

February 23, 2018

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

REFERENCE: Docket 50-186
University of Missouri-Columbia Research Reactor
Renewed Facility Operating License No. R-103

SUBJECT: University of Missouri Research Reactor
2017 Reactor Operations Annual Report

Enclosed is a copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor (MURR). The reporting period covers January 1, 2017 through December 31, 2017.

This document is submitted to the U.S. Nuclear Regulatory Commission in accordance with the MURR Technical Specification (TS) 6.6.e.

Please note the following three (3) changes in data presentation in this year's report compared to previous years.

1. On Page VII-1, the Sanitary Sewer Effluent activities listed in Table 1 are being reported in milliCuries (mCi) this year. In past annual reports, these activities were reported in Curies. However, these activities are calculated and tracked throughout the year in mCi. So, MURR has changed the annual report activity units to match existing records eliminating the potential for unit conversion errors when transferring data to the annual report. TS 6.6.e(6) requires MURR to summarize radioactive effluents to the environs in the annual report, but the TS does not state the specific radioactivity units to be provided.
2. On Page VII-2, the Stack Effluent total release activities listed in Table 2 are being reported in microCuries (μ Ci) this year. In past annual reports, these activities were reported in Curies. However, these activities are calculated and tracked throughout the year in μ Ci. So, MURR has changed the annual report activity units to match existing records eliminating the potential for unit conversion errors when transferring data to the annual report. TS 6.6.e(6) requires MURR to summarize radioactive effluents to the environs in the annual report, but the TS does not state the specific radioactivity units to be provided.

AD20
NRR


3. On Page VIII-5, the Environmental Thermoluminescent Dosimeter (TLD) summary provided in Table 3 has negative values reported for the net millirem (mrem) calculations. Since the net mrem is calculated by taking the gross mrem reading of each individual TLD and subtracting the mrem reading of a control TLD, statistical variations in TLD reading will cause net mrem calculations to be positive, zero, or negative. Beginning in 2006, MURR began to report all negative net environmental TLD calculations as zero (0) based on a comment from an external party. However, reporting zero (0) for every negative number artificially removes data from the annual report. MURR is now reversing its reporting back to pre-2006 annual report methods by including the actual value of the negative net TLD calculations in an attempt to show all relevant data with its statistical variation.

If you have any questions regarding the contents of this report, please contact Bruce Meffert at MeffertB@missouri.edu or by calling (573) 882-5118.

Sincerely,


Bruce A. Meffert
Reactor Manager

ENDORSEMENT:
Reviewed and Approved


Matthew R. Sanford
Interim Reactor Facility Director

BAM/jlm

Enclosure

xc: Mr. Geoffrey Wertz, U.S. NRC
Mr. Johnny Eads, U.S. NRC

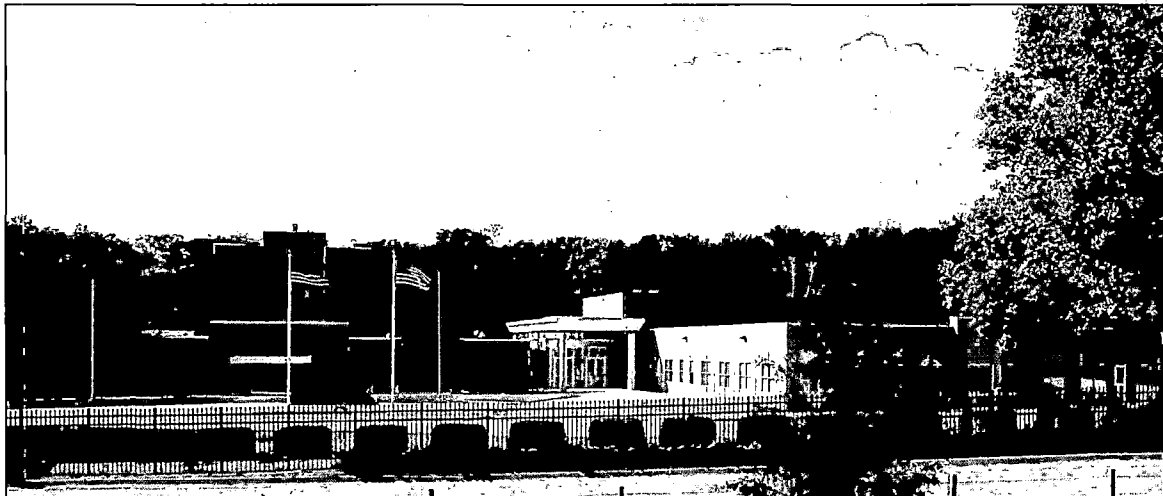


MURR[®]

**UNIVERSITY OF MISSOURI
RESEARCH REACTOR**

**REACTOR OPERATIONS
ANNUAL REPORT**

January 1, 2017 – December 31, 2017



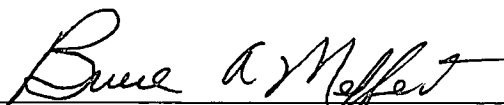
**UNIVERSITY OF MISSOURI
RESEARCH REACTOR FACILITY**

**REACTOR OPERATIONS
ANNUAL REPORT**

January 1, 2017 through December 31, 2017


Compiled by the Research Reactor Staff of MURR

Submitted by:



Bruce A. Meffert
Reactor Manager

**Reviewed and
approved by:**



Matthew R. Sanford
Interim Reactor Facility Director

**UNIVERSITY OF MISSOURI – COLUMBIA
RESEARCH REACTOR**

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2017 through December 31, 2017

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, boron neutron capture therapy, 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, heterogeneous 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 2017. Included within this report are changes to MURR operating procedures related to reactor safety; revisions to the Safety Analysis Report (SAR); plant and system modifications; new tests and experiments; special nuclear material and 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 6.6.e.

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 National Nuclear Security Administration (NNSA); Argonne National Laboratory (ANL); Idaho National Laboratory (INL); Sandia National Laboratories (SNL); the researchers; the students; the Columbia Fire Department (CFD); 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.

Significant efforts by MURR and NRC staff to complete the process of renewing the Facility Operating License resulted in the NRC issuing MURR's Renewed Facility Operating License No. R-103 on January 4, 2017. This renewed license authorizes MURR to operate until 2037.

Some of the major facility projects that were supported by Reactor Operations during this past calendar year included (1) installation of two additional charcoal filter banks to the I-131 processing hot cell ventilation exhaust system, (2)

replacement of nuclear instrumentation signal processor nos. 1 and 2 fission chambers and cabling, (3) replacement of nuclear instrumentation power range channel no. 6 detector and cabling, (4) replacement of the air actuator latching mechanism for reactor containment building truck entry door 101, (5) replacement of 30 valve diaphragms and 60 flange gaskets in both the primary and pool coolant demineralizer loops, (6) replacement of primary coolant circulation pump 501B casing gasket, and (7) irradiation and processing of multiple natural uranium targets to determine the feasibility of producing molybdenum-99 using a variety of processing technologies.

The facility continues to actively collaborate with the Reduced Enrichment for Research and Test Reactors (RERTR) Program and four other U.S. high-performance research and test 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 reactors is responsible for its own feasibility and safety studies, regulatory interactions, and fuel procurement and conversion, there are common interests and activities among all five reactors that will benefit from a coordinated, working-group effort. One PhD student completed their research work in determining the material property changes in the beryllium reflector, and hence its lifetime, as a result of fuel conversion. In August, MURR submitted its LEU Conversion Preliminary SAR to the NRC.

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

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Pages</u>
I.	Reactor Operations Summary	I-1 through 9
II.	MURR Procedures	II-1 through 13
	A. Changes to Reactor Operations Procedures	
	B. Changes to Emergency Plan Implementing Procedures	
	C. Changes to Radiological Control, Byproduct Material Shipping, and Preparation of Byproduct Material for Shipping Procedures	
III.	Revisions to the Safety Analysis Report	III-1
IV.	Plant and System Modifications	IV-1
V.	New Tests and Experiments	V-1
VI.	Special Nuclear Material and Reactor Physics Activities	VI-1
VII.	Radioactive Effluent	VII-1 through 2
	Table 1 – Sanitary Sewer Effluent	
	Table 2 – Stack Effluent	
VIII.	Environmental Monitoring and Health Physics Surveys	VIII-1 through 6
	Table 1 – Summary of Environmental Set 91 - Spring 2017	
	Table 2 – Summary of Environmental Set 92 - Fall 2017	
	Table 3 – Environmental TLD Summary	
	Table 4 – Number of Facility Radiation and Contamination Surveys	
IX.	Summary of Radiation Exposure to Facility Staff, Experimenters, and Visitors	IX-1

SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2017 through December 31, 2017

The following table and discussion summarizes reactor operations during the period from January 1, 2017 through December 31, 2017.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled *
January	640.88	267.15	86.1	96.4
February	601.64	250.77	89.5	100.3
March	673.75	280.78	90.6	101.4
April	632.57	263.65	87.9	98.5
May	658.40	274.45	88.5	99.1
June	634.62	264.62	88.1	98.9
July	623.47	260.00	83.8	93.8
August	678.06	282.65	91.1	102.0
September	645.20	268.93	89.6	100.5
October	656.66	273.76	88.3	98.8
November	615.37	259.37	85.5	95.9
December	668.87	278.84	89.9	100.7
Total for the Year	7,729.49	3,224.97	88.24	98.86

* 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 2017

The reactor operated continuously in January with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, one shutdown for operator licensing examinations, and three unscheduled/unplanned power reductions. A U.S. Nuclear Regulatory Commission (NRC) license examiner administered reactor operator licensing examinations. On January 4, the NRC issued Renewed Facility Operating License No. R-103.

On January 8, with the reactor operating at 10 MW in the automatic control mode, the reactor automatically scrambled due to a momentary loss of normal electrical power. All immediate and subsequent actions of reactor emergency procedure REP-11, "Momentary Loss of Normal Electrical Power," were completed. The momentary electrical power loss was confirmed by contacting the University of Missouri power plant. The power plant explained that a high voltage switch failed, knocking out power to half of the plant and causing several voltage spikes throughout the campus

electrical supply system. The reactor was returned to 10 MW operation after the scheduled maintenance day was completed.

On January 9, while conducting pre-startup checks on the regulating blade with the reactor operating, but all four shim control blades fully inserted at a shutdown power level, the expected 'Reg Rod Bottomed Rod Run-In' annunciation was not received when the regulating blade drive mechanism was inserted to the bottom end of its travel. The duty operator secured the reactor by placing Master Control Switch 1S1 to the 'OFF' position, thus minimizing the time that MURR deviated from Technical Specification (TS) 3.2.f.8. Investigation revealed that the fault was intermittent. However, the exact faulty component was not found. A suspect relay coil was replaced. Operability checks were performed satisfactorily, including the applicable sections of compliance procedure CP-14, "Regulating Rod 10% and Rod Bottomed RRI, Rod Not in contact with Magnet RRI." Permission to restart the reactor was obtained from the Reactor Facility Director, and the reactor was subsequently returned to 10 MW operation.

Failure of the regulating blade rod bottomed rod run-in during reactor operation is a deviation from TS 3.2.f.8. Licensee Event Report No. 17-01 was submitted to the NRC on January 23, 2017.

On January 10, the reactor was shut down to re-investigate the issue with the regulating blade drive mechanism that may not have been resolved on January 9. After reactor shutdown, the applicable portions of CP-14 were completed satisfactorily, and an investigation of the lower 'Reg Blade Bottomed' limit switch was performed. The lower limit switch was confirmed to have an intermittent fault and was replaced. After the switch was replaced, electronic maintenance procedure EMP-12B, "Regulating Blade Drive," was performed on the regulating blade drive mechanism, and the applicable portions of CP-14 were completed satisfactorily. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

On January 17, with the reactor operating at 10 MW in the automatic control mode, a 'Channel 4, 5, or 6 Downscale' alarm was received. Upon discovery that the regulating blade drive mechanism was not operating, the duty operator initiated a manual reactor scram. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. The output shaft of the gearbox for the drive had sheared. Inspection revealed some misalignment between the gearbox output shaft and the adapter. The cause of the misalignment was angular displacement between the inner and outer race of the thrust bearing which allowed the adapter to misalign. A new bearing with tighter tolerances was installed, and the output shaft was replaced. Operability checks were performed satisfactorily, including the applicable sections of CP-14. Permission to restart the reactor was obtained from the Reactor Facility Director, and the reactor was subsequently returned to 10 MW operation.

Failure of the regulating blade and the regulating blade $\leq 10\%$ rod run-in during reactor operation resulted in deviations from TSs 3.2.a and 3.2.f.8. Licensee Event Report No. 17-02 was submitted to the NRC on January 26, 2017.

Major maintenance items for the month included: replacing the regulating blade drive mechanism lower limit switch; replacing the regulating blade drive mechanism output shaft and thrust bearing; and replacing the anti-siphon system level controller's (LC 965) stainless steel cable that connects the displacer (float) to the controller switch.

FEBRUARY 2017

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

reduction. An NRC inspector conducted a routine scheduled inspection of Security and Material Control and Accountability.

On February 3, the duty operator observed a count rate rise on the iodine channel of the control room off-gas stack radiation monitor strip-chart recorder that corresponded to approximately 87% of the TS effluent release limit. Throughout the day, actions were taken to manage the release including swapping charcoal filter bank trains, decreasing exhaust ventilation flow rates, attempting to identify and encapsulate potential sources within the I-131 processing hot cells, and finally completely isolating the I-131 processing hot cells' exhaust flow. By calendar day February 4, 2017, releases returned to values below the TS limit.

On February 3, it was determined that exhaust ventilation stack effluents had exceeded the maximum controlled instantaneous release concentration limit; therefore, it was a deviation from TS 3.7.b. Licensee Event Report No. 17-03 was submitted to the NRC on February 17, 2017.

On February 7, with the reactor operating at 10 MW in the automatic control mode, the duty operator initiated a manual reactor scram after receiving an 'OPEN' indication on automatic pressurizer water drain valve 527A without the expected corresponding decrease in pressurizer liquid level. All immediate and subsequent actions of reactor emergency procedure REP-19, "Pressurizer Valves Fail To Operate," were completed. Investigation revealed that pressurizer drain to drain collection system manual throttle valve 515AA immediately downstream of automatic water drain valve 527A was closed, thus preventing the draining of the pressurizer. Manual throttle valve 515AA was repositioned, and the pressurizer drain function was restored and retested. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

Major maintenance items for the month included: performing two reactivity worth measurements in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" loading new de-ionizing bed 'B' and placing it on pool coolant system service; completing Modification Record 16-04, "Upgrade Secondary Coolant System Temperature Transmitters;" and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Control Blade, RTP-11(D)."

MARCH 2017

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

Major maintenance items for the month included: replacing the air actuator for decay heat removal system isolation valve 546B and completing Modification Record 04-03, Addendum 3, "Removal of Liquid Radioactive Retention System."

APRIL 2017

The reactor operated continuously in April with the following exceptions: four shutdowns for scheduled maintenance and/or refueling and one unscheduled/unplanned power reduction. An NRC inspector conducted a routine scheduled inspection of the Radiation Protection and Shipping Programs.

On April 20, with the reactor operating at 10 MW in the automatic control mode, a 'Channel 4, 5, or 6 Downscale' alarm was received. Upon discovery that the regulating blade drive mechanism was not operating, the duty operator initiated a manual reactor scram. All immediate and subsequent actions of reactor emergency procedures REP-2, "Reactor Scram," and REP-7, "Rod Position Indication System Failure," were completed. The drive chain for the rod position indication encoder on the regulating blade drive mechanism had disengaged from a sprocket and became bound in another sprocket. The drive chain was replaced, and its sprockets re-aligned. Operability checks were performed satisfactorily, including the applicable sections of compliance procedure CP-14, "Regulating Rod 10% and Rod Bottomed RRI, Rod Not in contact with Magnet RRI." Permission to restart the reactor was obtained from the Reactor Facility Director, and the reactor was subsequently returned to 10 MW operation.

Failure of the regulating blade and the regulating blade $\leq 10\%$ withdrawn rod run-in function during reactor operation resulted in deviations from TSs 3.2.a and 3.2.f.8. Licensee Event Report No. 17-04 was submitted to the NRC on May 3, 2017.

Major maintenance items for the month included: performing a back flush of the secondary coolant system side of pool coolant system heat exchanger 521; performing a back flush of the secondary coolant system side of primary coolant heat exchangers 503A and 503B; and replacing the primary coolant demineralizer system outlet filters.

MAY 2017

The reactor operated continuously in May with the following exceptions: five shutdowns for scheduled maintenance and/or refueling and two shutdowns for physics measurements. There were no unscheduled/unplanned power reductions this month. Supplemental Information to Licensee Event Report No. 17-03 was submitted to the NRC on May 16, 2017.

Major maintenance items for the month included: performing two reactivity worth measurements in accordance with reactor procedure RP-RO-201, "Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B);" loading new de-ionizing bed 'O' and placing it on pool coolant system service; loading new de-ionizing bed 'S' and placing it on primary coolant system service; completing compliance procedure CP-26, "Containment Building Compliance Test;" replacing 18 valve diaphragms and 36 flange gaskets in both the primary and pool coolant demineralizer loops; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Control Blade, RTP-11(D)."

JUNE 2017

The reactor operated continuously in June with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, one shutdown for physics measurements, and two unscheduled/unplanned power reductions. An NRC license examiner administered senior reactor operator licensing examinations.

On June 18, with the reactor operating at 10 MW in the automatic control mode, a Containment Actuation (Reactor Isolation) was automatically initiated by Air Plenum 1 Area Radiation Monitor (ARM). All immediate and subsequent actions of emergency procedure EP-RO-012, "Reactor Isolation," were completed. Radiation levels were determined to be normal. Based on the duty operator's observation of an elevated reading on the Air Plenum 1 ARM during the event, it is suspected the detector provided an intermittent false high signal that caused the trip. The detector circuit was replaced with a calibrated spare. Operability checks were performed satisfactorily, including the applicable

sections of compliance procedure CP-30, "ARMS and 16-inch Valve Cabinet and Associated Horns and Lights." Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

On June 26, with the reactor operating at 9 MW in the manual control mode, the reactor automatically scrambled while attempting to adjust the potentiometer to lower Power Range Nuclear Instrumentation (NI) Channel 5 (PRM-5) level indication. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. The potentiometer was adjusted in the correct downward direction, but an electrical spike caused a 'Channel 4, 5, 6 HI Power Scram.' All NI channels operated properly when checked in accordance with NI procedures. The decision was made to change the amplifier for Signal Processor Drawer No. 2 (SP-2) from its current configuration and place the standby amplifier on-service as a means of troubleshooting. Operability checks were performed satisfactorily, including compliance procedure CP-35B, "Nuclear Instrumentation Signal Processor No. 2," and the applicable steps of compliance procedure CP-9, "Nuclear Instrumentation Scram and Rod Run-in," for SP-2. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation. During the next maintenance shutdown, further investigation revealed the potentiometer had a position that caused erratic resistance. The potentiometer on the PRM-5 portion of the circuit was replaced, and CP-35B was again completed satisfactorily.

Major maintenance items for the month included: completing Modification Record 88-07, Addendum 4, "Addition of Charcoal Filters and Dehumidifier to HC-11 Exhaust;" completing the biennial change out of control blade 'A' offset mechanism; replacing the alarm/trip unit on the reactor core differential pressure instrumentation channel (DPS-929); replacing nuclear instrumentation signal processor drawers no. 1 and no. 2; 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 a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Control Blade, RTP-11(D)."

JULY 2017

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

On July 4, a manual scram was initiated during a normal reactor startup with the reactor subcritical and all shim control blades at a height of 5.00 inches withdrawn due to erratic indication on Source Range Nuclear Instrument Channel 1 meter and chart. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. The positive and negative power supplies in Signal Processor Drawer No. 1 (SP-1) were replaced. Operability checks of SP-1 were performed satisfactorily, including compliance procedure CP-35B, "Nuclear Instrumentation Signal Processor No. 1," and the applicable steps of compliance procedure CP-9, "Nuclear Instrumentation Scram and Rod Run-in," for SP-1. Permission to restart the reactor was obtained from the Reactor Facility Director, and the reactor was subsequently returned to 10 MW operation.

Failure of the source range nuclear instrument channel during reactor startup is a deviation from TS 3.5.a.3. Licensee Event Report No. 17-05 was submitted to the NRC on July 17, 2017.

On July 11, with the reactor operating at 7.5 MW in the manual control mode, a reactor scram was automatically initiated due to a Power Range Nuclear Instrumentation Channel 6 (PRM-6) Anomaly. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. The PRM-6 Drawer Inoperative

light was illuminated and was the suspected cause of the scram. After several hours of troubleshooting, no cause for the anomaly was found. Permission to restart the reactor was obtained from the Associate Director – Reactor & Facilities Operations, and the reactor was subsequently returned to 10 MW operation.

On July 24, with the reactor operating at 10 MW in the automatic control mode, a 'Power Level Interlock' reactor scram was automatically initiated by relay 1K26 contact loss of conductivity. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. Investigation revealed contacts 3 and 4 on relay 1K26 could be opened with minimal physical agitation. The contacts 3 and 4 were replaced with spare contacts. Operability checks included a successful simulated Power Level Interlock scram initiated by contacts 3 and 4 on relay 1K26. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

Major maintenance items for the month included: replacing nuclear instrumentation Signal Processor No. 2 fission chamber and cabling; replacing the pool coolant demineralizer system inlet filters; replacing a primary coolant system temperature recorder; replacing the emergency power generator batteries; replacing nuclear instrumentation Signal Processor No. 1 fission chamber and cabling; 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)."

AUGUST 2017

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

On August 28, with the reactor operating at 10 MW in the automatic control mode, the reactor was shut down by manual scram to investigate an abnormally rapid decrease in pressurizer liquid level indication. The pressure vessel head packing and flange gasket were checked, the flange gasket replaced, and the head was reinstalled. The reactor was subsequently returned 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);" performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Control Blade, RTP-11(D);" and replacing the air actuator latching mechanism for reactor containment building truck entry door (Door 101).

SEPTEMBER 2017

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

On September 24, with the reactor operating at 10 MW in the automatic control mode, a 'Reactor Loop Lo Press Scram' was automatically initiated by Pressure Transmitter 943 (PT-943) channel. All immediate and subsequent actions of reactor emergency procedure REP-3, "Primary Coolant System Low Pressure or Flow Scram," were completed. Investigation showed no mechanical reason for a low pressure condition in the system. Calibration and

scram set points of low pressure scram channels PT-943, PT-944A, and PT-944B were checked by performing compliance procedure CP-22, "Pressure Transmitters PT 944A/B and 943." No safety issues were found. However, the set points of PT-943 and PT-944 scrams were higher than the normal pressure band (more conservative than normal). Since this shutdown occurred on a Sunday, the Reactor Manager made the decision not to lower the pressure set points (the non-conservative direction) without more checks and more personnel analyzing the situation. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently restarted to 10 MW operation. The reactor was shut down the next day for scheduled maintenance and refueling, and more checks and testing were conducted on the PT-943 and PT-944 channels, which resulted in lowering the PT-943 and PT-944A scram set points.

Major maintenance items for the month included: replacing the cooling tower cell 1 float valve and inspecting the reactor pressure vessel head seating surface.

OCTOBER 2017

The reactor operated continuously in October with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, one shutdown for physics measurements, and two unscheduled/unplanned power reductions. An NRC inspector conducted a routine inspection of Reactor Operations and Emergency Preparedness.

On October 2, with the reactor operating at 10 MW in the automatic control mode, a 'Channel 4, 5, or 6 HI Power Rod Run-In' was automatically initiated due to excessive movement of the shim control blades while performing the 'Within a Shift' operability checks (TS 4.2.a) of the shim control blades and regulating blade. Permission to restart the reactor was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

On October 10, with the reactor operating at 10 MW in the automatic control mode, the reactor was shut down by manual scram to investigate an abnormally rapid decrease in pressurizer liquid level indication. The pressure vessel head packing and flange gasket were checked, the flange gasket replaced, and the head was reinstalled. The reactor was subsequently returned 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);" loading new de-ionizing bed 'W' and placing it on pool coolant system service; replacing 12 valve diaphragms and 24 flange gaskets in both the primary and pool coolant demineralizer loops; and replacing the pool coolant demineralizer system inlet filters.

NOVEMBER 2017

The reactor operated continuously in November with the following exceptions: four shutdowns for scheduled maintenance and/or refueling and eight unscheduled/unplanned power reductions.

On November 1, with the reactor operating at 10 MW in the automatic control mode, a manual scram was initiated by the duty operator in response to a 'Channel 4, 5, or 6 Downscale' alarm and outward motion on the regulating blade. All immediate and subsequent actions of reactor emergency procedure REP-2, "Reactor Scram," were completed. The power decrease was caused by at-power attempts to manually seat leaking anti-siphon isolation valves 543A and

543B. After the reactor shutdown, the anti-siphon isolation valves were seated satisfactorily. The reactor was subsequently returned to 10 MW operation.

On November 9, with the reactor operating at 10 MW in the automatic control mode, the reactor was shut down by manual scram to investigate a small leak originating from the pump casing of primary coolant circulation pump 501B. The pump casing gasket was replaced, and no leakage was observed during the subsequent primary coolant system operation. The reactor was subsequently returned to 10 MW operation.

On November 11 through November 12, six 'Channel 4, 5 or 6 HI Power Rod Run-Ins' were automatically initiated from Power Range Nuclear Instrumentation (NI) Channel 6 (PRM-6). For each of the rod run-ins, there was no indication of elevated power on any NI channel including PRM-6. Each time, the duty operator was able to reset the PRM-6 drawer, reset the rod run-in circuit, and commence power recovery. On November 13, investigation concluded that the rod run-ins probably occurred due to increased noise from the PRM-6 detector and/or detector cable. The PRM-6 detector and associated cabling were replaced.

Major maintenance items for the month included: replacing primary coolant circulation pump 501B casing gasket; completing the biennial change out of control blade 'C' offset mechanism; replacing power range nuclear instrumentation channel 6 uncompensated ion chamber detector and cabling; replacing anti-siphon isolation valve 543B actuator; replacing the north main air compressor; replacing control blade 'C' rod drop timer module; and performing a reactivity worth measurement in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Control Blade, RTP-11(D)."

DECEMBER 2017

The reactor operated continuously in December with the following exceptions: four shutdowns for scheduled maintenance and/or refueling and three unscheduled/unplanned power reductions. An NRC license examiner administered a reactor operator licensing examination.

On December 6, with the reactor operating at 10 MW in the automatic control mode, a firemain low pressure alarm was received due to a leak in the campus firemain system. Immediate actions of reactor emergency procedure REP-13, "Firemain Low Pressure," were initiated. The duty operator and reactor management concluded that firemain pressure would not be restored to above the alarm set point in a timely fashion. Therefore, the duty operator initiated a manual scram. Firemain pressure remained high enough during the event to ensure the emergency pool fill system was operable satisfying TS 3.9.b at all times. The firemain leak was eventually isolated, and the reactor was subsequently restored to 10 MW operation.

On December 26, with the reactor operating at 10 MW in the automatic control mode, a 'Channel 4, 5 or 6 HI Power Rod Run-In' was automatically initiated from Power Range Nuclear Instrumentation (NI) Channel 6 (PRM-6). There was no indication of elevated power on any NI channel including PRM-6. The duty operator was able to reset the PRM-6 drawer and the rod run-in circuit. Permission was obtained from the Reactor Manager, and the reactor was subsequently returned to 10 MW operation.

On December 30, with the reactor operating at 10 MW in the automatic control mode, an operator on routine patrol discovered that the differential pressure gauge in the reactor containment building was indicating zero (0) inches of water vacuum as compared to the laboratory building pressure. Initial investigation revealed the backup door in the reactor containment building exhaust air plenum had closed, causing a pressure increase in the reactor containment

building. The console operator subsequently manually scrammed and secured the reactor by placing Master Control Switch 1S1 to the 'OFF' position, thus ending the time that MURR deviated from TSs 3.4.b and 3.4.a. Further investigation revealed that ice had formed in the compressed air piping that supplied air to hold up the backup door. The ice in the piping was removed. Operability checks were performed satisfactorily, including compliance procedure CP-20, "Backup Doors." Permission to restart the reactor was obtained from the Interim Reactor Facility Director, and the reactor was subsequently returned to 10 MW operation.

Loss of reactor containment building negative pressure with respect to surrounding areas while the reactor is not secured is a deviation from TSs 3.4.b and 3.4.a. Licensee Event Report No. 17-06 was submitted to the NRC on January 12, 2018.

Major maintenance items for the month included: replacing the primary coolant demineralizer system outlet conductivity probe; replacing the primary coolant demineralizer loop outlet isolation valve 527F air actuator and bonnet; and replacing flange gaskets on primary coolant demineralizer loop piping.

SECTION II

MURR PROCEDURES

January 1, 2017 through December 31, 2017

As required by administrative MURR Technical Specification 6.6.e(5), this section of the Reactor Operations Annual Report includes a summary of procedure changes. These procedure changes were reviewed by the Reactor Manager or Reactor Health Physics Manager, as applicable, and others to assure compliance with the requirements of 10 CFR 50.59. These procedure changes were also reviewed by the Reactor Safety Procedure Review Subcommittee and/or the Isotope Use Procedure Review Subcommittee of the Reactor Advisory Committee to meet the requirements of MURR Technical Specification 6.2.a(2).

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 120 revisions issued to the Reactor Operations procedures, forms, operator aids, and policies. Two new procedures, one new form, one new operator aid, and five new charters were issued. The majority of these 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, operator aids, policies, and charters:

Number	Name	Rev	Rev Date	Notes
AP-RO-110	Conduct of Operations	23	06/22/17	Minor Editorial
AP-RO-110	Conduct of Operations	24	12/22/17	Minor Editorial
AP-RO-115	Modification Records	11	02/13/17	Full Review
AP-RO-115	Modification Records	12	11/03/17	Minor Editorial
AP-RO-130	Crane Operation	8	06/28/17	Minor Editorial
AP-RO-135	Reactor Utilization Requests	4	12/12/17	Minor Editorial
AP-RR-003	10 CFR 50.59 Evaluations	11	03/08/17	Minor Editorial
AP-RR-014	On-Site Fingerprinting Program	0	04/28/17	New Procedure
AP-RR-033	Access Authorization Program for Irradiated Reactor Fuel in Transit	1	06/05/17	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	24	12/22/17	Minor Editorial
EX-RO-110	Pneumatic Tube System	0	12/22/17	New Procedure
EX-RO-120	Beamport 'A' Operation	15	08/18/17	Minor Editorial
EX-RO-121	Beamport 'B' Operation	15	08/18/17	Minor Editorial
EX-RO-122	Beamport 'C' Operation	16	08/18/17	Minor Editorial
EX-RO-123	Beamport 'D' Operation	15	08/18/17	Minor Editorial
EX-RO-124	Beamport 'E' Operation	16	08/18/17	Minor Editorial
EX-RO-125	Beamport 'F' Operation	17	08/18/17	Minor Editorial
FM-08	Fuel Movement Sheet	9	11/03/17	Minor Editorial
FM-15	10 CFR 50.59 Qualified Reviewers List	22	04/28/17	Minor Editorial
FM-16	Primary - Pool Coolant Water Analysis	11	02/13/17	Full Review
FM-16	Primary - Pool Coolant Water Analysis	12	03/28/17	Minor Editorial
FM-16	Primary - Pool Coolant Water Analysis	13	07/25/17	Minor Editorial
FM-18	Deviation From Procedure Report	9	05/02/17	Minor Editorial
FM-18	Deviation From Procedure Report	10	11/03/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
FM-20	Waste Tank Sample Report	11	07/25/17	Cover Page
FM-21	ARMS Trip Setpoints	11	08/25/17	Minor Editorial
FM-43	Nuclear and Process Data Sheet	24	03/28/17	Minor Editorial
FM-43	Nuclear and Process Data Sheet	25	06/09/17	Minor Editorial
FM-47	Deviation From Procedure Report	7	12/11/17	Minor Editorial
FM-55	Startup Nuclear Data Sheet	8	05/02/17	Minor Editorial
FM-56	Reactor Routine Patrol	21	02/13/17	Full Review
FM-56	Reactor Routine Patrol	22	06/09/17	Minor Editorial
FM-57	Long Form Startup Checksheet	25	06/09/17	Full Review
FM-57	Long Form Startup Checksheet	26	11/03/17	Minor Editorial
FM-58	Short Form Startup Checksheet	13	01/27/17	Minor Editorial
FM-63	DI Water Makeup Log	12	01/27/17	Cover Page
FM-64	DI Resin Log	8	12/12/17	Cover Page
FM-65	Filter Status Log	8	12/12/17	Cover Page
FM-66	Customer Sample Pre-Encapsulation Evaluation Worksheet	9	05/15/17	Minor Editorial
FM-71	Pneumatic Tube User Approval	4	06/09/17	Cover Page
FM-90	Personal History Questionnaire (PHQ) and Self-Disclosure	8	04/28/17	Full Review
FM-93	Post Maintenance Valve Line-up Checksheet	7	06/20/17	Cover Page
FM-127	MURR Irradiations Encapsulation Evaluation Worksheet	4	06/05/17	Minor Editorial
FM-152	Fuel Element Inspection	3	12/12/17	Cover Page
FM-200	Authorization to Conduct Background Investigation for Unescorted Access to MURR	0	02/03/17	New Form
FM-200	Authorization to Conduct Background Investigation for Unescorted Access to MURR	1	03/27/17	Minor Editorial
IRR-PSO-100	Scheduling Flux Trap Tubes	9	08/31/17	Cover Page
IRR-PSO-111	Customer Sample Pre-Encapsulation Evaluation	10	05/15/17	Minor Editorial
LCC-001	Reactor Advisory Committee Charter	0	02/14/17	New Charter
LCC-002	Reactor Safety Subcommittee Charter	0	02/14/17	New Charter
LCC-003	Isotope Use Subcommittee Charter	0	02/14/17	New Charter
LCC-004	Reactor Safety Procedure Review Subcommittee Charter	0	02/14/17	New Charter
LCC-005	Isotope Use Procedure Review Subcommittee Charter	0	02/14/17	New Charter
OA-4	Valve Operation Air Compressor	10	02/13/17	Full Review
OA-27	Regulating Blade Drive Tower	0	10/09/17	New Operator Aid
OP-RO-101	Instrument Air System	13	03/28/17	Cover Page
OP-RO-210	Reactor Startup-Normal	17	06/09/17	Minor Editorial
OP-RO-210	Reactor Startup-Normal	18	10/03/17	Minor Editorial
OP-RO-210	Reactor Startup - Normal	19	12/12/17	Minor Editorial
OP-RO-211	Reactor Startup - Hot	15	10/03/17	Minor Editorial
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	15	12/22/17	Minor Editorial
OP-RO-220	Reactor Shutdown or Power Reduction	11	07/25/17	Minor Editorial
OP-RO-230	Changing Reactor Power Level	10	07/25/17	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	18	03/28/17	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	19	06/09/17	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	20	08/18/17	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	12	06/09/17	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	13	10/03/17	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	13	06/09/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	14	12/22/17	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	15	06/09/17	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	12	06/09/17	Minor Editorial
OP-RO-340	Nuclear Instrumentation Adjustment	12	06/09/17	Minor Editorial
OP-RO-350	Reactor Power Calculator Flow Potentiometer Adjustment	10	07/25/17	Minor Editorial
OP-RO-410	Primary Coolant System	14	05/02/17	Minor Editorial
OP-RO-410	Primary Coolant System	15	08/18/17	Minor Editorial
OP-RO-420	Primary and Pool Water Analysis	9	10/03/17	Minor Editorial
OP-RO-461	Pool Coolant System - One Pump Operation	18	10/03/17	Minor Editorial
OP-RO-465	Pool Level Control - Skimmer System	11	06/09/17	Minor Editorial
OP-RO-466	Pool Level Control - Pool Coolant System	14	05/02/17	Minor Editorial
OP-RO-480	Secondary Coolant System	21	01/03/17	Minor Editorial
OP-RO-510	Nitrogen System	9	05/02/17	Minor Editorial
OP-RO-515	Emergency Air System	13	12/22/17	Minor Editorial
OP-RO-516	Valve Operation Air System	12	07/25/17	Cover Page
OP-RO-520	Emergency Power Generator	15	06/20/17	Minor Editorial
OP-RO-520	Emergency Power Generator	16	10/03/17	Minor Editorial
OP-RO-525	Chill Water System	9	05/02/17	Minor Editorial
OP-RO-530	Demineralized Water Supply System	19	06/09/17	Minor Editorial
OP-RO-531	Primary and Pool Sample Station	14	06/20/17	Minor Editorial
OP-RO-532	Drain Collection System	11	07/25/17	Cover Page
OP-RO-533	Skimmer System	10	12/12/17	Cover Page
OP-RO-555	Fire Protection System	15	03/28/17	Minor Editorial
OP-RO-710	Area Radiation Monitoring System	10	08/25/17	Minor Editorial
OP-RO-720	Radiation Monitoring - Stack Monitor Operational Check	15	03/28/17	Minor Editorial
OP-RO-720	Off-Gas (Stack) Radiation Monitor Operational Checks	16	08/25/17	Minor Editorial
OP-RO-730	Facility Exhaust System	17	05/02/17	Minor Editorial
OP-RO-741	Waste Tank System Operation	22	05/02/17	Minor Editorial
POL-20	Special Nuclear Materials Manual	3	01/27/17	Minor Editorial
RM-RO-400	Waste Tank System Filter Replacement	9	03/28/17	Cover Page
RM-RO-405	Reactor Demineralizer System	15	06/09/17	Minor Editorial
RP-RO-100	Fuel Movement	13	08/25/17	Minor Editorial
RP-RO-200	Measurement of Differential Worth of a Shim Blade, RTP-11 (D)	7	08/18/17	Minor Editorial
RP-RO-201	Measurement of Reactivity Worth of Flux Trap Loadings or Individual Samples, RTP-17(B)	5	08/18/17	Cover Page
RP-RO-202	Measurement of Reactivity Worth of Movable Samples, RTP-6	4	06/09/17	Minor Editorial
RP-RO-203	Measurement of Primary Coolant/Moderator Temperature Coefficient of Reactivity, RTP-19	1	10/03/17	Minor Editorial
SM-RO-025	Removal, Transfer or Installation of an Offset Mechanism	2	07/10/17	Minor Editorial
SM-RO-100	Draining and Filling the Primary Coolant Side of Primary Coolant System Heat Exchangers	2	01/27/17	Minor Editorial
SM-RO-100	Draining and Filling the Primary Coolant Side of Primary Coolant System Heat Exchangers	3	12/11/17	Minor Editorial
SM-RO-300	Control Console And Instrument Panel-Securing Power	13	08/18/17	Minor Editorial
SM-RO-420	Pressurizer Operation - Maintenance & Test	7	08/18/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
SM-RO-620	Control Blade Leak Test	7	01/03/17	Minor Editorial
SM-RO-625	Measuring Control Blade Pull Weight and Blade Drop Time with the Test Magnet Assembly, RTP-21	5	03/31/17	Minor Editorial
SM-RO-635	Retracting and Reinserting Beamport 'A' Liner	6	01/27/17	Minor Editorial
SM-RO-636	Retracting and Reinserting Beamport 'B' Liner	6	01/27/17	Minor Editorial
SM-RO-637	Retracting and Reinserting Beamport 'C' Liner	6	01/27/17	Minor Editorial
SM-RO-638	Retracting and Reinserting Beamport 'D' Liner	7	01/27/17	Minor Editorial
SM-RO-639	Retracting and Reinserting Beamport 'E' Liner	6	01/27/17	Minor Editorial
SM-RO-640	Retracting and Reinserting Beamport 'F' Liner	7	01/27/17	Minor Editorial
SM-RO-660	Replacement of Inner and Outer Pressure Vessels	6	03/31/17	Cover Page
SM-RO-661	Pool Coolant Hold-Up Tank Welding Repair Instructions	4	09/26/17	Minor Editorial

B. CHANGES TO EMERGENCY PLAN IMPLEMENTING 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 42 revisions issued to the Emergency Plan implementing procedures, forms, and operator aids. The majority of these 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	Rev Date	Notes
EP-RO-001	Definitions	4	09/01/17	Minor Editorial
EP-RO-002	Emergency Responsibilities	6	09/01/17	Minor Editorial
EP-RO-003	Emergency Preparedness Training	5	09/01/17	Cover Page
EP-RO-004	Fire	7	09/01/17	Minor Editorial
EP-RO-005	Medical Emergency	3	09/01/17	Cover Page
EP-RO-006	Radiological Emergency	8	09/01/17	Minor Editorial
EP-RO-007	Severe Natural Phenomenon	7	09/01/17	Cover Page
EP-RO-008	Threat To Security	3	09/01/17	Minor Editorial
EP-RO-009	Notification of Unusual Event	3	09/01/17	Cover Page
EP-RO-010	Alert	3	09/01/17	Cover Page
EP-RO-011	Site Area Emergency	3	09/01/17	Cover Page
EP-RO-012	Reactor Isolation	4	09/01/17	Cover Page
EP-RO-013	Facility Evacuation	10	09/01/17	Minor Editorial
EP-RO-014	Emergency Planning Zone and Site Area Evacuations	9	09/01/17	Minor Editorial
EP-RO-015	Emergency Notifications	15	03/29/17	Minor Editorial
EP-RO-015	Emergency Notifications	16	09/01/17	Minor Editorial
EP-RO-016	Public Information	3	09/01/17	Minor Editorial
EP-RO-017	Emergency Air Sampling	7	09/01/17	Minor Editorial
EP-RO-018	Emergency Radiation Exposure	7	09/01/17	Minor Editorial
EP-RO-020	Emergency Equipment Maintenance	6	09/01/17	Cover Page
FM-100	Emergency Declaration	3	09/01/17	Cover Page
FM-101	FEO Management	3	09/01/17	Cover Page
FM-102	Emergency Event Log	3	09/01/17	Cover Page
FM-103	Facility Status	3	09/01/17	Cover Page
FM-104	Emergency Call List	31	03/29/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
FM-104	Emergency Call List	32	09/01/17	Minor Editorial
FM-104	Emergency Call List	33	10/26/17	Minor Editorial
FM-105	Initial/Follow-Up Emergency Message	3	09/01/17	Minor Editorial
FM-106	Log of Personnel Released From Site	3	09/01/17	Cover Page
FM-110	Fire Flowchart	5	09/01/17	Cover Page
FM-111	Medical Flowchart	3	09/01/17	Cover Page
FM-112	Radiological Flowchart	3	09/01/17	Cover Page
FM-113	Severe Natural Phenomenon Flowchart	3	09/01/17	Cover Page
FM-114	Security Flowchart	3	09/01/17	Cover Page
FM-115	Plant Conditions Flowchart	3	09/01/17	Cover Page
FM-116	Classification Flowchart	3	09/01/17	Cover Page
FM-117	Reactor Isolation Flowchart	3	09/01/17	Cover Page
FM-118	Evacuation Flowchart	5	09/01/17	Cover Page
OA-9	Combined Emergency Flowcharts	6	09/01/17	Cover Page
OA-10	Fire Extinguisher Locations and Types	14	09/01/17	Cover Page
OA-20	Emergency Equipment	22	09/01/17	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	21	06/09/17	Minor Editorial

C. CHANGES TO RADIOLOGICAL CONTROL, BYPRODUCT MATERIAL SHIPPING, AND PREPARATION OF BYPRODUCT MATERIAL FOR SHIPPING PROCEDURES

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

There were 258 revisions issued to the radiological control, byproduct materials shipping, and preparation for shipping byproduct material procedures, forms, operator aids, and plans. Six new procedures, four new forms, two new operator aids, and one new plan were issued. Three procedures and two forms were obsoleted. The majority of these revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the new, revised, and obsoleted procedures, forms, operator aids, and plans:

Number	Name	Rev	Rev Date	Notes
ACG-NAA-200	Cleaning Lab Ware for High Purity Materials Analysis	7	07/24/17	Cover Page
ACG-NAA-201	Preparation and Measurement of Standard Geometries for High Purity Materials	7	09/29/17	Minor Editorial
ACG-NAA-210	Scheduling and Sample Preparation of High Purity Materials	9	07/24/17	Minor Editorial
ACG-NAA-211	High Purity Materials Measurements	8	07/24/17	Cover Page
ACG-NAA-212	Pneumatic Tube Irradiation and Measurement of High Purity Materials	8	07/24/17	Cover Page
ACG-NAA-1725	Analyzing Platinum in Silicone	7	07/24/17	Cover Page
AP-HP-105	Radiation Work Permit	15	12/22/17	Cover Page
AP-HP-110	Controlled Special Exposures	7	10/25/17	Cover Page
AP-HP-117	MURR Initial Radiation Worker Training Program	13	02/14/17	Minor Editorial
AP-HP-117	MURR Initial Radiation Worker Training Program	14	12/22/17	Minor Editorial
AP-HP-119	High Radiation Area Access	9	04/26/17	Minor Editorial
AP-HP-122	Material License Projects Quarterly Review	11	07/10/17	Cover Page
AP-HP-123	Visitor Dosimetry - Reception Desk	12	04/26/17	Minor Editorial
AP-HP-124	Ordering and Assigning Dosimetry	1	12/22/17	Cover Page

Number	Name	Rev	Rev Date	Notes
AP-HP-127	Radioactive Material Licensing and Project Designation Change Request	5	02/13/17	Obsoleted
AP-HP-129	Hot Cell HC-01 Control	14	04/26/17	Minor Editorial
AP-HP-129	Hot Cell HC-01 Control	15	06/09/17	Minor Editorial
AP-HP-130	Reactor License Projects Annual Review	8	10/02/17	Minor Editorial
AP-HP-135	Project Authorization Requests	0	03/31/17	New Procedure
AP-HP-140	Bagging and Labeling of Non-Waste Radioactive Material	3	07/24/17	Cover Page
AP-RR-013	Access Authorization Program for Category 1 and/or Category 2 Quantities of Radioactive Material	0	02/03/17	New Procedure
AP-RR-013	Access Authorization Program for Category 1 and/or Category 2 Quantities of Radioactive Material	1	06/16/17	Minor Editorial
AP-SH-001	Administrative Procedure - Radioactive Material Shipping	10	05/01/17	Minor Editorial
AP-SH-001	Administrative Procedure - Radioactive Material Shipping	11	11/16/17	Cover Page
BPB-SH-023	Type B Equipment Calibration	6	06/02/17	Cover Page
BPB-SH-024	Type B USA/0697/B(U)-96 (F-458 Series) Packaging of Type B Radioactive Material	8	12/27/17	Cover Page
BPB-SH-025	Packaging of Type B Radioactive Material Using USA/0562/B(U)-96 (BEATRICE)	5	09/28/17	Cover Page
BPB-SH-027	Survey and Decontamination of Returned Shipping Containers	8	08/04/17	Minor Editorial
BPB-SH-028	Packaging of Type B Radioactive Material Using USA/9337/B(U)-96 (SAFKEG-LS) and USA/9338/B(U)-96 (SAFKEG-HS)	6	12/27/17	Minor Editorial
BPB-SH-030	Receipt Inspection of New SAFKEG LS/HS Type B Byproduct Material Shipping Packages	3	08/04/17	Cover Page
BP-SH-010	Packaging Radioactive Material for a Limited Quantity Shipment	8	09/28/17	Minor Editorial
BP-SH-011	Packaging of Type A Radioactive Material Using USA DOT 7A 55-Gallon	8	01/27/17	Minor Editorial
BP-SH-011	Packaging of Type A Radioactive Material Using USA DOT 7A 55-Gallon	9	09/28/17	Cover Page
BP-SH-015	Packaging of Type A Radioactive Material Using USA DOT 7A Model E-Box 030-181	6	03/08/17	Minor Editorial
BP-SH-015	Packaging of Type A Radioactive Material Using USA DOT 7A Model E-Box 030-181	7	12/27/17	Cover Page
BP-SH-016	Packaging of Radioactive Material Using USA DOT 7A Model H or I Package	8	08/17/17	Cover Page
BP-SH-017	Packaging of Reusable Type A Radioactive Material Using Tracerco LS-6	5	09/28/17	Minor Editorial
BP-SH-018	Packaging of Type A Radioactive Material Using USA DOT 7A NorthStar Medical Radioisotopes Package	4	07/24/17	Minor Editorial
BP-SH-018	Packaging of Type A Radioactive Material Using USA DOT 7A NorthStar Medical Radioisotopes Package	5	10/11/17	Minor Editorial
BP-SH-031	Packaging of Type A Radioactive Material Using DOT 7A 20WC-1	4	06/02/17	Minor Editorial
BP-SH-052	Radioactive Material Shipment Package Documentation and Labeling	17	07/24/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
BP-SH-059	Spectratek Services Reusable Packaging of Type A Radioactive Material	6	01/27/17	Minor Editorial
BP-SH-059	Spectratek Services Reusable Packaging of Type A Radioactive Material	7	11/16/17	Cover Page
BP-SH-099	Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model 1500	7	10/24/17	Cover Page
BP-SH-145	Packaging of Type A Radioactive Material Using USA DOT 7A F-458	2	08/17/17	Cover Page
BP-SH-192	Packaging of Radioactive Material Using USA DOT 7A Model MURR MAX	0	06/02/17	New Procedure
BP-SH-192	Packaging of Radioactive Material Using USA DOT 7A Model MURR MAX	1	08/04/17	Minor Editorial
BP-SH-302	Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model 6 or 12	10	08/17/17	Cover Page
FM-09	Gemstone Irradiation Sheet	7	12/07/17	Minor Editorial
FM-12	Gemstone Loading Sheet	7	12/07/17	Minor Editorial
FM-28	Controlled Special Exposure Authorization	6	10/11/17	Cover Page
FM-29	Dosimetry Request Packet	9	01/27/17	Minor Editorial
FM-29	Dosimetry Request Packet	10	10/11/17	Minor Editorial
FM-39	Control Checksheet for Packaging of Radioactive Material for a Limited Quantity Shipment	15	05/01/17	Minor Editorial
FM-39	Control Checksheet for Packaging of Radioactive Material for a Limited Quantity Shipment	16	08/17/17	Cover Page
FM-51	Dispensing Radiation Protection Data Sheet C	4	07/07/17	Obsoleted
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	19	02/10/17	Minor Editorial
FM-52	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment	20	09/28/17	Minor Editorial
FM-53	Radioactive Material Licensing and Project Designation Change Request	4	02/13/17	Obsoleted
FM-59	Control Checksheet for Spectratek Services Reusable Packaging of Type A Radioactive Material	10	11/16/17	Cover Page
FM-60	Control Check Sheet for Packaging of Type A Radioactive Material Using USA DOT 7A Model E-Box 030-181	7	7/24/17	Cover Page
FM-70	Control Checksheet for Packaging of Type A Radioactive Material Using Tracerco LS-6 Reusable	5	9/28/17	Minor Editorial
FM-76	Personnel Contamination Log	5	6/19/17	Minor Editorial
FM-79	Lutetium Chloride Radiation Protection Data Sheet B	11	9/19/17	Cover Page
FM-81	Yb/Lu-177 Separation DataSheet	5	12/20/17	Cover Page
FM-82	Concentration of Lu-177 Datasheet	6	12/20/17	Cover Page
FM-83	Concentration of PM-149 Data Sheet	6	12/20/17	Minor Editorial
FM-84	Dissolution of Lutetium Datasheet	6	12/20/17	Cover Page
FM-98	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model 6 or 12	12	8/17/17	Cover Page
FM-99	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model 1500	11	10/24/17	Cover Page

Number	Name	Rev	Rev Date	Notes
FM-107	Control Checksheet for Packaging Type A Radioactive Material in an Overpack	10	06/02/17	Minor Editorial
FM-120	Individual Type B QA Training Certification	6	05/01/17	Minor Editorial
FM-120	Individual Type B QA Training Certification	7	11/16/17	Cover Page
FM-125	Lutetium Chloride Process Notification	4	03/29/17	Cover Page
FM-125	Lutetium Chloride Process Notification	5	09/19/17	Minor Editorial
FM-128	Control Checksheet For Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model H or I	7	08/17/17	Cover Page
FM-130	Ho-166 Nitrate Data Sheet	4	12/20/17	Cover Page
FM-135	Control Checksheet for Packaging of Type B Radioactive Material Using USA/0562/B(U)-96 (BEATRICE)	6	12/27/17	Cover Page
FM-137	Type B Qualified Shipper List	16	02/10/17	Minor Editorial
FM-137	Type B Qualified Shipper List	17	05/01/17	Minor Editorial
FM-137	Type B Qualified Shipper List	18	07/18/17	Minor Editorial
FM-137	Type B Qualified Shipper List	19	08/04/17	Minor Editorial
FM-137	Type B Qualified Shipper List	20	11/08/17	Minor Editorial
FM-138	Control Checksheet for Leak Testing the SAFKEG-LS or SAFKEG-HS Shipping Package Using the CALT Leakage Testing Device	6	01/27/17	Minor Editorial
FM-138	Control Checksheet for Leak Testing the SAFKEG-LS or SAFKEG-HS Shipping Package Using the CALT Leakage Testing Device	7	12/27/17	Minor Editorial
FM-139	Lutetium Chloride Radiation Protection Data Sheet C	5	03/29/17	Minor Editorial
FM-141	Control Checksheet for Packaging of Type A Radioactive Material Using SAFKEG-LS and SAFKEG-HS	4	06/12/17	Minor Editorial
FM-142	End of Declaration of Pregnancy	1	06/19/17	Cover Page
FM-142	End of Declaration of Pregnancy	1	06/19/17	Cover Page
FM-144	Control Checksheet for Packaging of Type A Radioactive Material Using Tracerco LS-1	2	08/17/17	Cover Page
FM-145	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A F-458	2	08/17/17	Cover Page
FM-147	Control Checksheet for Packaging of Type A Radioactive Material Using Tracerco LS-15	2	06/02/17	Minor Editorial
FM-147	Control Checksheet for Packaging of Type A Radioactive Material Using Tracerco LS-15	3	08/17/17	Cover Page
FM-151	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A 55-Gallon	13	09/28/17	Minor Editorial
FM-156	Required Documentation for Non-MURR Owned Type B Shipping Packages	6	08/04/17	Cover Page
FM-157	Control Checksheet for Type B USA/0697/B(U)-96 (F-458 Series) Radioactive Material Package	9	06/02/17	Minor Editorial
FM-157	Control Checksheet for Type B USA/0697/B(U)-96 (F-458 Series) Radioactive Material Package	10	09/28/17	Minor Editorial
FM-158	NOA Waste Tank Sample Analysis	5	07/24/17	Cover Page
FM-159	Control Checksheet for Health Physics Review of Radioactive Material Shipment Documentation	8	06/09/17	Minor Editorial
FM-159	Control Checksheet for Health Physics Review of Radioactive Material Shipment Documentation	9	12/22/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
FM-163	Control Checksheet for Type B Radioactive Material Using USA/9337/B(U)-96 (SAFKEG-LS) and USA/9338/B(U)-96 (SAFKEG-HS)	8	08/04/17	Minor Editorial
FM-163	Control Checksheet for Type B Radioactive Material Using USA/9337/B(U)-96 (SAFKEG-LS) and USA/9338/B(U)-96 (SAFKEG-HS)	9	12/27/17	Cover Page
FM-165	Mo-99 Radiation Protection Data Sheet A	2	03/29/17	Minor Editorial
FM-165	Mo-99 Radiation Protection Data Sheet A	3	07/07/17	Cover Page
FM-169	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A 20WC-1	4	06/02/17	Minor Editorial
FM-170	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A Northstar Medical Radioisotopes Package	3	06/12/17	Minor Editorial
FM-170	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A Northstar Medical Radioisotopes Package	4	10/11/17	Minor Editorial
FM-172	Lutetium Chloride Radiation Protection Data Sheet D	1	07/21/17	Minor Editorial
FM-173	Control Checksheet for Health Physics Review of Limited Quantity Radioactive Material Shipment	0	03/08/17	New Form
FM-173	Control Checksheet for Health Physics Review of Excepted (Limited) Quantity Radioactive Material Shipment	1	06/09/17	Minor Editorial
FM-175	Control Checksheet for Receipt Inspection of Customer Owned Type B Shipping Package	2	10/24/17	Cover Page
FM-176	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A Northstar Medical Radioisotopes Package with 7.5 Ci of Mo-99	1	05/01/17	Minor Editorial
FM-176	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A Northstar Medical Radioisotopes Package with 7.5 Ci of Mo-99	2	10/11/17	Minor Editorial
FM-177	Control Checksheet for Receipt Inspection of SAFKEG LS and HS Type B Shipping Package	2	10/24/17	Cover Page
FM-178	Control Checksheet for Hot Cell HC-01 Access	2	01/20/17	Cover Page
FM-178	Control Checksheet for Hot Cell HC-01 Access	3	02/14/17	Minor Editorial
FM-179	Control Checksheet for Documentation and Labeling of Limited Quantity Radioactive Material Shipment	0	03/08/17	New Form
FM-179	Control Checksheet for Documentation and Labeling of Excepted (Limited) Quantity Radioactive Material Shipment	1	06/12/17	Minor Editorial
FM-192	Control Checksheet for Packaging of Type A Radioactive Material Using USA DOT 7A Model MURR MAX	0	06/02/17	New Form
FM-194	Control Checksheet for Documentation and Labeling of Radioactive Material Shipment Packaged in an Overpack	0	06/23/17	New Form
GMP-BR-213	Lutetium Chloride Batch Record for HC-08 A/B	5	03/07/17	Minor Editorial
GMP-BR-404	Mo-99 Process Cleaning and Line Clearance	4	07/26/17	Minor Editorial
GMP-BR-404	Mo-99 Process Cleaning and Line Clearance	5	11/14/17	Minor Editorial
GMP-BR-502	Sodium Iodide I-131 Solution Batch Record	3	09/15/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
GMP-MCE-124	Cleaning, Maintenance and Operation of HC-08 A/B	6	01/04/17	Minor Editorial
GMP-MCE-124	Cleaning, Maintenance and Operation of HC-08 A/B	7	10/02/17	Minor Editorial
GMP-MCE-129	Operation and Maintenance for a Tuttnauer 3870 EA-B/L Electronic Tabletop Autoclave	3	01/19/17	Minor Editorial
GMP-MCE-129	Operation and Maintenance for a Tuttnauer 3870 EA-B/L Electronic Tabletop Autoclave	4	11/07/17	Minor Editorial
GMP-PRC-201	Transfer of cGMP Lu-177 Chloride Product to Shipping	10	03/07/17	Minor Editorial
GMP-QC-201	Determination of the Metal Content and Specific Activity of Lu-177 Chloride Solution	8	05/22/17	Full Review
GMP-QC-201	Determination of the Metal Content and Specific Activity of Lu-177 Chloride Solution	9	10/02/17	Minor Editorial
GMP-QC-201	Determination of the Metal Content and Specific Activity of Lu-177 Chloride Solution	10	12/01/17	Minor Editorial
GMP-QC-252	Determination of Radiochemical Purity of Lu-177 Chloride Solution	14	03/09/17	Minor Editorial
GMP-QC-252	Determination of Radiochemical Purity of Lu-177 Chloride Solution	15	10/02/17	Minor Editorial
GMP-QC-253	Lu-177 Identification and Determination of Radionuclidic Purity	20	09/14/17	Minor Editorial
GMP-QC-253	Lu-177 Identification and Determination of Radionuclidic Purity	21	10/02/17	Minor Editorial
GS-RA-014	Use and Operation of the I-131 Production Facility Lifting Crane	1	04/28/17	Minor Editorial
GXP-MCE-123	Cleaning, Maintenance and Operation of Hot Cell HC-04	2	05/18/17	Minor Editorial
GXP-MCE-127	Operation and Maintenance of Optima 2100 DV ICP-OES	8	11/07/17	Minor Editorial
GXP-QC-400	Molarity Verification of Potassium Molybdate (Mo-99) Final Intermediate Radiochemical Solution	4	03/23/17	Minor Editorial
GXP-QC-400	Molarity Verification of Potassium Molybdate (Mo-99) Final Intermediate Radiochemical Solution	5	12/01/17	Cover Page
GXP-QC-402	Radiochemical Purity of Potassium Molybdate (Mo-99) Final Intermediate Radiochemical Solution	4	02/13/17	Minor Editorial
GXP-QC-402	Radiochemical Purity of Potassium Molybdate (Mo-99) Final Intermediate Radiochemical Solution	5	12/01/17	Minor Editorial
GXP-QC-403	Radionuclidic Purity and Identity Confirmation of Potassium Molybdate (Mo-99) Final Intermediate Radiochemical Solution	4	12/01/17	Minor Editorial
GXP-QC-406	Potassium Molybdate (Mo-99) Final Intermediate Peroxide Concentration Verification	4	10/02/17	Cover Page
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	17	07/07/17	Minor Editorial
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	18	08/17/17	Minor Editorial
HC-PSO-003	Glove Box Preparation of Radioactive Material for Shipment	12	08/17/17	Cover Page
HC-PSO-005	Hot Cell Loading of Host Cans	17	10/25/17	Cover Page

Number	Name	Rev	Rev Date	Notes
IC-HP-305	Calibration - Electrostatic Discharge Dosimeter	10	12/22/17	Obsoleted
IC-HP-310	Calibration - Eberline Model PING 1A Stack Monitor - Particulate Channel	8	02/22/17	Full Review
IC-HP-310	Calibration - Eberline Model PING 1A Stack Monitor - Particulate Channel	9	06/09/17	Minor Editorial
IC-HP-311	Calibration - Eberline Model PING 1A Stack Monitor - Iodine Channel	9	02/22/17	Full Review
IC-HP-311	Calibration - Eberline Model PING 1A Stack Monitor - Iodine Channel	10	06/09/17	Minor Editorial
IC-HP-312	Calibration - Eberline Model PING 1A Stack Monitor - Gas Channel	8	03/23/17	Minor Editorial
IC-HP-312	Calibration - Eberline Model PING 1A Stack Monitor - Gas Channel	9	06/09/17	Minor Editorial
IC-HP-346	Calibration - Lab Impex Smart MCA Continuous Air Monitor	3	10/11/17	Minor Editorial
IC-HP-349	Calibration - Lab Impex Stack Monitor - Particulate Channel	6	02/22/17	Full Review
IC-HP-349	Calibration - Lab Impex Stack Monitor - Particulate Channel	7	06/09/17	Minor Editorial
IC-HP-349	Calibration - Lab Impex Stack Monitor - Particulate Channel	8	11/02/17	Minor Editorial
IC-HP-350	Calibration - Lab Impex Stack Monitor Iodine Channel	4	02/22/17	Full Review
IC-HP-350	Calibration - Lab Impex Stack Monitor Iodine Channel	5	06/09/17	Minor Editorial
IC-HP-351	Calibration - Lab Impex Stack Monitor - Gas Channel	4	02/22/17	Full Review
IC-HP-351	Calibration - Lab Impex Stack Monitor - Gas Channel	5	06/09/17	Minor Editorial
IC-HP-352	Calibration - Lab Impex Stack Monitor - Flow Calibration	5	02/22/17	Full Review
IC-HP-352	Calibration - Lab Impex Stack Monitor - Flow Calibration	6	06/09/17	Minor Editorial
IC-HP-355	Calibration - NOA Lab Impex Stack Monitor - Gas Channel	3	07/24/17	Cover Page
IC-HP-356	Calibration - NOA Lab Impex Stack Monitor - Flow Calibration	3	10/02/17	Minor Editorial
IC-HP-357	Calibration - NOA Lab Impex Monitor - DP2001	2	06/23/17	Minor Editorial
IC-HP-359	Calibration - Ludlum Model 177 Frisker	2	06/05/17	Minor Editorial
IC-HP-362	Calibration - Eberline/Thermo Model AMS-4 Continuous Air Monitor: Radial Or In-Line Sampling Head	3	07/10/17	Minor Editorial
IC-HP-367	Calibration - I-131 Bioassay Detection System	2	06/05/17	Cover Page
IC-HP-369	Calibration - I-131 Lab Impex Monitor - DP2001	0	07/13/17	New Procedure
IC-HP-370	Calibration - Hi-Q Portable Air Sample - Model CF-993B	0	06/05/17	New Procedure
IRR-PSO-112	Preparing Shipping Paperwork	9	07/07/17	Minor Editorial
OA-8	Importing Authority Notification for the Netherlands	0	08/17/17	New Operator Aid
OA-25	Control Checksheet for Changing P-Tube Pre-Filters	2	08/28/17	Minor Editorial
OA-25	Control Checksheet for Changing P-Tube Pre-Filters	3	10/25/17	Minor Editorial

Number	Name	Rev	Rev Date	Notes
OA-26	NRC 749 Manual License Verification Report for Category 2 Materials	0	10/24/17	New Operator Aid
OA-60	Packaging of Type A Radioactive Material Using USA DOT 7A Model E-Box 030-181	1	06/02/17	Cover Page
OA-99	Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model 1500	1	08/17/17	Cover Page
OA-128	Packaging of Type A Radioactive Material Using USA DOT 7A MURR Model H or I	1	08/17/17	Cover Page
OP-HP-220	Tritium Bioassay	12	06/09/17	Cover Page
OP-HP-221	Environmental Sample - Analysis	7	03/08/17	Minor Editorial
OP-HP-222	Air Sampling - Containment Building Ar-41	8	03/23/17	Minor Editorial
OP-HP-228	Performing Iodine 131 Bioassay Measurements	5	10/11/17	Minor Editorial
OP-HP-231	Respirator Cleaning and Care	1	07/10/17	Minor Editorial
OP-HP-232	Respirator Storage, Maintenance and Inspection	1	06/19/17	Minor Editorial
OP-HP-233	Respirator Fit Test	1	07/10/17	Cover Page
OP-HP-234	Physical Exam for Respirator Program	1	07/10/17	Cover Page
OP-HP-235	Annual Respirator Training	1	07/10/17	Cover Page
OP-HP-300	Receipt of Radioactive Material	10	03/31/17	Full Review
OP-HP-305	Ordering or Transfer of Radioactive Materials	7	08/03/17	Cover Page
OP-HP-350	Eberline Model PING 1A - Filter Change	8	06/19/17	Minor Editorial
OP-HP-354	NOA Waste Tank System Filter Replacement	2	07/24/17	Minor Editorial
OP-HP-355	NOA Waste Tank System Operation	4	07/24/17	Minor Editorial
OP-HP-356	Operation - Lab Impex Stack Monitor: Filter Change and Source Checks	6	04/26/17	Minor Editorial
OP-HP-356	Operation - Lab Impex Stack Monitor: Filter Change and Source Checks	7	10/02/17	Minor Editorial
OP-HP-357	Operation - NOA Lab Impex Stack Monitor - Filter Change and Source Checks	5	07/10/17	Minor Editorial
OP-HP-365	Iodine 131 Processing Hot Cells Radiation Monitor (ALMO-6)	1	07/10/17	Minor Editorial
OP-HP-400	Gemstone Shipping Barrel Analysis	11	07/24/17	Minor Editorial
OP-HP-500	Operation of the Hot Cell (HC-09) Interim Storage Silo	1	03/31/17	Minor Editorial
OP-HP-505	Emergency Stack Monitor Filter Analysis	7	06/19/17	Cover Page
OP-HP-600	Europium Source Creation	5	10/02/17	Minor Editorial
PLAN-130	10 CFR 37 Security Plan for the University of Missouri Research Reactor	0	02/03/17	New Plan
PRC-RRD-214	LN1 Carrier-Free Lu-177 Process	8	12/20/17	Cover Page
PRC-RRD-215	Supplemental Sample Dispensing	6	06/05/17	Obsoleted
PRC-RRD-219	Lu-177m Processing	3	12/20/17	Minor Editorial
PRC-RRD-315	Separation of ND/PM-149	4	12/20/17	Minor Editorial
PRC-RRD-316	Concentration of PM-149	6	12/20/17	Minor Editorial
PRC-RRD-318	Dissolution of Copper Nitrate	2	01/19/17	Minor Editorial
PRC-RRD-319	Cd-115/In-115m Processing	1	07/07/17	Cover Page
PRC-RRD-401	Preparing Sm-153 DOTMP from Lyophilized Kits	2	07/07/17	Cover Page
PRC-RRD-402	Dissolving Sm-153	5	03/24/17	Minor Editorial
PRC-RRD-402	Dissolving Sm-153	6	06/05/17	Minor Editorial
PRC-RRD-405	Quality Control Testing of 153Sm DOTMP	2	07/07/17	Cover Page
PRC-RRD-421	Dissolving Re-186	5	03/24/17	Minor Editorial
PRC-RRD-422	Preparing 153Sm EDTMP From Lyophilized Kits	2	07/07/17	Cover Page
QAB-SH-002	Procurement of Type B Packages	5	03/08/17	Cover Page
QAB-SH-003	Material Control for Type B Shipping Program	7	05/01/17	Minor Editorial
QAB-SH-004	Type B Program Vendor Qualification	7	03/08/17	Cover Page

Number	Name	Rev	Rev Date	Notes
QAB-SH-005	Type B QA Personnel Training	4	05/01/17	Minor Editorial
QAB-SH-006	Type B Shipping Program Quality Audits	3	08/17/17	Minor Editorial
QAB-SH-007	Leak Testing the SAFKEG-HS or SAFKEG-LS Shipping Package Using the CALT Leakage Testing Device	5	01/27/17	Cover Page
QAB-SH-007	Leak Testing the SAFKEG-HS or SAFKEG-LS Shipping Package Using the CALT Leakage Testing Device	6	12/27/17	Minor Editorial
QA-SH-002	Sodium Iodide Spectral Qualitative Analysis for Excepted, License-to-License, Type A, and Type B Radioactive Material Shipments	8	11/02/17	Minor Editorial
RCP-PSO-001	P-33 Sublimation Set Up	9	10/25/17	Cover Page
RCP-PSO-002	P-33 Glove Box Can Opening	8	12/22/17	Minor Editorial
RCP-PSO-003	P-33 Purification Set-Up	11	11/16/17	Minor Editorial
RCP-PSO-004	P-33 Purification	11	11/16/17	Minor Editorial
RCP-PSO-005	P-33 Sublimation with Hot Cell Can Opening	12	11/28/17	Minor Editorial
RCP-PSO-007	PSO Glove Box Welding	12	03/29/17	Minor Editorial
RCP-PSO-007	PSO Glove Box Welding	13	12/07/17	Minor Editorial
RCP-PSO-020	Selenium-75 Process	1	05/15/17	Minor Editorial
RCP-PSO-020	Selenium-75 Process	2	09/19/17	Minor Editorial
RCP-PSO-020	Selenium-75 Process	2	09/19/17	Minor Editorial
RM-HP-101	Stack Monitor Preventive Maintenance - Eberline Ping 1A	6	06/19/17	Minor Editorial
RP-HP-139	Beamport Radiation Level Monitoring During Reactor Startup	6	06/09/17	Cover Page
SEP-RR-130	Security Event Procedures	0	02/03/17	New Procedure
SEP-RR-130	Security Event Procedures	1	06/09/17	Minor Editorial
SI-PSO-009	Operation of the Can Press	3	12/22/17	Cover Page
SV-HP-100	Reactor Chemistry Isotope Counter Trending and Investigative Level Determination	8	03/08/17	Minor Editorial
SV-HP-105	Sealed Calibration Source - Leak Check	9	06/23/17	Minor Editorial
SV-HP-110	Environmental Sampling	8	02/22/17	Full Review
SV-HP-117	Secondary Coolant and Sump Water Analysis	6	02/22/17	Minor Editorial
SV-HP-119	Property Release	9	01/20/17	Minor Editorial
SV-HP-119	Property Release	10	07/24/17	Cover Page
SV-HP-130	Emergency Air Sampling of Exhaust Plume	9	06/19/17	Cover Page
TPZ-PSO-001	Receiving Gemstone Irradiation Shipping Drums	8	07/21/17	Cover Page
TSP-02	Transportation Security Plan	8	09/29/17	Cover Page
WM-SH-100	Radioactive Waste - Preparation and Storage	10	05/01/17	Minor Editorial
WM-SH-104	Solidification of Radioactive Liquid for Shipment	2	05/01/17	Minor Editorial
WM-SH-104	Solidification of Radioactive Liquid for Shipment	3	09/28/17	Minor Editorial
WM-SH-105	Radioactive Waste Processing	13	06/12/17	Minor Editorial
WM-SH-110	Radioactive Waste - Barrel Analysis for Shipment and Disposal	3	06/12/17	Minor Editorial
WM-SH-115	Iodine I-131 Waste Handling	1	06/20/17	Minor Editorial
WM-SH-115	Iodine I-131 Waste Handling	2	11/02/17	Minor Editorial
WM-SH-300	Exclusive Use Shipment of LSA or SCO Radioactive Waste	17	12/27/17	Cover Page

SECTION III

REVISIONS TO THE SAFETY ANALYSIS REPORT

January 1, 2017 through December 31, 2017

On January 4, 2017, the U.S. Nuclear Regulatory Commission (NRC) issued Renewed Facility Operating License No. R-103. During calendar year 2017, no modifications or changes to the facility occurred that required a revision to the Safety Analysis Report (SAR) as submitted to the NRC in 2006 for relicensing.

During 2017, thousands of person-hours were spent by MURR staff to update the 2006 edition of the SAR with all the modifications that occurred between 2006 and 2017, and with applicable information from the hundreds of MURR responses to NRC Requests for Additional Information during the relicensing process. MURR expects to complete the SAR revisions and updates during 2018.

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

January 1, 2017 through December 31, 2017

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

MODIFICATION RECORD 16-04

Upgrade Secondary Coolant System Temperature Transmitters

This Modification Record documents the replacement of the existing Rosemount Alphaline 442 Platinum Resistance Temperature Detector (RTD) and Transmitter Assemblies with new Rosemount 3144P 3-wire Platinum RTD and Temperature Transmitters in the Secondary Coolant System. Based on comparative specifications, these were determined to be equivalent design replacements of the existing assemblies.

MODIFICATION RECORD 04-03, ADDENDUM 3

Removal of Liquid Radioactive Waste Retention System

This addendum to Modification Record 04-03, "Liquid Radioactive Waste Modification," documents the removal of the stand-alone Liquid Radioactive Waste (LRW) Retention Tank System in MURR Industrial Building (MIB) Room 299A from the rest of the Facility LRW Retention Tank System. This included dismantling and removal of Waste Tanks 299-1, 299-2, and 299-3; Waste Pump WP-33; and associated piping and valves. The remaining MIB stand-alone LRW Retention Tank System remains functional and connected to the Facility LRW Retention Tank System.

MODIFICATION RECORD 88-07, ADDENDUM 4

Addition of Charcoal Filters and Dehumidifier to HC-11 Exhaust

This addendum to Modification Record 88-07, "Exhaust Ventilation Upgrade," documents the addition of two sets of charcoal filters in the Hot Cell 11 (HC-11) exhaust ventilation line, a recirculation line for HC-11 cleanup, and the addition of a dehumidifier loop supporting HC-11. This modification facilitates proper humidity control, which will improve filter performance. Additionally, the two new filter banks and recirculation line will provide greater exhaust treatment and defense-in-depth against challenging Technical Specification exhaust limits, should a radioactive release occur within the hot cells.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2017 through December 31, 2017

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

RUR 455

Gallium Nitride Irradiation

This RUR authorizes the irradiation of up to 77.0 grams of gallium nitride wafers in the graphite reflector region of the reactor in support of research and development activities.

In addition, MURR continued to participate in molybdenum-99 research and development work by performing test irradiations and target processing using various methodologies.

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, 2017 through December 31, 2017

INSPECTIONS

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

REACTOR CHARACTERISTIC MEASUREMENTS

Sixty-one refueling evolutions were completed in 2017. Reactor core excess reactivity verifications were performed for each refueling. The largest measured excess reactivity was 3.3%. MURR Technical Specification 3.1.a requires reactor core excess reactivity above reference core condition to be less than 9.8%.

REACTIVITY MEASUREMENTS

Differential blade-worth measurements of five 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.

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

Five reactivity measurements were performed to determine the impact of TheraSphere target can design and target mass changes for irradiation in the flux trap region.

One reactivity measurement was performed to determine the reactivity worth of a target consisting of silicon microspheres in the flux trap region.

SECTION VII

RADIOACTIVE EFFLUENT

January 1, 2017 through December 31, 2017

TABLE 1
SANITARY SEWER EFFLUENT

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

<u>Nuclide</u>	<u>Activity (mCi)</u>
H-3	1.001E+02
S-35	8.905E+00
Co-60	6.494E+00
Zn-65	2.953E+00
Lu-177	2.100E+00
Ca-45	1.268E+00
P-32	1.232E+00
Mo-99	5.721E-01
Sb-124	4.920E-01
Sc-46	2.234E-01
Fe-59	1.596E-01
Mn-54	1.448E-01
Tc-99m	1.288E-01
Cr-51	8.253E-02
I-124	4.646E-02
Cd-109	4.392E-02
Pd-109	3.369E-02
Lu-177m	2.769E-02
W-181	2.738E-02
Ru-105	1.589E-02
Total H-3	1.001E+02
Total Other	2.495E+01

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

TABLE 2
STACK EFFLUENT

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration ($\mu\text{Ci/ml}$)	Total Release (μCi)	TS Limit Multiplier	% TS
Ar-41	1.99E-06	9.31E+08	350	56.9143
I-131	3.36E-12	1.57E+03	1	1.6785
C-14*	1.80E-11	8.19E+03	1	0.6000
H-3	1.17E-08	5.46E+06	350	0.0333
Co-60	1.05E-14	4.89E+00	1	0.0209
I-125	1.18E-14	5.50E+00	1	0.0039
Kr-79	6.93E-10	3.24E+05	350	0.0028
Xe-131m	1.68E-08	7.85E+06	350	0.0024
Sc-46	3.21E-15	1.50E+00	1	0.0011
Os-191	8.16E-15	3.82E+00	1	0.0004
Ba-140	5.30E-15	2.48E+00	1	0.0003
Hf-181	1.38E-15	6.43E-01	1	0.0002
Cs-137	4.53E-16	2.12E-01	1	0.0002
Sb-124	1.14E-15	5.32E-01	1	0.0001

* 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 = ~30,000 cfm

Stack effluent releases are in compliance with University of Missouri-Columbia Research Reactor, Renewed Facility Operating License No. R-103 Technical Specifications.

SECTION VIII

ENVIRONMENTAL MONITORING AND HEALTH PHYSICS SURVEYS

January 1, 2017 through December 31, 2017

Environmental samples are collected two times per year at eight locations and analyzed for radioactivity. Soil and vegetation samples are also taken at each location. Water samples are taken at three locations while subsurface soil samples are taken at six locations each period. Analytical results are shown in Tables 1 and 2.

Table 3 lists the radiation doses recorded by the environmental monitors deployed around MURR in 2017. All doses are approximately 10 mrem/year or less, except monitor number 9. This monitor is located at or near loading dock areas where packages containing radioactive material are loaded or traverse prior to being placed on transport vehicles. The dose recorded by this monitor is considered to be the result of exposure to packages in transit. The environmental monitoring program confirms that minimal 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 91 - Spring 2017

Detection Limits*

<u>Matrix</u>	<u>Alpha</u>	<u>Beta</u>	<u>Gamma</u>	<u>Tritium</u>
Vegetation	1.43 pCi/g	9.45 pCi/g	1.44 pCi/g	5.02 pCi/mL
Soil	0.72 pCi/g	4.72 pCi/g	0.62 pCi/g	N/A
Water	1.02 pCi/L	4.95 pCi/L	193.38 pCi/L	4.94 pCi/mL
Subsurface Soil	1.01 pCi/g	5.12 pCi/g	0.51 pCi/g	N/A

Activity Levels – Vegetation

<u>Sample</u>	<u>Alpha</u> <u>(pCi/g)</u>	<u>Beta</u> <u>(pCi/g)</u>	<u>Gamma</u> <u>(pCi/g)</u>	<u>Tritium</u> <u>(pCi/mL)</u>
1V91	<MDA	34.03	<MDA	<MDA
2V91	<MDA	21.29	1.45	<MDA
3V91	<MDA	24.70	<MDA	<MDA
4V91	<MDA	80.19	<MDA	<MDA
5V91	<MDA	45.77	<MDA	<MDA
6V91	<MDA	40.45	1.99	<MDA
7V91	<MDA	40.80	1.44	<MDA
10V91	<MDA	32.35	<MDA	<MDA

TABLE 1 (Cont'd)
SUMMARY OF ENVIRONMENTAL SET 91 - Spring 2017

Activity Levels – Soil

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>
1S91	<MDA	12.59	3.43
2S91	<MDA	<MDA	3.09
3S91	<MDA	21.64	2.58
4S91	1.09	24.96	2.27
5S91	0.93	18.24	3.79
6S91	0.93	16.53	2.64
7S91	<MDA	11.77	2.86
10S91	<MDA	24.13	3.79

Activity Levels – Water

<u>Sample</u>	<u>Alpha (pCi/L)</u>	<u>Beta (pCi/L)</u>	<u>Gamma (pCi/L)</u>	<u>Tritium (pCi/mL)</u>
4W91	<MDA	<MDA	<MDA	<MDA
6W91	<MDA	<MDA	<MDA	<MDA
10W91	<MDA	11.00	<MDA	<MDA

Activity Levels – Subsurface Soil

<u>Sample</u>	<u>Alpha (pCi/g)</u>	<u>Beta (pCi/g)</u>	<u>Gamma (pCi/g)</u>
S91	<MDA	18.61	3.57
SW91	<MDA	31.92	3.59
W91	<MDA	20.02	3.73
N91	<MDA	22.52	4.23
NE91	<MDA	19.67	3.85
E91	<MDA	21.28	3.47

* 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 (MDA).

TABLE 2
SUMMARY OF ENVIRONMENTAL SET 92 - Fall 2017

Detection Limits*

<u>Matrix</u>	<u>Alpha</u>	<u>Beta</u>	<u>Gamma</u>	<u>Tritium</u>
Vegetation	2.03 pCi/g	10.98 pCi/g	1.83 pCi/g	5.05 pCi/mL
Soil	0.72 pCi/g	4.69 pCi/g	0.59 pCi/g	N/A
Water	0.00 pCi/L	2.99 pCi/L	185.55 pCi/L	5.01 pCi/mL
Subsurface Soil	1.01 pCi/g	4.19 pCi/g	0.66 pCi/g	N/A

Activity Levels – Vegetation

<u>Sample</u>	<u>Alpha</u> <u>(pCi/g)</u>	<u>Beta</u> <u>(pCi/g)</u>	<u>Gamma</u> <u>(pCi/g)</u>	<u>Tritium</u> <u>(pCi/mL)</u>
1V92	<MDA	27.48	<MDA	<MDA
2V92	<MDA	<MDA	<MDA	<MDA
3V92	<MDA	<MDA	<MDA	<MDA
4V92	<MDA	22.49	<MDA	<MDA
5V92	<MDA	31.05	<MDA	<MDA
6V92	<MDA	13.56	<MDA	<MDA
7V92	<MDA	16.42	<MDA	<MDA
10V92	<MDA	21.42	<MDA	<MDA

Activity Levels – Soil

<u>Sample</u>	<u>Alpha</u> <u>(pCi/g)</u>	<u>Beta</u> <u>(pCi/g)</u>	<u>Gamma</u> <u>(pCi/g)</u>
1S92	0.93	19.81	3.19
2S92	0.77	10.71	2.82
3S92	1.08	15.71	2.21
4S92	0.94	16.58	3.08
5S92	1.70	36.05	3.75
6S92	0.77	13.43	2.34
7S92	<MDA	13.03	3.16
10S92	0.92	18.73	3.13

TABLE 2 (Cont'd)
SUMMARY OF ENVIRONMENTAL SET 92 - Fall 2017

Activity Levels – Water

<u>Sample</u>	<u>Alpha</u> <u>(pCi/g)</u>	<u>Beta</u> <u>(pCi/g)</u>	<u>Gamma</u> <u>(pCi/g)</u>	<u>Tritium</u> <u>(pCi/mL)</u>
4W92	0.15	7.85	<MDA	<MDA
6W92	0.31	6.42	<MDA	<MDA
10W92	0.15	12.85	<MDA	<MDA

Activity Levels – Subsurface Soil

<u>Sample</u>	<u>Alpha</u> <u>(pCi/g)</u>	<u>Beta</u> <u>(pCi/g)</u>	<u>Gamma</u> <u>(pCi/g)</u>
E92	1.08	24.12	5.22
S92	<MDA	19.67	4.32
SW92	1.54	22.35	4.53
W92	1.08	21.64	5.08
N92	1.08	23.41	5.05
NE92	<MDA	23.35	4.22

* 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 (MDA).

TABLE 3
ENVIRONMENTAL TLD SUMMARY

Badge Number	Direction from MURR	Map Distance from MURR Stack (meters)	1st Qtr 2017 (net mrem)	2nd Qtr 2017 (net mrem)	3rd Qtr 2017 (net mrem)	4th Qtr 2017 (net mrem)	Total 2017 (net mrem)
0*	Control	72210	23.0	21.0	25.0	33.0	102.0
1*	Schnieders	72210	24.0	24.0	26.0	25.0	99.0
2*	Schnieders	72210	23.0	21.0	25.0	30.0	99.0
3	W	31	12.0	-8.0	-14.0	-19.0	-29.0
4	SW	49	3.0	-5.0	-16.0	-20.0	-38.0
5	NE	119	6.0	-8.0	-13.0	-15.0	-30.0
6	NNE	87	12.0	-2.0	-7.0	-10.0	-7.0
7	NE	55	9.0	-4.0	-10.0	-17.0	-22.0
8	SW	33	0.0	0.0	0.0	0.0	0.0
9	SE	28	25.0	9.0	0.0	1.0	35.0
10	NE	149	-8.0	-9.0	-11.0	-20.0	-48.0
11	NNW	149	11.0	-5.0	-9.0	-16.0	-19.0
12	NE	284	16.0	-6.0	-8.0	-11.0	-9.0
13	SE	320	-9.0	-9.0	-13.0	-19.0	-50.0
14	SSW	166	8.0	-6.0	-8.0	-15.0	-21.0
15	S	74	7.0	**	**	-16.0	-9.0
16	SE	114	9.0	-7.0	-10.0	-16.0	-24.0
17	E	299	4.0	-10.0	-14.0	-19.0	-39.0
18	NE	454	4.0	-9.0	-11.0	-19.0	-35.0
19	NE	671	3.0	-13.0	-17.0	-22.0	-49.0
20	NE	872	-11.0	-11.0	-16.0	-19.0	-57.0
21	SSW	294	10.0	-7.0	-10.0	-15.0	-22.0
22	SW	174	1.0	-9.0	-16.0	-22.0	-46.0
23	NW	67	10.0	-5.0	-9.0	-16.0	-20.0
24	SSW	499	7.0	-8.0	-8.0	-17.0	-26.0
25	NNE	123	9.0	-8.0	-11.0	-20.0	-30.0
26	SW	318	7.0	-9.0	-11.0	-19.0	-32.0
27	SW	174	3.0	-11.0	-16.0	-22.0	-46.0
28	NE	496	8.0	-6.0	-7.0	-12.0	-17.0
29	NE	498	5.0	-8.0	-10.0	-15.0	-28.0
30	N	340	5.0	-10.0	-13.0	-21.0	-39.0
31	NNE	687	6.0	-7.0	-12.0	-13.0	-26.0
32	NNE	616	9.0	-7.0	-9.0	-17.0	-24.0
33	ESE	572	2.0	-11.0	-16.0	-22.0	-47.0
34	NE	613	2.0	-13.0	-18.0	-23.0	-52.0
35	SSE	473	13.0	-4.0	-6.0	-9.0	-6.0
36	SE	428	8.0	-8.0	-13.0	-18.0	-31.0
37	NE	734	3.0	-10.0	-14.0	-21.0	-42.0
38	NW	517	9.0	-6.0	-8.0	-12.0	-17.0
39	W	535	6.0	-8.0	-11.0	-15.0	-28.0
40	N	470	5.0	-9.0	-14.0	-19.0	-37.0
41	NE	155	7.0	-6.0	-14.0	-21.0	-34.0
42	Spare	N/A	10.0	-2.0	**	-17.0	-9.0
43	Spare	N/A	11.0	-5.0	-8.0	-16.0	-18.0
44	SW	99	8.0	-5.0	-13.0	-18.0	-10.0
45	SE	98	20.0	0.0	-2.0	-8.0	10.0
46	SE	105	8.0	-7.0	-10.0	-17.0	-26.0

* The control monitors are approximately 50 miles SE of MURR, and gross values are shown.

** During collection, three TLDs were reported missing; therefore, data is not available.

TABLE 4
NUMBER OF FACILITY RADIATION AND CONTAMINATION SURVEYS

	<u>Radiation</u>	Surface <u>Contamination*</u>	<u>Air Samples**</u>	<u>RWPs</u>
January	103	103	62	17
February	85	85	59	13
March	88	88	68	18
April	94	94	60	23
May	93	93	67	10
June	100	100	66	24
July	86	86	58	16
August	91	91	67	10
September	100	100	62	8
October	87	87	66	22
November	88	88	59	20
December	<u>94</u>	<u>94</u>	<u>62</u>	<u>11</u>
TOTALS	1,109	1,109	756	192

* 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 Note

During calendar year 2017, MURR shipped 1,270.4 cubic feet of low-level radioactive waste containing 23,400 mCi of activity.

SECTION IX

SUMMARY OF RADIATION EXPOSURE TO FACILITY STAFF, EXPERIMENTERS, AND VISITORS

January 1, 2017 through December 31, 2017

Total Personnel Dose (mrem) by Dosimetry Group

	AC/PRD	BCS	DO	FOE	HC	HP	IRR	NA	NS	NSP	OPS	PRO	QA	RES	RP	SH	SIL	TEE	WC	Total
January	83	0	0	0	233	131	0	7	15	12	1336	6	64	1	1	166	219	6	13	2293
February	63	0	0	0	171	170	0	4	52	4	1336	15	62	11	3	98	191	0	13	2193
March	95	0	0	7	221	183	3	5	49	2	1393	0	93	4	0	94	108	13	25	2295
April	110	8	0	0	261	202	3	13	16	11	1509	11	141	2	21	111	153	0	108	2680
May	61	2	0	0	324	226	5	0	39	18	1707	12	113	3	9	112	159	1	28	2819
June	45	0	0	0	267	510	0	6	36	17	1540	0	41	2	6	126	120	0	16	2732
July	96	2	0	0	249	167	0	10	11	22	1886	8	34	2	9	90	127	0	35	2748
August	91	5	0	2	311	187	13	16	53	27	1197	1	46	4	0	114	124	3	14	2208
September	62	0	0	1	262	150	0	5	15	0	1118	0	4	6	3	85	132	3	28	1874
October	128	6	0	0	227	229	8	5	14	23	1347	3	39	0	0	91	116	0	38	2274
November	43	0	0	0	193	237	0	2	14	2	1741	0	13	0	0	131	134	0	103	2613
December	86	0	0	0	262	159	0	1	22	4	1706	11	81	0	3	106	134	0	25	2600
Total for Year	963	23	0	10	2981	2551	32	74	336	142	17816	67	731	35	55	1324	1717	26	446	29329
Monthly Average	80	2	0	1	248	213	3	6	28	12	1485	6	61	3	5	110	143	2	37	2444
Highest WB (annual)	231	17	0	3	1130	617	15	35	113	49	1113	28	172	21	23	308	1134	13	98	
High Extremity (annual)	4870	26	NM	21	3237	687	433	2073	213	94	1414	59	1118	677	284	902	2219	54	671	

AC/PRD-Analytical Chemistry/Production

BCS-Business & Central Services

DO-Director's Office

FOE-Shops & Support

HC-Hot Cell

HP-Health Physics

IRR-Irradiations

NA-Nuclear Analysis

NS-Neutron Scattering

NSP-NorthStar Partners

OPS-Operations

PRO-Isotope Processing

QA-Quality Assurance

RES-Research

RP-Radiopharmaceutical

SH-Shipping

SIL-Silicon

TEE-Trace Elemental Epidemiology

WC-Work Control

WB-Whole Body

NM-Not Monitored

Analysis of personnel exposure levels indicates that exposures are significantly below the limits of 10 CFR 20.1201 and are generally maintained ALARA. No significant personnel exposures occurred during this monitoring year.

NOTE:

Dosimetry services are provided by Mirion Technologies (except self reading dosimetry).