/17/2011	Cover Page
FM-64	DI Resin Log	5	9/9/2011	Cover Page
FM-65	Filter Status Log	5	9/9/2011	Cover Page
FM-71	Pneumatic Tube User Approval	3	6/14/2011	Cover Page
FM-93	Post-Maintenance Valve Lineup Checksheet	4	7/26/2011	Cover Page
FM-152	Fuel Element Inspection	2	12/9/2011	Cover Page
OA-1	Facility Exhaust Fans EF-13 and EF-14, EF-13 Running	6	12/9/2011	Minor Editorial
OA-2	Facility Exhaust Fans EF-13 and EF-14, EF-14 Running	6	12/9/2011	Minor Editorial
OA-3	Beamport and Pool Overflow Loop Seals	6	2/18/2011	Minor Editorial
OA-3	Beamport and Pool Overflow Loop Seals	7	11/17/2011	Cover Page
OA-4	Valve Operation Air Compressor	5	11/17/2011	Cover Page
OA-5	Emergency Air Compressor	5	11/17/2011	Cover Page
OA-7	Receiving Bulk Chemicals	4	9/9/2011	Cover Page
OP-RO-100	Main Air System	8	3/31/2011	Cover Page
OP-RO-101	Instrument Air System	8	3/31/2011	Cover Page
OP-RO-210	Reactor Startup-Normal	11	6/14/2011	Minor Editorial
OP-RO-211	Reactor Startup – Hot	9	7/26/2011	Cover Page
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	9	11/17/2011	Cover Page
OP-RO-220	Reactor Shutdown or Power Reduction	6	7/26/2011	Cover Page
OP-RO-230	Changing Reactor Power Level	6	7/26/2011	Cover Page
OP-RO-250	In-Pool Fuel Handling	14	9/9/2011	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	15	11/17/2011	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	8	6/14/2011	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	9	6/14/2011	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	11	6/14/2011	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	8	7/11/2011	Minor Editorial
OP-RO-340	Nuclear Instrument Adjustment	8	6/14/2011	Minor Editorial
OP-RO-350	Reactor Power Calculator Flow Potentiometer Adjustment	5	9/9/2011	Cover Page
OP-RO-410	Primary Coolant System	9	3/15/2011	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
OP-RO-420	Primary and Pool Water Analysis	5	10/13/2011	Minor Editorial
OP-RO-460	Pool Coolant System - Two Pump Operation	13	8/12/2011	Minor Editorial
OP-RO-461	Pool Coolant System - One Pump Operation	11	2/7/2011	Minor Editorial
OP-RO-461	Pool Coolant System - One Pump Operation	12	8/12/2011	Minor Editorial
OP-RO-465	Pool Level Control – Skimmer System	7	6/14/2011	Minor Editorial
OP-RO-466	Pool Level Control - Pool Coolant System	10	6/14/2011	Minor Editorial
OP-RO-480	Secondary Coolant System	14	7/11/2011	Minor Editorial
OP-RO-510	Nitrogen System	6	6/14/2011	Minor Editorial
OP-RO-515	Emergency Air System	7	11/17/2011	Minor Editorial
OP-RO-516	Valve Operation Air System	8	9/9/2011	Minor Editorial
OP-RO-520	Emergency Diesel Generator	9	11/17/2011	Minor Editorial
OP-RO-525	Chill Water System	4	6/14/2011	Minor Editorial
OP-RO-525	Chill Water System	5	7/11/2011	Minor Editorial
OP-RO-530	Demineralized Water Supply System	11	9/9/2011	Minor Editorial
OP-RO-531	Primary and Pool Sample Station	9	7/26/2011	Minor Editorial
OP-RO-532	Drain Collection System	8	7/26/2011	Minor Editorial
OP-RO-533	Skimmer System	6	10/13/2011	Minor Editorial
OP-RO-710	Radiation Monitoring – Area Monitors	6	10/6/2011	Minor Editorial
OP-RO-720	Radiation Monitoring – Stack Monitor Operational Check	8	9/9/2011	Minor Editorial
OP-RO-730	Facility Exhaust System	13	6/14/2011	Cover Page
OP-RO-741	Waste Tank System Operation	11	6/14/2011	Minor Editorial
OP-RO-741	Waste Tank System Operation	12	11/17/2011	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	12	2/17/2011	Cover Page
REP-RO-100	Reactor Emergency Procedures	13	7/6/2011	Minor Editorial
RM-RO-400	Waste Tank System Filter Replacement	6	3/31/2011	Cover Page
RM-RO-405	Reactor Demineralizer System	12	10/6/2011	Minor Editorial
RM-RO-470	Sulfuric Acid System	6	3/31/2011	Minor Editorial
RM-RO-470	Sulfuric Acid System	7	9/9/2011	Minor Editorial
RP-RO-100	Fuel Movement	10	6/14/2011	Minor Editorial
RP-RO-200	Measurement of Differential Worth of a Shim Blade, RTP-11(D)	5	9/9/2011	Minor Editorial
RP-RO-201	Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)	4	9/9/2011	Cover Page
RP-RO-202	Measurement of Reactivity Worth of Movable Samples, RTP-6	2	6/14/2011	Cover Page
RP-RO-203	Measurement of Primary Coolant/Moderator Temperature Coefficient of Reactivity, RTP-19	0	7/26/2011	New Procedure
RP-RO-300	Receipt, Inspection and Accounting of Unirradiated Fuel	2	6/9/2011	Minor Editorial
SM-RO-011	Beryllium Reflector Replacement	2	2/15/2011	Cover Page
SM-RO-200	Manual Operation of Airlock Doors 276 and 277	1	10/6/2011	Minor Editorial
SM-RO-300	Control Console And Instrument Panel-Securing Power	9	10/6/2011	Minor Editorial
SM-RO-420	Pressurizer Operation – Maintenance & Test	4	9/15/2011	Minor Editorial
SM-RO-620	Control Blade Leak Test	4	12/9/2011	Cover Page

Number	Name	Rev.	Revision Date	Notes
SM-RO-625	Measuring Control Blade Pull Weight and Blade Drop Time with the Test Magnet Assembly, RTP-21	1	9/15/2011	Minor Editorial
SM-RO-630	Removing and Reinstalling Reflector Elements in the GH and No. 9 Positions	1	7/5/2011	Minor Editorial
SM-RO-635	Retracting and Reinserting Beamport 'A' Liner	4	2/15/2011	Minor Editorial
SM-RO-636	Retracting and Reinserting Beamport 'B' Liner	4	2/15/2011	Minor Editorial
SM-RO-637	Retracting and Reinserting Beamport 'C' Liner	4	2/15/2011	Minor Editorial
SM-RO-638	Retracting and Reinserting Beamport 'D' Liner	5	2/15/2011	Minor Editorial
SM-RO-639	Retracting and Reinserting Beamport 'E' Liner	4	1/31/2011	Minor Editorial
SM-RO-640	Retracting and Reinserting Beamport 'F' Liner	5	7/5/2011	Minor Editorial
SM-RO-650	Cleaning the Acid Day Tank Sight Glass	1	4/15/2011	Minor Editorial
SM-RO-661	Pool Coolant Hold-Up Tank Welding Repair Instructions	1	12/9/2011	Cover Page

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 forty-five (45) 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-001	Definitions	3	5/25/2011	Cover Page
EP-RO-002	Emergency Responsibilities	3	5/25/2011	Cover Page
EP-RO-003	Emergency Preparedness Training	4	5/25/2011	Cover Page
EP-RO-004	Fire	5	5/25/2011	Cover Page
EP-RO-005	Medical Emergency	2	5/25/2011	Minor Editorial
EP-RO-006	Radiological Emergency	4	5/25/2011	Minor Editorial
EP-RO-007	Severe Natural Phenomenon	4	5/25/2011	Cover Page
EP-RO-008	Threat to Security	2	5/25/2011	Cover Page
EP-RO-009	Notification of Unusual Event	2	5/25/2011	Cover Page
EP-RO-010	Alert	2	5/25/2011	Cover Page
EP-RO-011	Site Area Emergency	2	5/25/2011	Cover Page
EP-RO-012	Reactor Isolation	3	5/25/2011	Cover Page
EP-RO-013	Facility Evacuation	4	5/25/2011	Minor Editorial
EP-RO-014	EPZ and Site Area Evacuations	7	5/25/2011	Cover Page
EP-RO-015	Emergency Notifications	6	5/25/2011	Cover Page
EP-RO-015	Emergency Notifications	7	11/7/2011	Minor Editorial
EP-RO-016	Public Information	2	5/25/2011	Cover Page
EP-RO-017	Emergency Air Sampling	6	5/25/2011	Cover Page
EP-RO-018	Emergency Radiation Exposure	4	5/25/2011	Cover Page
EP-RO-019	Emergency Dosimeters	2	5/25/2011	Cover Page
EP-RO-020	Emergency Equipment Maintenance	5	5/25/2011	Cover Page

Number	Name	Rev.	Revision Date	Notes
FM-100	Emergency Declaration	2	5/25/2011	Cover Page
FM-101	FEO Management	2	5/25/2011	Cover Page
FM-102	Emergency Event Log	2	5/25/2011	Cover Page
FM-103	Facility Status	2	5/25/2011	Cover Page
FM-104	Emergency Call List	16	3/23/2011	Minor Editorial
FM-104	Emergency Call List	17	5/25/2011	Cover Page
FM-104	Emergency Call List	18	11/07/2011	Minor Editorial
FM-105	Initial/Follow-Up Emergency Message	2	5/25/2011	Cover Page
FM-106	Log of Personnel Released From Site	2	5/25/2011	Cover Page
FM-110	Fire Flowchart	3	5/25/2011	Cover Page
FM-111	Medical Flowchart	2	5/25/2011	Cover Page
FM-112	Radiological Flowchart	2	5/25/2011	Cover Page
FM-113	Severe Natural Phenomenon Flowchart	2	5/25/2011	Cover Page
FM-114	Security Flowchart	2	5/25/2011	Cover Page
FM-115	Plant Conditions Flowchart	2	5/25/2011	Cover Page
FM-116	Classification Flowchart	2	5/25/2011	Cover Page
FM-117	Reactor Isolation Flowchart	2	5/25/2011	Cover Page
FM-118	Evacuation Flowchart	4	5/25/2011	Cover Page
OA-09	Combined Emergency Flowcharts	4	5/25/2011	Cover Page
OA-10	Fire Extinguisher Locations and Types	6	5/25/2011	Cover Page
OA-10	Fire Extinguisher Locations and Types	7	10/12/2011	Minor Editorial
OA-20	Emergency Equipment	9	5/25/2011	Cover Page
OA-20	Emergency Equipment	10	7/21/2011	Minor Editorial
OA-20	Emergency Equipment	11	10/12/2011	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 eighty-five (85) revisions issued to the health physics, radioactive materials shipping, and preparation for shipping procedures and forms. Additionally, two (2) new forms and two (2) new procedures were issued, and two (2) outdated 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-117	MURR Initial Radiation Worker Training Program	10	1/11/2011	Minor Editorial
AP-HP-119	Hot Cell, HC-01 Control	7	4/27/2011	Minor Editorial
AP-HP-119	Hot Cell, HC-01 Control	8	12/9/2011	Minor Editorial
AP-SH-001	Administrative Procedure, Radioactive Materials Shipping	7	3/11/2011	Cover Page
AP-SH-002	In-House Radioactive Shipping Request Form Instructions	0	5/18/2011	New Procedure

Number	Name	Rev.	Revision Date	Notes
BPB-SH-002	20WC-1 Packaging and Shipment of Type B Non-Waste Radioactive Material	10	9/29/2011	Minor Editorial
BPB-SH-005	DOT 6M Packaging of Type B Non-Waste Radioactive Material	9	5/18/2011	Minor Editorial
BPB-SH-020	Receipt Inspection of Type B Byproduct Material Shipping Containers	2	8/11/2011	Minor Editorial
BPB-SH-021	20 WC-1 All-Thread Rod Replacement	2	9/29/2011	Minor Editorial
BPB-SH-022	Painting USA DOT 20 WC-1 Overpack	2	8/11/2011	Minor Editorial
BPB-SH-024	Type B(U) F-327 Series Packaging of Type B Non-Waste Radioactive Material	1	9/29/2011	Minor Editorial
BPB-SH-026	Type B(U) ZA/NNR1005 (Beatrice) Packaging of Type B Non-Waste Radioactive Material	0	6/7/2011	Full Review
BP-SH-007	F-327 Packaging and Shipment of Type A Radioactive Material	7	4/6/2011	Obsoleted
BP-SH-010	Packaging and Shipment of Non-Waste Radioactive Materials in Excepted Packages	4	12/5/2011	Minor Editorial
BP-SH-011	Shipment of Non-Waste USA DOT 7A Type A 55-Gallon Radioactive Material Package	5	12/5/2011	Minor Editorial
BP-SH-012	DOT-7A Package Certification	5	4/6/2011	Cover Page
BP-SH-013	Packaging and Shipment of Radioactive Materials Using MURR Reusable Type A Package	5	3/24/2011	Cover Page
BP-SH-014	Packaging and Shipment of Radioactive Material Using an Overpack	4	4/6/2011	Minor Editorial
BP-SH-015	Packaging and Shipment of Radioactive Material using a USA DOT 7A Model 30	3	12/5/2011	Minor Editorial
BP-SH-016	Packaging and Shipment of Radioactive Material using a USA DOT 7A Model H or I Package	2	9/16/2011	Cover Page
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	7	74/22/2011	Minor Editorial
BP-SH-302	Packaging and Shipment of Radioactive Material Using MURR Models 6 and 12	4	9/16/2011	Minor Editorial
FM-09	Gemstone Irradiation Sheet	5	12/22/2011	Cover Page
FM-10	MURR Sample Log	4	12/22/2011	Cover Page
FM-12	Gemstone Loading Sheet	5	12/22/2011	Cover Page
FM-13	Receipt of Radioactive Material	6	1/14/2011	Minor Editorial
FM-17	Radiation Work Permit	9	11/23/2010	Cover Page
FM-27	In-House Radioactive Shipping Request Form	9	5/18/2011	Minor Editorial
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	14	9/16/2011	Cover Page
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	15	12/5/2011	Minor Editorial
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	8	2/17/2011	Minor Editorial
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	9	4/22/2011	Minor Editorial
FM-60	Control Check Sheet for MURR Shipment Using USA DOT 7A Model 30	2	9/16/2011	Cover Page
FM-60	Control Check Sheet for MURR Shipment Using USA DOT 7A Model 30	3	12/5/2011	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
FM-62	Radiation Instrument Certification of Calibration	6	6/22/2011	Minor Editorial
FM-67	Receipt of Radioactive Gemstone Shipping Containers	6	5/11/2011	Cover Page
FM-69	Control Checksheet for MURR Reusable Type A Radioactive Materials Shipment	7	5/11/2011	Cover Page
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	13	9/16/2011	Cover Page
FM-94	Exclusive Use Shipment Controls	3	4/6/2011	Cover Page
FM-98	Control Checksheet for MURR Shipment Using USA DOT 7A MURR Model 6 or 12	6	9/16/2011	Cover Page
FM-99	Control Checksheet for USA DOT 7A MURR Model 1500 Series	6	12/5/2011	Cover Page
FM-107	Control Check Sheet for Overpack Shipment	4	1/31/2011	Cover Page
FM-107	Control Check Sheet for Overpack Shipment	5	4/6/2011	Cover Page
FM-120	Individual Type B QA Training Certification	3	3/11/2011	Cover Page
FM-126	Documentation of Compliance for DOT-7A Shipping Container	2	4/6/2011	Cover Page
FM-128	Control Check Sheet For MURR Shipment Using USA DOT 7A MURR Model H or I	2	9/16/2011	Cover Page
FM-129	Control Checksheet for Receipt Inspection of Type B Byproduct Material Shipping Containers	2	12/5/2011	Minor Editorial
FM-150	Statement of Training and Experience	3	12/29/2011	Minor Editorial
FM-151	Control Checksheet for Non-Waste USA DOT 7A Type A 55-Gallon Radioactive Material Package	6	1/31/2011	Cover Page
FM-151	Control Checksheet for Non-Waste USA DOT 7A Type A 55-Gallon Radioactive Material Package	7	12/5/2011	Cover Page
FM-154	Control Checksheet for USA DOT 20 WC-1 Overpack Rod Replacement	2	9/29/2011	Minor Editorial
FM-156	Required Documentation for Non-MURR Owned Type B Shipping Containers	1	1/14/2011	Cover Page
FM-157	Control Checksheet for Type B(U) F-458 Series Radioactive Materials Shipment	1	2/11/2011	Minor Editorial
FM-159	Control Checksheet for Health Physics Review of Radioactive Materials Shipment Documentation	0	4/22/2011	Full Review
FM-159	Control Checksheet for Health Physics Review of Radioactive Materials Shipment Documentation	1	6/7/2011	Minor Editorial
FM-160	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	0	6/7/2011	Full Review
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	10	12/15/2011	Minor Editorial
HC-PSO-005	Hot Cell Loading of Host Cans	8	1/7/2011	Minor Editorial
IC-HP-310	Calibration – Eberline Ping 1a Stack Monitor – Particulate Channel	6	10/6/2011	Minor Editorial
IC-HP-311	Calibration – Eberline Ping 1a Stack Monitor – Iodine Channel	6	10/6/2011	Minor Editorial
IC-HP-312	Calibration – Eberline Ping 1a Stack Monitor – Gas Channel	6	10/6/2011	Minor Editorial
IC-HP-348	Calibration – Canberra S5XLB-G & Tennelec Series 4 with Gamma, & Tennelec Series 3	5	12/9/2011	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
IC-HP-349	Calibration - Lab Impex Stack Monitor-Particulate Channel	2	12/9/2011	Minor Editorial
IC-HP-350	Calibration – Lab Impex Stack Monitor Iodine Channel	1	12/9/2011	Minor Editorial
IC-HP-351	Calibration – Lab Impex Stack Monitor - Gas Channel	1	12/9/2011	Minor Editorial
IC-HP-352	Calibration – Lab Impex Stack Monitor – Particulate Channel	1	12/9/2011	Minor Editorial
IC-HP-353	Calibration – Lab Impex Monitor – DP2001	0	2/24/2011	Full Review
IRR-PSO-112	Preparing Shipping Paperwork	5	8/16/2011	Cover Page
OP-HP-200	Air Sampling – Containment Building Tritium	4	3/16/2011	Cover Page
OP-HP-220	Tritium Bioassay	7	5/19/2011	Minor Editorial
OP-HP-222	Air Sampling – Containment Building Ar-41	5	3/16/2011	Cover Page
OP-HP-227	Tennelec LB-5100 Alpha/Beta – Operation	4	6/22/2011	Obsoleted
OP-HP-353	Waste Tank Sample - Analysis	7	6/22/2011	Minor Editorial
OP-HP-356	Operation - Lab Impex Stack Monitor - Filter Change and Source Checks	1	6/24/2011	Minor Editorial
POL-03	Radiation Protection Program	10	1/7/2011	Minor Editorial
POL-03	Radiation Protection Program	11	10/10/2011	Minor Editorial
QAB-SH-002	Procurement of Type B Packages	1	2/11/2011	Cover Page
QAB-SH-003	Material Control for Type B Shipping Program	1	2/11/2011	Cover Page
QAB-SH-003	Material Control for Type B Shipping Program	2	9/29/2011	Minor Editorial
QAB-SH-004	Type B Program Vendor Qualification	1	2/11/2011	Cover Page
QAB-SH-005	Type B QA Personnel Training	2	12/5/2011	Minor Editorial
RP-HP-105	Transfer of Radioactive Material – In Facility	6	3/16/2011	Cover Page
RP-HP-110	Survey and Decontamination of Returned Shipping Container	5	4/27/2011	Cover Page
SI-PSO-008	Post-Irradiation Processing: Exported Flooded Silicon Cans	5	5/12/2011	Cover Page
SV-HP-119	Property Release	5	6/24/2011	Minor Editorial
TPZ-PSO-001	Receiving Gemstone Irradiation Shipping Drums	6	4/14/2011	Cover Page
TPZ-PSO-002	Irradiation of Gemstone Irradiation Containers	5	4/14/2011	Cover Page
TPX-PSO-003	Loading Gemstone Shipping Drums	4	4/14/2011	Cover Page
WM-SH-100	Radioactive Waste – Preparation and Storage	6	12/5/2011	Cover Page
WM-SH-105	Radioactive Waste Processing	7	12/5/2011	Minor Editorial
WM-SH-300	Exclusive Use Shipment of LSA or SCO Radioactive Waste	9	12/5/2011	Cover Page

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2011 through December 31, 2011

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

HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

Original HSR, Section 7.2.9, Table 7.2, page 7-21 (as revised by the 1995, 2001, 2007 and 2009 Reactor Operations Annual Reports):

Add: The following after "Room 2041":

"Room 2046
Room 2047A
Room 2048"

Add: The following after "Room 103":

"Room 110"

Add: The following after "Room 267A":

"Room 269"

Original HSR, Figure 5.1, Piping & Instrument Diagram (as revised by the 1972-73, 1973-74, 1994, 1996, 2001, 2002, 2003, 2004, 2006, 2007, 2009 and 2010 Reactor Operations Annual Reports):

Replace with: Updated Figure 5.1, Piping & Instrument Diagram (MURR Dwg No. 156, Sheet 1 of 1, dated 7/1/11)

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, 2009 and 2010 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.3.a, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 10/6/11)

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, 2009 and 2010 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 6/28/11)

HSR, Addendum 3, Figure 2.3.c, page 23c, Electrical Distribution (as added by the 2004 and revised by the 2005, 2007, 2009 and 2010 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 11/16/11)

HSR, Addendum 3, Figure 2.3.d, page 23d, Electrical Distribution (as added by the 2007 and revised by the 2008, 2009 and 2010 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, dated 12/1/10)

HSR, Addendum 3, Figure 2.3.e, page 23e, Electrical Distribution (as added by the 2007 and revised by the 2009 and 2010 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 6/28/11)

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

HSR, Addendum 4, Figure A.2, page A-20, Piping & Instrument Diagram (as revised by the 1995, 2001, 2002, 2003, 2004, 2006, 2007, and 2009 Reactor Operations Annual Reports):

Replace with: Updated Figure A.2, Piping & Instrument Diagram (MURR Dwg No. 156, Sheet 1 of 1, dated 7/1/11)

HSR, Addendum 4, Figure A.11, page A-29, Schematic Diagram of Laboratory and Containment Building Ventilation Systems (as revised by the 1995, 2002, 2005, 2009 and 2010 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 9/11/11)

ADDENDUM 5 - HAZARDS SUMMARY REPORT (JANUARY 1974)

HSR, Addendum 5, Figure 2.1, page 15, Electrical Distribution (as revised by the 1989-90, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2009 and 2010 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.1, Electrical Distribution Reactor/Laboratory (MURR Dwg No. 522, Sheet 1 of 5, dated 10/6/11)

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

January 1, 2011 through December 31, 2011

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 01-2, Addendum 5:

Intercommunication and Paging System Changes in Support of the North Office Addition Lab Space

This addendum to modification record 01-2, "Installation of a New Reactor Facility Intercommunication and Paging System," documents changes to the facility intercommunication and paging system that were necessary in order to safely occupy the new laboratory space in the North Office Addition (NOA). To ensure a prompt and effective response from facility staff to an emergency or abnormal condition, the intercommunication and paging system was extended into the NOA laboratory space.

Modification 01-2, Addendum 6:

Intercommunication and Paging System Changes in Support of the North Office Addition Classroom Space, Laboratory Break Room and Laboratory Basement

This addendum to modification record 01-2, "Installation of a New Reactor Facility Intercommunication and Paging System," documents changes to the facility intercommunication and paging system that were necessary in order to safely occupy the new classroom space in the North Office Addition (NOA) and provide additional coverage within NOA. To ensure a prompt and effective response from facility staff to an emergency or abnormal condition, the intercommunication and paging system was extended into the NOA classroom space, NOA break room and NOA basement.

Modification 09-04:

Cooling Tower Temporary Cooling

This modification record documents the changes to the Secondary Coolant and Normal Electrical Power Systems to allow connection of temporary cooling to the existing system. The existing cooling towers cells were approaching the end of their operational lifetime due to the degrading integrity of wooden structure members as well as steel fan support members. The planned replacement of these cells required several weeks to complete. To ensure continued reactor operation at 10 MW for the duration of the maintenance, rental cooling towers were connected to provide a means of cooling the Secondary Coolant System.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2011 through December 31, 2011

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

RUR 219, as amended: Irradiations

Description: This RUR authorizes an unrestricted fluence on the irradiation of silicon. Silicon spacer material has been irradiated for long periods of time without complications.

RUR 231, as amended: Produce Semiconductor Materials

Description: This RUR authorizes an unrestricted fluence on the irradiation of silicon. Silicon spacer material has been irradiated for long periods of time without complications.

RUR 439: Molybdenum (Mo)

Description: This RUR authorizes the irradiation of up to 480.0 grams of molybdenum, natural or enriched up to 95% in the isotope Mo-98, in support of research and development activities.

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, 2011 through December 31, 2011

Inspections:

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

Reactor Characteristic Measurements:

Sixty-two (62) refueling evolutions were completed in 2011. Excess reactivity verifications were performed for each refueling. The largest measured excess reactivity value was 3.68%. MURR Technical Specification 3.1(f) requires excess reactivity to be less than 9.8%.

Reactivity Measurements:

Differential blade-worth measurements of six (6) 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.

Five (5) reactivity measurements were performed to determine the reactivity worth of all the samples, including the sample holder, loaded in the flux trap region.

Four (4) reactivity measurements were performed to determine the reactivity worth of various sample cans irradiated in the flux trap region, including the worth of an empty sample holder.

In support of the Nuclear Engineering student labs, two (2) differential blade-worth measurements and two (2) primary coolant temperature coefficient measurements were also performed.

SECTION VII

RADIOACTIVE EFFLUENT

January 1, 2011 through December 31, 2011

TABLE I
SANITARY SEWER EFFLUENT

January 1, 2011 through December 31, 2011

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

Nuclide	Activity (Ci)
H-3	9.802E-02
S-35	2.482E-02
Lu-177	9.168E-03
P-32	5.175E-03
Co-60	2.589E-03
Zn-65	7.669E-04
Ca-45	6.199E-04
Sc-46	1.348E-04
Re-188	6.633E-05
Sb-124	6.141E-05
Mn-54	3.182E-05
Na-22	3.059E-05
I-131	3.045E-05
Ag-110m	2.323E-05
Co-57	1.237E-05
Total H-3	9.802E-02
Total Other	4.353E-02

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

TABLE 2
STACK EFFLUENT

January 1, 2011 through December 31, 2011

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration (μCi/ml)	Total Release (Ci)	TS Limit Multiplier	% TS
Ar-41	1.58E-06	7.97E+02	350	45.1400
C-14	1.43E-11	6.80E-03	1	0.4770
I-131	1.01E-13	5.12E-05	1	0.0506
H-3	1.74E-08	8.80E+00	350	0.0496
Cs-137	2.39E-15	1.21E-06	1	0.0012
Zn-65	3.54E-15	1.79E-06	1	0.0009
Os191	1.55E-14	7.85E-06	1	0.0008
Zr-95	2.08E-15	1.06E-06	1	0.0005
Pa-233	2.59E-15	1.31E-06	1	0.0003
Cu-67	5.41E-12	2.74E-03	350	0.0003
Co-58	2.42E-15	1.22E-06	1	0.0002
S-35	5.96E-15	3.02E-06	1	0.0002
Hf-175	1.18E-15	5.99E-07	1	0.0001
I-133	2.09E-13	1.06E-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, 2011 through December 31, 2011

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 2011. All doses are approximately 16 mRem/year or less, except monitor numbers 9 and 15. 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 79

Spring 2011

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.73 pCi/L	3.26 pCi/L	200.40 pCi/L	3.89 pCi/mL of sample
Soil	0.00 pCi/g	2.78 pCi/g	0.52 pCi/g	N/A
Vegetation	1.01 pCi/g	5.01 pCi/g	1.42 pCi/g	3.74 pCi/mL of distillate

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V79	< 1.01	19.71	< 1.42	< 3.74
2V79	< 1.01	21.65	< 1.42	< 3.74
3V79	< 1.01	12.33	< 1.42	< 3.74
4V79	< 1.01	18.19	< 1.42	< 3.74
5V79	< 1.01	23.86	< 1.42	< 3.74
6V79	< 1.01	21.13	< 1.42	< 3.74
7V79	1.10	17.13	< 1.42	< 3.74
10V79	< 1.01	22.94	< 1.42	< 3.74

TABLE 1 (Cont'd)

Summary of Environmental Set 79

Spring 2011

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S79	0.63	12.37	2.19
2S79	0.30	11.12	2.88
3S79	0.00	10.10	1.92
4S79	0.65	12.25	13.61
5S79	2.21	15.70	3.06
6S79	1.25	12.97	2.25
7S79	1.06	8.94	1.96
10S79	1.41	13.37	2.91

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W79	< 0.73	< 3.26	< 200.40	< 3.89
6W79	< 0.73	< 3.26	< 200.40	< 3.89
10W79	< 0.73	3.27	< 200.40	< 3.89

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 80

Fall 2011

Detection Limits[1]

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.03 pCi/L	2.98 pCi/L	207.40 pCi/L	6.03 pCi/mL of sample
Soil	0.00 pCi/g	3.08 pCi/g	0.60 pCi/g	N/A
Vegetation	1.32 pCi/g	6.14 pCi/g	1.63 pCi/g	5.70 pCi/mL of distillate

TABLE 2 (Cont'd)

Summary of Environmental Set 80

Fall 2011

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V80	< 1.32	16.37	< 1.63	< 5.70
2V80	< 1.32	14.06	3.34	23.88
3V80	< 1.32	< 6.14	5.57	< 5.70
4V80	< 1.32	20.79	4.04	< 5.70
5V80	< 1.32	19.80	19.36	< 5.70
6V80	< 1.32	6.66	17.62	28.09
7V80	< 1.32	16.57	12.27	< 5.70
10V80	< 1.32	30.55	4.24	< 5.70

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S80	1.37	11.92	3.60
2S80	1.24	9.71	3.16
3S80	0.77	10.39	2.22
4S80	0.63	6.44	3.49
5S80	1.24	14.90	3.53
6S80	1.55	9.12	3.80
7S80	0.92	55.63	3.86
10S80	1.70	10.69	3.22

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W80	< 1.03	5.64	< 207.40	< 6.03
6W80	< 1.03	3.37	< 207.40	< 6.03
10W80	< 1.03	10.69	< 207.40	< 6.03

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, 2011 through December 31, 2011

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2011 Net mR	2nd Qtr. 2011 Net mR	3rd Qtr. 2011 Net mR	4th Qtr. 2011 Net mR	Total 2011 Net mR
	Control 0	N/A	32.0	30.0	22.0	28.0	112.0
1	Control 1	16600	28.0	25.0	25.0	28.0	106.0
2	Control 2	16600	24.0	25.0	24.0	30.0	103.0
3	WSW	N/A	0.0	0.0	0.0	1.3	1.3
4*							
5*							
6	N	34	0.0	0.0	0.2	5.3	5.5
7	NE	57	0.0	0.0	0.0	1.3	1.3
8	SW	27	4.3	2.3	3.3	6.3	16.0
9	S	27	21.3	27.3	11.3	20.3	80.0
10	NE	149	0.0	0.0	0.0	0.0	0.0
11	NW	149	2.3	0.0	0.2	0.2	2.7
12	ENE	301	0.0	0.0	2.3	7.3	9.5
13	NNE	316	1.3	0.0	0.0	0.0	1.3
14	S	156	0.0	0.0	1.3	4.3	5.5
15	S	65	13.3	13.3	11.3	19.3	57.0
16	SE	107	0.0	0.0	0.0	0.0	0.0
17	E	293	0.0	0.0	0.0	0.0	0.0
18	NE	476	0.0	0.0	0.0	0.0	0.0
19	NNE	606	0.0	0.0	0.0	0.0	0.0
20	NE	907	0.0	0.0	0.0	0.0	0.0
21	SE	236	0.0	0.0	0.2	1.3	1.5
22	ESE	168	0.0	0.0	0.0	0.0	0.0
23	NW	110	0.0	0.0	0.0	2.3	2.3
24	SSW	328	0.0	0.0	0.0	0.2	0.2
25	SSW	480	0.0	0.0	0.2	1.3	1.5
26	SW	301	0.0	0.0	0.0	0.0	0.0
27	WSW	141	0.0	0.0	0.0	0.0	0.0
28	WNW	210	0.0	0.0	0.0	1.3	1.3
29	NW	255	0.0	0.0	0.0	5.3	5.3
30	NNW	328	0.2	0.0	0.0	0.0	0.2
31	NNW	671	0.2	0.0	0.2	0.2	0.7
32	NNW	724	0.0	0.0	0.0	0.0	0.0
33	E	671	0.0	0.0	0.0	0.0	0.0
34	ENE	587	0.0	0.0	0.0	0.0	0.0
35	SSE	499	0.0	absent	0.2	5.3	5.5
36	SE	419	0.0	0.0	0.0	0.0	0.0
37	NE	690	0.0	0.0	0.0	0.0	0.0
38	NW	556	0.0	0.0	0.0	2.3	2.3
39	W	491	0.0	0.0	0.0	0.0	0.0
40	N	541	0.0	0.0	0.0	0.0	0.0
41	NNE	137	0.0	0.0	0.0	0.2	0.2
42*							
43*							
44	Spare	N/A	0.0	0.0	0.0	4.3	4.3
45	S	65	0.0	0.0	0.0	0.2	0.2
46	E	70	4.3	0.2	0	4.3	8.7

*These badge numbers are no longer used.

TABLE 4
Number of Facility Radiation and Contamination Surveys

January 1, 2011 through December 31, 2011

	Radiation	Surface Contamination*	Air Samples**	RWP's
January	67	67	45	8
February	75	75	54	2
March	115	115	71	9
April	53	53	62	10
May	78	78	62	8
June	74	74	54	5
July	82	82	53	7
August	37	37	58	8
September	79	79	56	12
October	81	81	51	5
November	58	58	46	5
December	64	64	54	8
TOTALS	**863**	**863**	**666**	**87**

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

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

Miscellaneous Notes

Nathan Hogue was promoted to Health Physicist in August 2011.

Jason Mitchell and Dan Nickolaus were promoted to Health Physics Technician II in October 2011.

During calendar year 2011, MURR shipped 711.3 cubic feet of low-level radioactive waste containing 5,503 mCi of activity.

Summary of Radiation Exposure to Facility Staff, Experimenters and Visitors
January 1, 2011 through December 31, 2011

TOTAL PERSONNEL DOSE (MREM) BY DOSIMETRY GROUP

	AC	BCS	DO	FOE	HC/SH	HP	IRR	NA	NS	OPS	PRO	QA	RES	RP	SIL	TEE	WC	Total
January	88	N/A	203	256	455	283	40	147	120	1382	143	N/A	161	199	138	N/A	N/A	3615
February	33	N/A	21	74	559	362	9	44	23	1024	103	N/A	71	88	94	N/A	N/A	2505
March	14	N/A	41	89	435	262	10	19	21	1298	118	N/A	56	109	162	N/A	N/A	2634
April	30	N/A	7	132	258	164	9	21	24	1070	125	N/A	13	82	117	N/A	N/A	2052
May	39	N/A	121	168	227	382	17	80	116	1162	108	N/A	172	224	122	N/A	N/A	2938
June	64	N/A	68	126	329	598	27	133	139	1246	252	N/A	199	233	188	N/A	N/A	3602
July	53	56	20	41	431	203	16	101	154	1403	290	82	266	114	177	N/A	87	3494
August	47	3	2	12	442	179	6	39	82	1852	239	44	512	36	165	N/A	106	3766
September	60	13	2	2	538	227	0	72	36	1361	213	66	132	27	131	N/A	103	2983
October	20	9	10	13	245	200	9	30	72	1307	165	21	11	37	106	3	97	2355
November	68	34	0	13	252	212	3	8	79	1383	141	57	24	97	154	27	112	2664
December	24	23	0	7	232	153	3	4	29	1567	95	42	21	70	126	18	101	2515
Total for Year	**540**	**138**	**495**	**933**	**4403**	**3225**	**149**	**698**	**895**	**16055**	**1992**	**312**	**1638**	**1316**	**1680**	**48**	**606**	**35123**
Monthly Avg	**45**	**23**	**41**	**78**	**367**	**269**	**12**	**58**	**75**	**1338**	**166**	**52**	**137**	**110**	**140**	**16**	**101**	**2927**
Highest WB (annual)	**126**	**60**	**34**	**52**	**1253**	**1248**	**60**	**103**	**278**	**1010**	**536**	**183**	**212**	**199**	**579**	**94**	**305**	
High EXT (annual)	**1751**	**91**	**M**	**51**	**3209**	**1609**	**36**	**1430**	**574**	**2895**	**2887**	**668**	**260**	**1326**	**1208**	**742**	**2903**	

AC - Analytical Chemistry
BCS - Business & Central Services
DO - Director's Office
FOE - Shops & Support
HC/SH - Hot Cell-Shipping
HP - Health Physics
IRR - Irradiations
NA - Nuclear Analysis
NS - Neutron Scattering
OPS - Operations
PRO - Isotope Processing
QA - Quality Assurance
RES - Research
RP - Radiopharmaceutical
SIL - Silicon
TEE - Trace Elemental Epidemiology
WC - Work Control

WB = Whole Body EXT = Extremities M = Minimal

Dosimetry services are provided by Mirion Technologies (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.

NOTES:
Due to splitting of groups, some annual WB and EXT numbers may reflect dose received prior to that person moving from one group to another.
BCS members were split off from the DO Group to better reflect their activities related to radiation exposure potential.
QA members were split off from the old Regulatory Assurance Group (now HP) to better reflect their job functions and radiation exposure potential.
TEE members were split off from the RES Group to better reflect their job functions and radiation exposure potential.
WC members were split off from the FO Group (now FOE) to better reflect their job functions and radiation exposure potential.