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

SUBJECT: University of Missouri Research Reactor
2005 Reactor Operations Annual Report

I have enclosed one copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers January 1, 2005 through December 31, 2005.

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

If you have any questions regarding the contents of this report, please contact me at (573) 882-5276.

Sincerely,

Les Foyto
Reactor Manager

Enclosure

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

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UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2005 – December 31, 2005

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

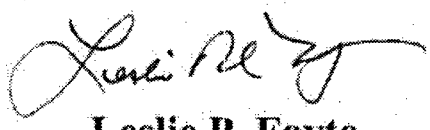
RESEARCH REACTOR FACILITY

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2005 through December 31, 2005

Compiled by the Research Reactor Staff

Submitted February 2006 by:



Leslie P. Foyto
Reactor Manager

Reviewed and Approved by:

Ralph A. Butler, PE
Director

UNIVERSITY OF MISSOURI – COLUMBIA
RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

January 1, 2005 through December 31, 2005

INTRODUCTION

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

The Reactor Operations Annual Report presents a summary of reactor operating experience for calendar year 2005. Included within this report are changes to MURR procedures, revisions to the Hazards Summary Report, facility modifications, new tests and experiments, reactor physics activities, and environmental and health physics data.

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

ACKNOWLEDGMENTS

The success of MURR and these scientific programs is due to the dedication and hard work of many individuals and organizations. Included within this group are: the University administration; the governing officials of the State of Missouri; the Missouri State Police; the City of Columbia Police Department; the Missouri University Police Department; our Regulators; those who have provided funding including the Department of Energy (DOE) and the Department of Homeland Security; the Researchers; the Students; the Columbia Fire Department; the Campus Facilities organization; members of the National Organization of Test, Research, and Training Reactors; 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.

In addition to the items discussed in this Report, a considerable amount of time and resources were directed this year towards the beryllium reflector replacement, and renewal and relicensing projects. Replacement of the beryllium reflector is performed every eight years, with the next replacement scheduled for January 2006. Including low power physics testing, approximately seven to eight days is required to disassemble the necessary piping and equipment, remove the old beryllium and insert the new, and then reassembly of all piping and equipment. Planning for this evolution takes approximately one year, including training, procedure writing, and the procurement of all spare parts and tools, and involves nearly every group within the facility. Additionally, in conjunction with the beryllium replacement, three beamtubes will be retracted in order to replace four graphite reflector elements.

The facility's operating license, R-103, is due to expire on October 11, 2006. Efforts to revise and update the Safety Analysis Report for relicensing submittal are ongoing, with a considerable amount of energy focused on the necessary computer codes to support the nucleonics and accident analyses chapters. Renewal projects are also ongoing, with the completion of two major projects this year: cooling tower electrical and radioactive liquid waste disposal system upgrades.

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

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SECTION I

REACTOR OPERATIONS SUMMARY

January 1, 2005 through December 31, 2005

The following table and discussion summarize reactor operations during the period from January 1, 2005 through December 31, 2005.

Month	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Scheduled*
January	670.48	279.46	90.12	100.90
February	604.64	252.04	89.98	100.77
March	662.67	276.20	89.07	99.72
April	547.65	228.34	76.06	85.30
May	673.75	280.87	90.56	101.39
June	670.17	279.33	93.08	104.39
July	681.09	283.90	91.54	102.50
August	669.82	279.19	90.03	100.80
September	639.11	266.67	88.76	99.55
October	626.76	261.32	84.24	94.32
November	631.52	263.28	87.71	98.37
December	683.72	285.07	91.90	102.89
Total for the Year	**7761.38**	**3235.67**	**88.60 %**	**99.24 %**

*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 2005

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

Major maintenance items for the month included: replacing the shaft keeper key on cooling tower fan CTF-3 motor coupling; completing Compliance Procedure No. 31, "Calibration of the Eberline Radiation Stack Monitor;" adjusting the operating linkage on pool coolant system heat exchanger bypass valve S-2; replacing the filter cartridges in pool coolant demineralizer system inlet filter housing F-200; cleaning the suction strainer for secondary coolant system pump SP-3; replacing the flange gaskets, studs, and nuts, and valve diaphragms for primary coolant demineralizer system inlet filter housing F-201; and replacing the high pressure isolation valve for primary coolant system heat exchanger differential pressure transmitter DPS-928B.

February 2005

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

On February 8, a "Rod Not In Contact With Magnet" rod run-in was automatically initiated when control blade 'D' anvil separated from its electro-magnet during a routine outward shimming evolution. The reactor was shutdown, the pull rod to housing alignment was checked and verified satisfactory, and the anvil and magnet were cleaned. The control rod was withdrawn 26-inches to the full out position as part of the retest. The reactor was refueled and subsequently returned to 10 MW operation.

Major maintenance items for the month included: completing Modification Record 80-5, Addendum 1, "Removal of the Bulk Pool Lead Shield Facility;" replacing the pneumatic tube system photo sensor collar on row 2 irradiation position as part of Modification Record 05-1, "Pneumatic Tube System Photo Sensor Collar Upgrade;" completing Modification Record 04-5, Addendum 1, "Phase 1 of the Cooling Tower Electrical Upgrade Project – Installation of a New Lighting Panel LP-41;" completing Modification Record 04-5, Addendum 2, "Phase 2 of the Cooling Tower Electrical Upgrade Project – Install Independent 13.8 kV Feeder Lines to the Cooling Tower and Laboratory Building Transformers;" completing Modification Record 04-5, Addendum 3, "Phase 3 of the Cooling Tower Electrical Upgrade Project – Replacement of the 500 kVA Cooling Tower Transformer with a 1,500 kVA Transformer;" loading new pool coolant system de-ionization bed 'P;' reinstalling refurbished secondary coolant system flow distribution valve S-17; and completing Modification Record 05-1, "Pneumatic Tube System Photo Sensor Collar Upgrade."

March 2005

The reactor operated continuously in March with the following exceptions: four shutdowns for scheduled maintenance and/or refueling, and one unscheduled shutdown.

On March 10, a reactor scram was manually initiated by the control room operator when it was discovered that the containment building personnel airlock inner door-sealing gasket did not remain inflated after a door closing cycle. This resulted in a loss of containment integrity and a deviation from Technical Specification (TS) 3.5.a.; one of two Limiting Conditions for Operation regarding containment integrity. TS 3.5.a requires that containment integrity be maintained at all times except when the reactor is secured, and irradiated fuel with a decay time less than sixty days is not being handled. One of the six conditions for reactor containment integrity to exist is "The personnel airlock door operable." This implies that one of the two personnel airlock doors must be fully closed with its gasket inflated, thus providing a satisfactory seal. Upon investigation, it was determined that the inner airlock door three-way, dual solenoid-pilot valve had not remained in the "latched" position following the door closing cycle. Once the closing solenoid de-energized, the three-way valve returned to the "unlatched" position, thereby venting air pressure from the sealing gasket resulting in a loss of containment integrity. The three-way valve bonnet and dual solenoid-pilot control assembly were replaced. The door was then cycled five times to verify proper adjustment and operability. The reactor was subsequently refueled and returned to 10 MW operation. Licensee Event Report No. 05-01, providing a detailed description of this event and the corrective actions taken, was submitted within the Technical Specification thirty-day time requirement.

Major maintenance items for the month included: reinstalling refurbished secondary coolant system flow distribution valve S-18; performing a backflush on the secondary coolant side of pool coolant system heat exchanger HX521;

replacing the drive motor for the containment building personnel airlock outer door; reinstalling refurbished secondary coolant system flow distribution valve S-19; and completing Compliance Procedure No. 29, "Calibration of the NMC RAK Radiation Stack Monitor."

April 2005

The reactor operated continuously in April with the following exceptions: three shutdowns for scheduled maintenance and/or refueling, and three unscheduled shutdowns. NRC regional inspector arrived at MURR for routine inspection.

On April 5 during a normal reactor startup, a "Nuclear Instrumentation Channel No. 4 High Power" rod run-in was automatically initiated while proceeding from 5 to 10 MWs. The set point for the rod run-in is 114%, while the highest power attained was 110% - as indicated by Channel No. 4 chart recorder and the remote meter on the control console. All other Nuclear Instrumentation (NI) channel indications were normal. Troubleshooting revealed a mismatch between the remote indicators (chart recorder and console meter) and the linear bar graph display on the NI drawer. Calibration of the linear bar graph was verified in specification. The isolator module, which amplifies and isolates the drawer output signal for use by the remote indicators, was replaced and calibration between the linear bar graph and the remote indicators was verified satisfactory. Trip settings were then verified after replacement and then confirmed again during "Front Panel Checks" prior to startup. The reactor was subsequently restarted to 10 MW operation. NOTE: Trip settings are set based on drawer calibrated indication, not remote indication. No deviation from Technical Specification Limiting Conditions of Operation for high power rod run-in or reactor scram occurred.

On April 8, a "Nuclear Instrumentation Channel No. 4 High Power" rod run-in was automatically initiated while adjusting Signal Processor drawer No. 1 gain potentiometer to increase console remote meter indication to greater than 100%. This is a routine adjustment at power that is necessary to maintain Nuclear Instrumentation (NI) indications within the administrative operating range of 100 to 105%, after first verifying power by manual heat balance. At the start of the adjustment, remote meter indication was reading approximately 98.5% with a gain potentiometer setting of 369. A Senior Reactor Operator had increased the setting to 427, which caused console meter indication to increase to approximately 99.5% when the rod run-in occurred. Console meter indication was observed by two operators. Chart recorder indication was approximately 114%, the value of the rod run-in set point. Drawer indication was not known, as this indication is not typically viewed during adjustment. However, comparison of local and remote indications is verified prior to startup. All other NI channel indications were normal, thus indicating that no actual reactivity transient occurred. Troubleshooting efforts did not reveal any discrepancies. The NI drawer was removed and a spare drawer was installed and calibrated. The reactor was subsequently refueled and returned to 10 MW operation. The removed NI drawer will undergo further bench top troubleshooting. NOTE: A potentiometer adjustment of 100 correlates to a percent power indication change of approximately 3%. In this case, an increase in the setting of 58 would be expected to increase meter indication approximately 1 to 1-½ %, as it did.

On April 22, a reactor scram was manually initiated by the control room operator when facility fire main pressure decreased and remained below the minimum pressure required for emergency pool fill availability. Upon investigation, the University water supply line immediately outside the facility grounds had ruptured, causing a low-pressure condition. Campus Energy Management isolated and repaired the leak. The reactor was subsequently refueled and returned to 10 MW operation.

Major maintenance items for the month included: placing an epoxy patch on the secondary coolant side of primary heat exchanger HX503A; completing Modification Record 95-3, Addendum 1, "Redesign and Replacement of the

GH Reflector Wedge;" replacing a section of emergency pool fill piping which enters the containment structure through the utility seal trench; performing a backflush on the secondary coolant side of pool coolant system heat exchanger HX521; completing the biannual cleaning of the cooling tower sump and basin; and completing the biennial changeout of control blade 'A' offset mechanism.

May 2005

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

On May 9 during a normal reactor startup, a "Rod Not in Contact with Magnet" rod run-in was automatically initiated when control blade 'A' separated from its electro-magnet while performing a shimming evolution. Initial troubleshooting efforts revealed no abnormalities. Compliance Procedure No. 10 was performed, which verified satisfactory alignment for the control blade's full travel (26-inches), and the reactor was eventually restarted to 10 MW operation. During the following scheduled maintenance day it was discovered that the allen head screw, which attaches the magnet to the drive tube, was installed backwards. The drive tube is a hollow aluminum tube that is tapped on one side and has a non-threaded hole on the other side. The screw was attached to the drive tube first through the threaded side, which allowed more "slop" between the magnet and drive tube. Additionally, the magnet cabling was pulled too tight through its securing clamp, thus not allowing sufficient freedom for the magnet to hang. Both of these conditions caused the magnet to tilt approximately 20 degrees off vertical centerline. With the magnet not hanging freely and vertically, it had a tendency to push the anvil to one side as it engaged, thus causing the anvil to drag against the housing and the magnet to pull off. The remaining control blade magnets were also checked to ensure that they hung freely and vertically.

On May 18, the control Rod Position Indication (RPI) system remote Operator Display Assembly (ODA) display screen on the control console failed (went blank). The master local display chassis on the Instrument Panel remained operational; therefore RPI was still available to the operators. After conferring with the Reactor Manager, the Lead Senior Reactor Operator shutdown the reactor to troubleshoot the ODA. The Chief Electronic Technician determined that the ODA display control card had failed. The spare display control card was installed which returned the ODA to operation. The reactor was subsequently refueled and returned to 10 MW operation.

Major maintenance items for the month included: replacing Nuclear Instrumentation Signal Processor No. 2 drawer; replacing the batteries for the Uninterruptible Power Supply; completing Compliance Procedure No. 26, "Containment Building Compliance Test;" and completing Modification Record 95-1, Addendum 1D, "Replace Existing Gamma-Metrics High Voltage Plasma Bargraphs with Liquid Crystal Displays."

June 2005

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

On June 6 during a normally scheduled reactor shutdown, it was discovered that the head pin, which secures the hold-down rod assembly, had been improperly installed on the three-tube flux trap sample holder during the previous reactor shutdown on May 30. Failure to have the head pin properly installed resulted in a deviation from Technical Specification (TS) 3.6.e; one of fifteen (15) Limiting Conditions for Operation regarding experiments. TS 3.6.e

states, "Only movable experiments in the center test hole shall be removed or installed with the reactor operating. All other experiments in the center test hole shall be removed or installed only with the reactor shut down. Secured experiments shall be rigidly held in place during reactor operation." Additionally, TS definition 1.24 for a secured experiment states "A secured experiment is any experiment which is rigidly held in place by mechanical means with sufficient restraint to withstand any anticipated forces to which the experiment might be subjected." Failure to have the head pin properly installed resulted in a component of a secured experiment, which was installed in the center test hole, not being rigidly held in place during reactor operation.

It should be noted that the flux trap sample holder itself was at all times rigidly held in place while inserted into the reactor. As described in the safety analysis section of the Licensee Event Report, the reactivity worth of the sample holder is approximately 75% of the total reactivity worth of the experiment. The reactivity worth of all of the samples and spacers in the holder was only 0.00114 ΔK – slightly greater than the TS limit for a movable experiment. The reactivity that could have been introduced by movement of these samples and spacers in all three tubes was only 0.00037 ΔK, less than the limit for a movable experiment. Furthermore, any potential movement of samples or spacers was confined within the sample holder. Therefore, no reactor safety hazard existed with the flux trap sample holder pin improperly installed during reactor operation. Licensee Event Report No. 05-02, providing a detailed description of this event and the corrective actions taken, was submitted within the Technical Specification thirty-day time requirement.

Major maintenance items for the month included: replacing the roots blower on the NMC RAK radiation stack monitor; performing a zero and span, and calibration on the pool coolant system flow transmitter FT-912D; performing a backflush on the secondary coolant side of pool coolant system heat exchanger HX521; replacing the rod run-in system trip actuator amplifier; replacing the secondary coolant system pH probe; completing Compliance Procedure No. 31, "Calibration of the Eberline Radiation Stack Monitor;" and replacing a fuse on the display control card for the Rod Position Indication system remote Operator Display Assembly.

July 2005

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

On July 8, a "Nuclear Instrumentation Channel No. 5 High Power" rod run-in was automatically initiated when a movable sample was being removed from the graphite reflector region during a routine sample handling evolution. While pulling the sample holder out, its handling cable became entangled with an adjacent sample's cables, causing both sample holders to be withdrawn from the reflector region at the same time. The reactivity insertion caused by the removal of both samples automatically initiated the rod run-in. The rod run-in was reset, and the reactor was returned to 10 MW operation. The operators involved were counseled on the importance of ensuring only one sample is pulled from the reflector region at a time. Note: The combined reactivity effect due to the removal of both sample holders simultaneously did not exceed the Technical Specification limit of 0.001 ΔK for a movable experiment.

Major maintenance items for the month included: replacing the power supply for the Rod Position Indication system remote Operator Display Assembly; loading new pool coolant system de-ionization bed 'B;' replacing the air compressor for the facility instrument air system; replacing Nuclear Instrumentation Intermediate Range Channel No. 2 remote meter face; completing Modification Record 04-5, Addendum 4, "Phase 4 of the Cooling Tower Electrical Upgrade Project – Replacement of Substation 'A' and the Motor Control Centers;" completing Modification Record 04-5, Addendum 6, "Phase 6 of the Cooling Tower Electrical Upgrade Project – Replacement of the 15 kVA

Transformer with a 45 kVA Transformer;" and replacing the bypass piping for the secondary coolant system auto make-up water valve.

August 2005

The reactor operated continuously in August with the following exceptions: five shutdowns for scheduled maintenance and/or refueling, and one unscheduled shutdown.

On August 22 during a normal reactor startup, a "Nuclear Instrumentation Channel No. 3 Short Period" rod run-in was automatically initiated when an "Anti-Siphon Tank HI-LO Pressure" annunciator alarm occurred. The control rods had been withdrawn to a height of approximately two inches from the fully inserted position when the rod run-in occurred. Anti-Siphon System pressure had lowered to the alarm set point as a result of system cool-down prior to startup. The rod run-in was most likely caused by electrical "noise" from the annunciator alarm because the pressure switch is located immediately adjacent to the nuclear instrumentation detector. A reactor startup was subsequently performed to 10 MW operation.

Major maintenance items for the month included: replacing the logic relay in the building exhaust ventilation system fan failure circuit; transferring the old beryllium reflector and tantalum wedge from the reactor pool to a storage cask; completing Modification Record 05-3, "Electrical Distribution Modifications Associated with the New Chill Water Loop;" and installing a rebuilt cooling fan in the Instrument Panel.

September 2005

The reactor operated continuously in September with the following exceptions: three shutdowns for scheduled maintenance and/or refueling, and five unscheduled shutdowns.

Four (4) reactor loop low flow scrams occurred within a three-day period while operating at 10 MW. The following indications were common to each occurrence:

1. No indications of an actual reduction in primary coolant flow was recorded on the chart recorder;
2. No reactor loop low flow alarm was received; and
3. All lights on the "Yellow Leg" and only lights 1 and 2 remained lit on the "Green Leg" of the reactor scram monitoring system ("White Rat"), thus indicating that the most likely cause was the "B" loop of the primary coolant system – flow transmitter FT-912E Instrumentation String.

First Shutdown at 15:32, September 3: Suspected air bubbles in the sensing lines of flow transmitter FT-912E as the most probable cause. Transmitter high and low-pressure sides were vented and Compliance Procedure No. 4B was performed to verify scram set point and transmitter calibration – both were within specification. Permission to restart the reactor was obtained from the Reactor Manager.

Second Shutdown at 21:59, September 3: Because the above stated indications would imply that there was no actual drop in current, or signal, within the instrument loop (i.e., no corresponding low flow alarm), troubleshooting efforts were directed at components that could intermittently fail and provide only a reactor scram and annunciation: dual alarm unit EP-920C/D, scram relay K-38, and any interconnect wiring. After systematically eliminating K-38 and any interconnect wiring as the probable cause, focus was placed on the dual alarm unit. The dual alarm unit was replaced with one from spare parts. Compliance Procedure No. 4B and 7A were performed to verify scram set point

settings were satisfactory. Additionally, a multi-meter was connected to the chart recorder test points to continuously monitor the instrumentation current loop. The multi-meter was selected to the MIN function, which would record the lowest current reading during a transient. Permission to restart the reactor was obtained from the Reactor Manager.

Third Shutdown at 08:15, September 4: The multi-meter did not record any decrease in current that would have caused a reactor scram – lowest current reading correlated to a flow rate of 1880 gpm; well above the scram set point of 1725 gpm. Interconnected wiring was rechecked. Replaced primary coolant "B" loop flow scram relay K-38 and once again replaced dual alarm unit EP-920C/D with one from spare parts. Compliance Procedure No. 4B and 7A were performed to verify scram set point settings were satisfactory. In addition to the multi-meter that was already connected to the chart recorder, a second multi-meter was connected to the dual alarm unit to monitor its +24V output. The multi-meter was selected to the MIN function, which would record the lowest voltage reading during a transient. By the use of the two multi-meters and the installed "White Rat," all instrumentation output signals within the FT-912E Instrumentation String were monitored. Permission to restart the reactor was obtained from the Reactor Manager.

Fourth Shutdown at 03:12, September 5: This shutdown occurred while performing Compliance Procedure No. 10, "Control Rod Drop Times," during the normally scheduled Monday morning shutdown. All indications provided by the multi-meters were normal, suggesting that no actual trip signal was generated by either the flow transmitter or the dual alarm unit. Troubleshooting efforts were again focused at the interconnect wiring between the output of the dual alarm unit and relay K-38. A more rigorous investigation of the interconnect wiring and connection points was performed including the disassembly and inspection of the "Green Leg" connector and K relay drawer. This inspection once again yielded no definitive cause. After exhausting all known options and testing, the dual alarm units for the "Green" and "Yellow Legs," EP-920C/D and EP-920A/B respectively, were swapped. If another shutdown would have occurred, this would have provided us additional troubleshooting information depending on whether the scram was generated in the "Yellow" or "Green Leg." Compliance Procedure No. 4A/B and 7A/B were performed to verify scram set point settings were satisfactory. Permission to startup the reactor was obtained from the Reactor Manager following completion of the normal maintenance day activities.

No further reactor loop low flow scrams have been received. Although no definitive cause could be found, nor could a duplication of the event be created during troubleshooting activities, the most probable cause was a loose connector that was not apparent when disconnected.

On September 13, a "Reactor Loop Low Flow" scram was automatically initiated when primary coolant system pump P-501B breaker opened while operating. The motor phase currents and resistance to ground were measured with all readings indicating nothing unusual. Both motor and pump were checked for free rotation. Additionally, vibration analysis of the motor/pump did not indicate any abnormalities. No definitive cause could be identified. An electronic data logger was connected to all three phases of the motor to record run current in the event of a similar occurrence. The primary coolant system was operated for approximately 30 minutes with no abnormal indications. The reactor was refueled and subsequently returned to 10 MW operation.

Major maintenance items for the month included: replacing the reactor safety system dual alarm unit EP-920C/D; replacing the primary coolant 'B' loop low flow scram relay K-38; replacing the pool coolant 'B' loop low flow scram relay K-37; replacing the sensing line piping on the high-pressure side of pool coolant system flow transmitter FT-912F; and replacing the primary coolant system temperature element TE-980B meter relay unit.

October 2005

The reactor operated continuously in October with the following exceptions: six shutdowns for scheduled maintenance and/or refueling, and one unscheduled shutdown. NRC regional inspector arrived at MURR for routine inspection. Three reactor startups were performed for NRC operator licensing examinations.

On October 6, a "Reflector HI-LOW Differential Pressure" scram was automatically initiated when a 3-inch sample holder was removed from the reactor pool reflector region during a normal sample handling evolution. Removal of the sample holder, combined with a lower than normal pool coolant flow, created a low differential pressure condition across the reflector region. Pool coolant flow had gradually decreased over the 12 hours prior to the shutdown for no apparent reason. During troubleshooting efforts, the pool coolant and pool coolant demineralizer system filters were removed and inspected. Fibrous material, similar to that of nylon rope, was found on the filters. The filters were either replaced or cleaned, as applicable, and pool coolant system flows returned to normal. The most probable scenario is that a section of nylon rope, which is used to hang off items in the pool, had come loose and entered the pool coolant loop through natural convection valve 547. This valve is located near the pool bottom and is maintained open during operation. Once in the loop, the combination of gamma radiation and the pool coolants pumps had deteriorated the rope to point where it had disintegrated and collected on the filters. The reactor was refueled and subsequently returned to 10 MW operation.

Major maintenance items for the month included: completing Compliance Procedure No. 29, "Calibration of the NMC RAK Radiation Stack Monitor;" replacing the filter cartridges in pool coolant demineralizer system inlet filter housing F-200; completing the biannual cleaning of the cooling tower sump and basin; performing a backflush on the secondary coolant side of pool coolant system heat exchanger HX521; completing the biennial changeout of control blade 'C' offset mechanism; replacing the leadscrew assembly for control rod 'C' drive mechanism; replacing the electro-magnet cabling for control rod 'C' drive mechanism; and replacing the fuses in the south roof top air handler control circuit.

November 2005

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

On November 2, a "Rod Not In Contact With Magnet" rod run-in was automatically initiated when control blade 'C' anvil separated from its electro-magnet during a routine outward shimming evolution. The reactor was shutdown and the pull rod to housing alignment was checked and verified satisfactory. During the October 31 maintenance day activities, the electro-magnet cabling for control rod 'C' drive mechanism was replaced due to degradation of the cabling insulation. In comparison to the other drive mechanisms, it appeared that the new cabling was a few inches longer than the others. This may have caused the cabling to "bunch up" as the drive tube retracted into the upper housing. The cabling was shortened approximately 6-inches and the control rod was satisfactorily withdrawn to the full out position as part of the retest. The reactor was refueled and subsequently returned to 10 MW operation.

On November 6, a "Rod Not In Contact With Magnet" rod run-in was automatically initiated when control blades 'C' and 'D' separated from their respective electro-magnets. It was immediately noted by the reactor operator that the trip actuator amplifier (TAA) for the "Green Leg" of the reactor safety system had tripped. Troubleshooting efforts revealed no specific cause and the condition could not be re-created. As a precaution, the TAA was replaced with

one from spare parts. Further bench-top testing will be performed on the removed TAA. The reactor was refueled and subsequently returned to 10 MW operation.

On November 25, the reactor was shutdown when all four control rods automatically inserted by rod run-in for no apparent reason. Troubleshooting efforts revealed that the rod run-in trip actuator amplifier (TAA) had failed and could not be reset. Bench-top testing discovered two failed transistors. The TAA was replaced with one from spare parts and tested satisfactorily. The reactor was refueled and subsequently returned to 10 MW operation.

On November 28 during a reactor startup (the reactor was still subcritical), a "Pool Loop Valve 509 Off Open" scram was automatically initiated. Valve 509 position indication on the Instrument Panel indicated that the valve was open and the scram condition immediately cleared. Additionally, had the valve actually come off of its open seat, the pool coolant system pumps would have secured as part of the valve-pump interlock circuitry. The most probable cause was either dirt between the contact surfaces or the contact had not properly seated during system startup causing a momentary break in connectivity. All contacts on the relay block were burnished and the relay was manually cycled to ensure freedom of movement. All retesting indicated proper operation of the relay and its contacts. The reactor was subsequently restarted to 10 MW operation.

Major maintenance items for the month included: shortening the cabling on control rod 'C' drive mechanism electro-magnet; replacing the vibration switch on cooling tower fan CTF-2; replacing the reactor safety system "Green Leg" trip actuator amplifier; loading new pool coolant system de-ionization bed 'F;' replacing the pressure switch for the facility main air compressor; completing Modification Record 05-9, "Redirect Resin Sluice Water to Waste Tanks;" replacing the rod run-in system trip actuator amplifier; flooding Beamport 'C' with demineralized water; replacing the level control switch for waste tank No. 4; replacing the harmonic filter for secondary coolant system pump SP-1; and completing Modification Record 05-4, "Secondary Coolant System Changes in support of Upgrades to the Facility HVAC System."

December 2005

The reactor operated continuously in December with the following exceptions: eight shutdowns for scheduled maintenance and/or refueling, and one unscheduled shutdown.

On December 26 during a reactor startup, a "Nuclear Instrumentation Channel 4, 5 & 6 Hi Power" rod run-in was automatically initiated when Nuclear Instrumentation (NI) Channel No. 5 exceeded its rod run-in set point of 114% immediately after placing the reactor in automatic control at 10 MWs. The rod run-in was reset, with Reactor Manager's approval, and the reactor was subsequently returned to 10 MW operation.

A contributor to the unscheduled shutdown was a previous action that was performed on December 12. In preparation for the upcoming beryllium change-out, Beamport 'A' was filled with demineralized water. Filling a beamport with water secures the neutron beam to its experimental apparatus. This is performed with the reactor shutdown, and in keeping with the principles of ALARA, allows the experiment and its shielding to have a sufficient period of decay before being dismantled. Filling or draining a beamport also affects neutron signal strength to NIs that are adjacent to the beamport; filling decreases signal strength whereas draining increases it. NI Channel No. 6 and the Wide Range Monitor (WRM) are adjacent to Beamport 'A.' A change in signal strength can be compensated by gain adjustment on Channel No. 6; however, the WRM does not have sufficient gain adjustment to increase meter indication to 100% with the beamport filled. The WRM, which has no reactor safety functions, provides an input signal to the Rod Control System for automatic control of reactor power. The reactor may be operated at 10 MW in

automatic control with WRM meter indication less than 100% by matching power schedule set point to WRM indication. In this instance, the unfamiliarity of placing the reactor in automatic control with WRM indication less than 100% allowed Channel No. 5 to increase to its rod run-in set point. The reactor operators have been informed to approach 10 MWs more conservatively and place the reactor in automatic control at 9 MWs and increase power from that point. Beamport 'A' will be drained after reassembly of its experiment.

Major maintenance items for the month included: cleaning the high and low level probes in the drain collection tank; flooding Beamport 'C' with demineralized water; replacing the test and feedback module for nuclear instrumentation channel No. 6; replacing the pool and primary coolant system differential temperature meters; performing a flux profile measurement of the flux trap region; completing Compliance Procedure No. 31, "Calibration of the Eberline Radiation Stack Monitor;" and replacing the power supply for the primary power calculator.

SECTION II

MURR PROCEDURES

January 1, 2005 through December 31, 2005

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

A. CHANGES TO REACTOR OPERATIONS PROCEDURES

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

There were 93 new and revised Reactor Operations procedures, forms and operator aids issued. The majority of the revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the new and revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	3	2/11/2005	Cover Page
EX-RO-120	Beamport "A" Operation	2	8/15/2005	Cover Page
EX-RO-121	Beamport "B" Operation	2	8/15/2005	Cover Page
EX-RO-123	Beamport "D" Operation	2	8/15/2005	Cover Page
EX-RO-124	Beamport "E" Operation	2	8/15/2005	Cover Page
EX-RO-125	Beamport "F" Operation	2	8/15/2005	Cover Page
EX-RO-126	Thermal Column Door	2	10/20/2005	Cover Page
FM-08	Fuel Movement Sheet	6	9/15/2005	Cover Page
FM-18	Deviation From Procedure Report	3	10/20/2005	Cover Page
FM-19	Unscheduled Power Reduction Report	2	12/14/2005	Cover Page
FM-20	Waste Tank Sample Report	6	6/9/2005	Cover Page
FM-21	ARMS Trip Setpoints	3	6/30/2005	Cover Page
FM-23	MURR Tag Out Index Record	3	8/18/2005	Cover Page
FM-24	MURR Tag Out Sheet	4	8/18/2005	Cover Page
FM-25	MURR Tag Out Monthly Audit	3	8/18/2005	Cover Page
FM-55	Startup Nuclear Data Sheet	3	4/18/2005	Cover Page
FM-57	Long Form Startup Checksheet	5	2/11/2005	Cover Page
FM-57	Long Form Startup Checksheet	6	10/20/2005	Cover Page
FM-58	Short Form Startup Checksheet	3	2/11/2005	Cover Page
FM-58	Short Form Startup Checksheet	4	10/20/2005	Cover Page
FM-64	DI Resin Log	3	9/15/2005	Cover Page
FM-65	Filter Status Log	3	9/15/2005	Cover Page
FM-68	Target Material Control Checksheet	3	4/21/2005	Cover Page

Number	Name	Rev.	Revision Date	Notes
FM-71	Pneumatic Tube User Approval	1	6/9/2005	Cover Page
GS-RA-100	MURR Equipment Tag Out	4	8/18/2005	Cover Page
OA-1	Facility Exhaust Fans EF-13 and EF-14, EF-13 Running	3	10/20/2005	Cover Page
OA-2	Facility Exhaust Fans EF-13 and EF-14, EF-14 Running	3	10/20/2005	Cover Page
OA-3	Beamport and Pool Overflow Loop Seals	3	10/20/2005	Cover Page
OA-4	Valve Operation Air Compressor	3	10/20/2005	Cover Page
OA-5	Emergency Air Compressor	3	10/20/2005	Cover Page
OP-RO-211	Reactor Startup - Hot	4	8/15/2005	Cover Page
OP-RO-212	Reactor Startup - Recovery from Temporary Power Reduction	4	9/15/2005	Cover Page
OP-RO-220	Reactor Shutdown or Power Reduction	4	8/15/2005	Cover Page
OP-RO-350	Reactor Power Calculator Flow Potentiometer Adjustment	3	8/15/2005	Cover Page
OP-RO-420	Primary and Pool Water Analysis	2	8/15/2005	Cover Page
OP-RO-460	Pool Coolant System-Two Pump Operation	5	6/9/2005	Cover Page
OP-RO-516	Valve Operation Air System	4	8/15/2005	Cover Page
OP-RO-520	Emergency Diesel Generator	4	9/15/2005	Cover Page
OP-RO-531	Primary and Pool Sample Station	4	6/30/2005	Cover Page
OP-RO-532	Drain Collection System	4	6/9/2005	Cover Page
OP-RO-533	Skimmer System	3	8/15/2005	Cover Page
OP-RO-710	Radiation Monitoring - Area Monitors	3	8/15/2005	Cover Page
RM-RO-405	Reactor Demineralizer System	6	9/15/2005	Cover Page
RP-RO-200	RTP-11D Measurement of Differential Worth of a Shim Blade	1	8/15/2005	New Procedure
AP-RO-110	Conduct of Operations	4	3/28/2005	Full Review
EX-RO-105	Reactor Irradiation Experiments	5	5/3/2005	Full Review
EX-RO-105	Reactor Irradiation Experiments	6	8/15/2005	Full Review
FB-SH-005	Type B Shipment of Spent Fuel Using the BMI-1 Shipping Cask	0	6/1/2005	New Procedure
FM-66	Customer Sample Pre-Encapsulation Evaluation Worksheet	0	3/16/2005	Full Review
OP-RO-250	In-Pool Fuel Handling	7	8/15/2005	Full Review
OP-RO-480	Secondary Coolant System	6	8/15/2005	Full Review
OP-RO-730	Facility Exhaust System	8	12/14/2005	Full Review
REP-RO-100	Reactor Emergency Procedures	4	6/24/2005	Full Review
AP-RO-110	Conduct of Operations	5	10/20/2005	Minor Editorial
EX-RO-105	Reactor Irradiation Experiments	7	10/20/2005	Minor Editorial
EX-RO-122	Beamport "C" Operation	2	9/15/2005	Minor Editorial
FM-33	Containment Building Restricted Materials	2	10/20/2005	Minor Editorial
FM-41	Fuel Shipping Drum Return Inspection Form	2	5/18/2005	Minor Editorial
FM-56	Reactor Routine Patrol	8	3/28/2005	Minor Editorial
FM-56	Reactor Routine Patrol	9	5/18/2005	Minor Editorial
FM-63	DI Water Makeup Log	4	6/9/2005	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
FM-66	Customer Sample Pre-Encapsulation Evaluation Worksheet	1	7/26/2005	Minor Editorial
FM-93	Post-Maintenance Valve Lineup Checksheet	2	5/18/2005	Minor Editorial
GS-RA-100	MURR Equipment Tag Out	5	9/16/2005	Minor Editorial
OA-7	Receiving Bulk Chemicals	2	8/15/2005	Minor Editorial
OP-RO-100	Main Air System	5	3/28/2005	Minor Editorial
OP-RO-101	Instrument Air System	4	3/28/2005	Minor Editorial
OP-RO-210	Reactor Startup-Normal	5	3/28/2005	Minor Editorial
OP-RO-210	Reactor Startup-Normal	6	5/3/2005	Minor Editorial
OP-RO-230	Changing Reactor Power Level	3	6/30/2005	Minor Editorial
OP-RO-250	In-Pool Fuel Handling	6	6/9/2005	Minor Editorial
OP-RO-310	Nuclear Instrumentation - Signal Processor #1	4	5/18/2005	Minor Editorial
OP-RO-311	Nuclear Instrumentation - Signal Processor #2	4	5/18/2005	Minor Editorial
OP-RO-312	Nuclear Instrumentation Power Range Monitor - Channel 6	5	5/18/2005	Minor Editorial
OP-RO-330	Nuclear Instrumentation - Wide Range Monitor	4	5/18/2005	Minor Editorial
OP-RO-340	Nuclear Instrumentation Adjustment	5	6/9/2005	Minor Editorial
OP-RO-340	Nuclear Instrumentation Adjustment	6	8/15/2005	Minor Editorial
OP-RO-461	Pool Coolant System-One Pump Operation	4	6/9/2005	Minor Editorial
OP-RO-480	Secondary Coolant System	7	10/20/2005	Minor Editorial
OP-RO-515	Emergency Air System	4	9/15/2005	Minor Editorial
OP-RO-530	Demineralized Water Supply System	5	6/9/2005	Minor Editorial
OP-RO-555	Fire Protection System	1	12/14/2005	Minor Editorial
OP-RO-720	Radiation Monitoring - Stack Monitor Operational Check	4	6/9/2005	Minor Editorial
OP-RO-730	Building Exhaust System Fans	7	3/28/2005	Minor Editorial
OP-RO-741	Waste Tank System Operation	6	3/28/2005	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	3	5/24/2005	Minor Editorial
REP-RO-100	Reactor Emergency Procedures	5	12/14/2005	Minor Editorial
RM-RO-405	Reactor Demineralizer System	5	2/11/2005	Minor Editorial
RM-RO-405	Reactor Demineralizer System	7	12/14/2005	Minor Editorial
RM-RO-470	Sulfuric Acid System	4	8/15/2005	Minor Editorial
RP-RO-100	Fuel Movement	4	5/18/2005	Minor Editorial
RP-RO-201	RTP-17B Measurement of Total Reactivity Worth of Flux Trap Loadings	1	8/15/2005	Minor Editorial
FM-152	Spent Fuel Element Inspection	0	10/20/2005	New Form

B. CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

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

There were 44 revisions issued to the emergency procedures, forms and operator aids. The majority of the revisions were strictly format or editorial in nature, such as cover page changes. The following is a list of the revised procedures, forms and operator aids:

Number	Name	Rev.	Revision Date	Notes
EP-RO-003	Emergency Preparedness Training	2	7/19/2005	Cover Page
EP-RO-004	Fire	1	7/19/2005	Cover Page
EP-RO-005	Medical Emergency	1	7/19/2005	Cover Page
EP-RO-006	Radiological Emergency	1	7/19/2005	Cover Page
EP-RO-007	Severe Natural Phenomenon	1	7/19/2005	Cover Page
EP-RO-008	Threat To Security	1	7/19/2005	Cover Page
EP-RO-009	Notification of Unusual Event	1	7/19/2005	Cover Page
EP-RO-011	Site Area Emergency	1	7/19/2005	Cover Page
EP-RO-012	Reactor Isolation	1	7/19/2005	Cover Page
EP-RO-013	Facility Evacuation	1	7/19/2005	Cover Page
EP-RO-014	EPZ and Site Area Evacuations	2	7/19/2005	Cover Page
EP-RO-016	Public Information	1	7/19/2005	Cover Page
EP-RO-017	Emergency Air Sampling	1	7/19/2005	Cover Page
EP-RO-018	Emergency Radiation Exposure	2	7/19/2005	Cover Page
EP-RO-019	Emergency Dosimeters	1	7/19/2005	Cover Page
FM-102	Emergency Event Log	1	7/19/2005	Cover Page
FM-103	Facility Status	1	7/19/2005	Cover Page
FM-105	Initial/Follow-Up Emergency Message	1	7/19/2005	Cover Page
FM-106	Log of Personnel Released From Site	1	7/19/2005	Cover Page
FM-110	Fire Flowchart	1	7/19/2005	Cover Page
FM-111	Medical Flowchart	1	7/19/2005	Cover Page
FM-112	Radiological Flowchart	1	7/19/2005	Cover Page
FM-113	Severe Natural Phenomenon Flowchart	1	7/19/2005	Cover Page
FM-115	Plant Conditions Flowchart	1	7/19/2005	Cover Page
FM-116	Classification Flowchart	1	7/19/2005	Cover Page
EP-RO-010	Alert	1	7/19/2005	Cover Page
FM-100	Emergency Declaration	1	7/19/2005	Cover Page
FM-101	FEO Management	1	7/19/2005	Cover Page
OA-10	Fire Extinguisher Locations and Types	1	7/19/2005	Full Review
OA-20	Emergency Equipment	1	7/19/2005	Full Review
EP-RO-001	Definitions	1	2/17/2005	Minor Editorial
EP-RO-001	Definitions	2	7/19/2005	Minor Editorial
EP-RO-002	Emergency Responsibilities	2	7/19/2005	Minor Editorial
EP-RO-003	Emergency Preparedness Training	1	2/17/2005	Minor Editorial
EP-RO-014	EPZ and Site Area Evacuations	1	2/17/2005	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
EP-RO-015	Emergency Notifications	1	2/17/2005	Minor Editorial
EP-RO-015	Emergency Notifications	2	7/19/2005	Minor Editorial
EP-RO-020	Emergency Equipment Maintenance	1	7/19/2005	Minor Editorial
FM-104	Emergency Call List	1	2/17/2005	Minor Editorial
FM-104	Emergency Call List	2	7/19/2005	Minor Editorial
FM-114	Security Flowchart	1	7/19/2005	Minor Editorial
FM-117	Reactor Isolation Flowchart	1	7/19/2005	Minor Editorial
FM-118	Evacuation Flowchart	1	7/19/2005	Minor Editorial
OA-09	Combined Emergency Flowcharts	1	7/19/2005	Minor Editorial

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

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

There were 109 new and revised health physics, radioactive materials shipping, and preparation for shipping procedures and forms issued. The majority of the revisions were strictly format or editorial in nature. The following is a list of the new and revised procedures and forms:

Number	Name	Rev.	Revision Date	Notes
AP-HP-105	Radiation Work Permit	4	10/21/2005	Cover Page
AP-HP-110	Controlled Special Exposures	4	10/21/2005	Cover Page
AP-HP-117	MURR Initial Radiation Worker Training Program	6	2/4/2005	Minor Editorial
AP-HP-123	Visitor Dosimetry - Reception Desk	3	2/4/2005	Cover Page
AP-HP-125	Review Of Unplanned Radiation Exposure	1	6/2/2005	Minor Editorial
AP-HP-129	Hot Cell Control	3	5/6/2005	Cover Page
AP-PSO-001	General Requirements for Preparation of Radioactive Materials for Shipping	2	11/9/2005	Cover Page
AP-SH-001	Administrative Procedure, Radioactive Materials Shipping	3	4/4/2005	Minor Editorial
BPB-SH-001	2R Shipping Container Leak Check	4	11/30/05	Minor Editorial
BPB-SH-002	20WC-1 Packaging and Shipment of Type B Non-Waste Radioactive Material	5	11/30/05	Minor Editorial
BPB-SH-005	DOT 6M Packaging and Shipment of Type B Non-Waste Radioactive Material	3	11/30/05	Minor Editorial
BPB-SH-008	Type B(U) F-327 Series Packaging and Shipment of Type B Non-Waste Radioactive Material	3	10/20/2005	Minor Editorial
BPB-SH-009	GB/0924BP/B(U) Packaging and Shipment of Type B(U) Non-Waste Radioactive Material	1	6/1/2005	Minor Editorial
BP-SH-007	F-327 Packaging and Shipment of Type A Non-Waste Radioactive Material	1	6/1/2005	Minor Editorial
BP-SH-010	Packaging and Shipment of Non-Waste Radioactive Materials in Excepted Packages	1	11/30/05	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
BP-SH-011	Shipment of Non-Waste USA DOT 7A Type A (Gemstone) Radioactive Material Package	1	10/20/2005	Minor Editorial
BP-SH-012	DOT-7A Package Certification	0	2/28/2005	New Procedure
BP-SH-013	Packaging and Shipment of Radioactive Materials Using MURR Reusable Type A Package	0	2/28/2005	New Procedure
BP-SH-036	Packaging of Non-Waste Radioactive Material Using MURR MODEL 1100	1	6/1/2005	Minor Editorial
BP-SH-037	Packaging of Non-Waste Radioactive Material Using MURR MODEL 1220	1	6/1/2005	Minor Editorial
BP-SH-038	Packaging of Non-Waste Radioactive Material Using MURR MODEL 1300	1	6/1/2005	Minor Editorial
BP-SH-099	Packaging of Radioactive Material Using MURR Model 1500	0	10/20/2005	New Procedure
BP-SH-302	Packaging and Shipment of Radioactive Material Using MURR Models 6 and 12	0	8/16/2005	New Procedure
FB-SH-005	Type B Shipment of Spent Fuel Using the BMI-1 Shipping Cask	0	6/1/2005	New Procedure
FM-09	Gemstone Irradiation Sheet	3	5/24/2005	Minor Editorial
FM-12	Gemstone Loading Sheet	3	10/26/05	Minor Editorial
FM-151	Control Checksheet for Non-Waste USA DOT 7A Type A (Gemstone) Radioactive Material Package	2	10/20/2005	Minor Editorial
FM-17	Radiation Work Permit	4	10/21/2005	Minor Editorial
FM-27	In-House Radioactive Shipping Request Form	4	4/4/2005	Minor Editorial
FM-28	Controlled Special Exposure Authorization	3	10/21/2005	Minor Editorial
FM-29	Initial Radiation Worker Training Packet	4	2/4/2005	Minor Editorial
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	8	4/4/2005	Minor Editorial
FM-35	Control Checksheet for Type B USA DOT 20WC-1 Radioactive Materials Shipment	9	10/20/2005	Minor Editorial
FM-36	Control Checksheet for USA DOT 7A- MURR Model 1100 Series	6	10/20/2005	Minor Editorial
FM-37	Control Checksheet for USA DOT 7A -MURR Model 1220 Series	6	10/20/2005	Minor Editorial
FM-38	Control Checksheet for USA DOT 7A MURR Model 1300 Series	6	10/20/2005	Minor Editorial
FM-39	Control Checksheet for Excepted Package Radioactive Materials Shipment	6	10/20/2005	Minor Editorial
FM-44	Request for Radioisotope Shipment	5	6/1/2005	Minor Editorial
FM-62	Radiation Instrument Certificate of Calibration	3	6/28/2005	Cover Page
FM-69	Control Checksheet for MURR Reusable Type A Radioactive Materials Shipment	0	2/28/2005	New Form
FM-69	Control Checksheet for MURR Reusable Type A Radioactive Materials Shipment	1	6/1/2005	Minor Editorial
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	5	4/4/2005	Minor Editorial
FM-74	Control Checksheet for Type B USA DOT 6M Radioactive Materials Shipment	6	10/20/2005	Cover Page

Number	Name	Rev.	Revision Date	Notes
FM-75	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	4	4/4/2005	Minor Editorial
FM-75	Control Checksheet for Type B(U) F-327 Series Radioactive Materials Shipment	5	10/20/2005	Minor Editorial
FM-76	Personnel Contamination Log	1	6/2/2005	Cover Page
FM-77	Control Checksheet for GB/0924BP/B(U) Radioactive Materials Shipment	3	4/4/2005	Minor Editorial
FM-77	Control Checksheet for GB/0924BP/B(U) Radioactive Materials Shipment	4	6/1/2005	Cover Page
FM-89	Control Checksheet for Type A F-327 Series Radioactive Material Shipment	3	4/4/2005	Minor Editorial
FM-98	Control Checksheet for MURR Shipment Using USA DOT 7A MURR Model 6 or 12	0	8/16/2005	New Procedure
FM-99	Packaging of Radioactive Material Using MURR Model 1500 Checksheet	0	10/20/2005	New Procedure
HC-PSO-002	Hot Cell Preparation of Radioactive Material for Shipment	4	11/9/2005	Cover Page
HC-PSO-003	Hot Laboratory Preparation of Radioactive Material for Shipment	3	11/9/2005	Cover Page
HC-PSO-005	Hot Cell Loading of Host Cans	3	11/9/2005	Minor Editorial
IC-HP-300	Calibration - Radiation Survey Instruments	3	3/3/2005	Minor Editorial
IC-HP-305	Calibration - Electrostatic Discharge Dosimeter	2	2/10/2005	Minor Editorial
IC-HP-310	Calibration - Eberline Ping 1a Stack Monitor - Particulate Channel	3	3/3/2005	Minor Editorial
IC-HP-311	Calibration - Eberline Ping 1a Stack Monitor - Iodine Channel	3	3/3/2005	Minor Editorial
IC-HP-312	Calibration - Eberline Ping 1a Stack Monitor - Gas Channel	3	3/3/2005	Minor Editorial
IC-HP-318	NMC Model RAK Stack Monitor Offsets/Multipliers/High Voltages Determination	3	2/10/2005	Minor Editorial
IC-HP-333	Eberline BC-4 Beta Swipe Counter-Calibration	3	2/4/2005	Minor Editorial
IC-HP-341	Calibration -High Resolution Gamma Spectroscopy Systems	2	2/10/2005	Minor Editorial
IC-HP-341	Calibration -High Resolution Gamma Spectroscopy Systems	3	12/19/2005	Minor Editorial
IC-HP-343	Calibration - Sodium Iodide Detector	3	6/2/2005	Minor Editorial
IC-HP-347	Calibration - Protean Model WPC 9550 Alpha-Beta Swipe Counter	4	8/18/2005	Cover Page
IC-HP-348	Calibration - Canberra S5XLB-G	0	5/6/2005	New Procedure
IC-HP-348	Calibration - Canberra S5XLB-G & Tennelec Series 4 with Gamma	1	8/18/2005	Minor Editorial
IRR-PSO-103	Receipt of Radioactive Material for Irradiation	3	11/9/2005	Minor Editorial
IRR-PSO-112	Preparing Shipping Paperwork	0	6/29/2005	New Procedure
OP-HP-220	Tritium Bioassay	3	8/18/2005	Cover Page
OP-HP-221	Environmental Sample - Analysis	3	2/10/2005	Minor Editorial
OP-HP-222	Air Sampling - Containment Building Ar-41	2	12/19/2005	Cover Page
OP-HP-223	Spent Fuel Shipping Cask Water Sample Analysis	2	8/18/2005	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
OP-HP-224	Spent Fuel Shipping Cask Air Sample Analysis	2	6/28/2005	Minor Editorial
OP-HP-353	Waste Tank Sample - Analysis	2	2/10/2005	Minor Editorial
OP-HP-353	Waste Tank Sample - Analysis	3	9/16/2005	Minor Editorial
OP-HP-400	Gemstone Shipping Barrel Analysis	5	12/19/2005	Minor Editorial
OP-HP-420	Decontamination of Enclosed Processing Units	1	10/21/2005	Cover Page
OP-HP-505	Emergency Stack Monitor Filter Analysis	2	6/28/2005	Cover Page
OP-HP-600	Europium Source Creation	2	9/16/2005	Cover Page
QA-SH-002	Sodium Iodide Spectral Analysis for Excepted, Exempt, License-to-License, Type A, or Type B Radioactive Materials Shipments	1	10/20/2005	Minor Editorial
RM-HP-100	Stack Monitor Preventive Maintenance - NMC Model RAK	3	6/2/2005	Minor Editorial
RM-HP-101	Stack Monitor Preventative Maintenance - Eberline Ping 1A	2	10/21/2005	Cover Page
RP-HP-100	Contamination Monitoring - Performing a Swipe	3	2/4/2005	Minor Editorial
RP-HP-100	Contamination Monitoring - Performing a Swipe	4	12/19/2005	Minor Editorial
RP-HP-105	Transfer of Radioactive Material - In Facility	3	12/19/2005	Cover Page
RP-HP-110	Survey and Decontamination of Returned Shipping Container	3	5/6/2005	Cover Page
RP-HP-130	Receipt of New Fuel Elements	3	5/6/2005	Minor Editorial
RP-HP-135	Room 114 Entry - Self Monitored	2	5/6/2005	Cover Page
RP-HP-137	Handling Radioactive Material in the Reactor Pool	3	9/16/2005	Minor Editorial
RP-HP-139	Beamport Radiation Level Monitoring During Reactor Startup	2	6/2/2005	Cover Page
SI-PSO-008	Post-Irradiation Processing: Exported Flooded Silicon Cans	3	6/29/2005	Minor Editorial
SV-HP-100	Reactor Chemistry Isotope Counter Trending and Investigative Level Determination	3	2/4/2005	Cover Page
SV-HP-100	Reactor Chemistry Isotope Counter Trending and Investigative Level Determination	4	12/19/2005	Cover Page
SV-HP-105	Sealed Calibration Source - Leak Check	4	2/4/2005	Minor Editorial
SV-HP-105	Sealed Calibration Source - Leak Check	5	6/2/2005	Minor Editorial
SV-HP-115	Building Exhaust Stack Effluent - Tritium Monitoring	2	2/10/2005	Minor Editorial
SV-HP-130	Emergency Air Sampling of Exhaust Plume	2	6/2/2005	Cover Page
SV-HP-131	Emergency Analysis of Environmental Samples For Callaway Nuclear Plant	2	9/16/2005	Cover Page
SV-HP-135	Containment Air - Emergency Remote Sampling	2	12/19/2005	Cover Page
TPZ-PSO-001	Receiving Gemstone Irradiation Shipping Drums	2	4/21/2005	Minor Editorial
TPZ-PSO-002	Irradiation of Gemstone Irradiation Containers	2	4/21/2005	Minor Editorial
TPZ-PSO-003	Loading Gemstone Shipping Drums	2	4/21/2005	Minor Editorial
WMB-SH-005	Shipment of Type B Radioactive Waste Using Chem-Nuclear System 1-13G Cask	3	8/16/2005	Minor Editorial
WM-SH-011	Shipment of Radioactive Material n.o.s., Waste For Hot Cell Host Cans	1	2/28/2005	Cover Page
WM-SH-100	Radioactive Waste - Preparation and Storage	3	6/1/2005	Minor Editorial

Number	Name	Rev.	Revision Date	Notes
WM-SH-105	Radioactive Waste Processing	2	6/20/2005	Cover Page
WM-SH-200	Exclusive Use Shipment of LSA or SCO Radioactive Waste Utilizing a Broker	3	8/16/05	Obsolete 8/16/05
WM-SH-300	MURR Exclusive Use Shipment of LSA or SCO Radioactive Waste	2	8/16/2005	Minor Editorial

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

January 1, 2005 through December 31, 2005

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

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

HSR, Addendum 3, page 20, Figure 2.2, Secondary Cooling System (as revised by the 1989-90, 1990-91, 1994, 1995, 2001, 2002, 2003, and 2004 Reactor Operations Annual Reports):

Replace with: Updated Figure 2.2, Secondary Cooling System (MURR Dwg No. 502, Sheet 1 of 1, dated 10/24/05)

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

Replace with: Updated Figure 2.3.a, Electrical Distribution (MURR Dwg No. 522, Sheet 1 of 3, dated 8/4/05)

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

Replace with: Updated Figure 2.3.b, Electrical Distribution (MURR Dwg No. 522, Sheet 2 of 3, dated 8/8/05)

HSR, Addendum 3, page 23c, Figure 2.3.c, Electrical Distribution (new print added by the 2004 Reactor Operations Annual Report):

Replace with: Updated Figure 2.3.c, Electrical Distribution (MURR Dwg No. 522, Sheet 3 of 3, dated 8/8/05)

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

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

Replace with: Updated Figure A.3, 10 MW Process Instrumentation Control & Interlock (MURR Dwg No. 41, Sheet 3 of 4, dated 7/13/05)

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

Replace with: Updated Figure A.5, 10 MW Process Instrumentation Control & Interlock (MURR Dwg No. 41, Sheet 1 of 4, dated 4/16/02)

HSR, Addendum 4, page A-33, Figure A.6, 10 MW Process Instrumentation Control & Interlock (as revised by the 1995, 2001, 2002, and 2003 Reactor Operations Annual Reports):

Replace with: Updated Figure A.6, 10 MW Process Instrumentation Control & Interlock (MURR Dwg No. 41, Sheet 2 of 4, dated 12/20/05)

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

Replace with: Updated Figure A.7, Annunciator Control 10 MW (MURR Dwg No. 138, Sheet 1 of 2, dated 3/25/04)

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

Replace with: Updated Figure A.11, Schematic Diagram of Laboratory and Containment Buildings Ventilation System (MURR Dwg No. 1125, Sheet 1 of 3, dated 12/15/04)

ADDENDUM 5 - HAZARDS SUMMARY REPORT (JANUARY 1974)

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

Replace with: Updated Figure 2.1, Electrical Distribution (MURR Dwg No. 522, Sheet 1 of 3, dated 8/4/05)

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

January 1, 2005 through December 31, 2005

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

Modification 80-5, Addendum 1:
Removal of the Bulk Pool Lead Shield Facility
This addendum to modification record 80-5, "Bulk Pool Lead Shield," documents the removal of the bulk pool lead shield (BPLS) facility from service to support installation of the new GH position graphite reflector element. The BPLS facility was an aluminum box, which contained a series of lead slabs and an irradiation position, attached to the reflector tank and supported vertically by two long legs. Irradiation services using the BPLS were relocated to the graphite reflector region.

Modification 95-1, Addendum 1D:
Replace Existing Gamma-Metrics High Voltage Plasma Bargraphs with Liquid Crystal Displays
This addendum to modification record 95-1, "Replacement of Nuclear Instruments," documents the conversion from linear plasma bargraphs to liquid crystal display (LCD) units on all Gamma-Metrics nuclear instruments. The plasma bargraphs were overly sensitive to high humidity conditions and suffered gradual degradation during normal operation. Gamma-Metrics recognized the problems and deficiencies associated with the plasma bargraphs and initiated an upgrade which involved LCD unit replacements.

Modification 95-3, Addendum 1:
Redesign and Replacement of the GH Reflector Wedge
This addendum to modification record 95-3, "P-Tube Relocation from North Side to South Side of Pool (to Wedge 3)," documents the redesign and replacement of the GH position reflector wedge. The old wedge configuration accommodated the following five irradiation positions and sample diameters: two 3-inch, two 2-inch, and one 1-inch. Due to a change in programming needs, the new reflector wedge was designed to accommodate the following four irradiation positions and diameters: one 5-inch, and three 1-inch.

Modification 04-5, Addendum 1:
Phase 1 of the Cooling Tower Electrical Upgrade Project – Installation of a New Lighting Panel LP-41
This addendum to modification record 04-5, "Cooling Tower Electrical Upgrade Project," implements the first phase of the cooling tower electrical upgrade project and documents the transfer of electrical loads from existing lighting panels LP-41 and LP-41A to a newly installed single panel that is also designated LP-41. The new panel has a larger load carrying capacity which now supports the electrical loads from both the old panels while also providing for any future expansion.

Modification 04-5, Addendum 2:
Phase 2 of the Cooling Tower Electrical Upgrade Project – Install Independent 13.8 kV Feeder Lines to the Cooling Tower and Laboratory Building Transformers
This addendum to modification record 04-5, "Cooling Tower Electrical Upgrade Project," implements the second phase of the cooling tower electrical upgrade project and documents the installation of two new

independent 13.8 kV feeder lines to the cooling tower and laboratory building transformers. Independent feeder lines were required in order to support the future upgrade of the cooling tower transformer from 500 to 1,500 kVA.

Modification 04-5, Addendum 3:

Phase 3 of the Cooling Tower Electrical Upgrade Project – Replacement of the 500 kVA Cooling Tower Transformer with a 1,500 kVA Transformer

This addendum to modification record 04-5, "Cooling Tower Electrical Upgrade Project," implements the third phase of the cooling tower electrical upgrade project and documents the replacement and upgrade of the existing 500 kVA cooling tower transformer with a new 1,500 kVA transformer. The new transformer was installed on a concrete pad external to the cooling tower building, thus reducing the heating load within the building.

Modification 04-5, Addendum 4:

Phase 4 of the Cooling Tower Electrical Upgrade Project – Replacement of Substation "A" and the Motor Control Centers

This addendum to modification record 04-5, "Cooling Tower Electrical Upgrade Project," implements the fourth phase of the cooling tower electrical upgrade project and documents the replacement and upgrade of substation "A" and motor control centers 1, 2A and 2B with a new supply switch and motor control center which supports all of the electrical loads from the old motor control centers.

Modification 04-5, Addendum 6:

Phase 6 of the Cooling Tower Electrical Upgrade Project – Replacement of the 15 kVA Transformer with a 45 kVA Transformer

This addendum to modification record 04-5, "Cooling Tower Electrical Upgrade Project," implements the sixth and final phase of the cooling tower electrical upgrade project and documents the replacement of the existing 15 kVA transformer with a new 45 kVA transformer. The new transformer supports the existing electrical loads from lighting panel LP-41 while also providing for any future expansion.

Modification 05-1:

Pneumatic Tube System Photo Sensor Collar Upgrade

This modification record documents the upgrade and standardization of the pneumatic tube system photo sensor collars. Previously, two different collar designs were utilized. One collar had an open optical path such that removal of the photo sensor collar required that containment integrity, in accordance with Technical Specification 3.5.a, be met. The other collar had a transparent acrylic insert that served as both the optical path and pressure boundary. The new collars are designed similar to the one which had the acrylic insert, thus allowing greater flexibility in maintenance, troubleshooting and repairs.

Modification 05-3:

Electrical Distribution System Modifications Associated with the New Chill Water Loop

This modification record documents the installation of electrical equipment in support of upgrades to the chill water system. Previously, the electrical distribution system provided electrical power to the following components of the chill water system: the 241-ton LiBr absorption unit, the 100-ton vapor compression unit, and the north and south chill water pumps. Due to the removal of the LiBr absorption unit, and the installation of a research park chill water loop, modifications were made which included disconnecting electrical power to the LiBr absorption unit and providing power to a new variable speed, 30 HP chill water booster pump and emergency chiller unit.

Modification 05-4:

Secondary Coolant System Changes in Support of Upgrades to the Facility HVAC System

This modification record documents changes to the secondary coolant system that are in support of upgrades to the facility heating, ventilation and air conditioning system. Specifically, the removal of portions of the secondary coolant system piping that is no longer needed to supply cooling water to the 241-ton LiBr absorption unit. The LiBr absorption unit was removed as part of modification record 05-3.

Modification 05-9:

Redirect Resin Sluice Water to Waste Tanks

This modification record documents the changes required to ensure that resin transfer evolutions can be performed with minimal delays, without the risk of spreading contamination, and adhering to the principles of ALARA. The reactor demineralizer system is equipped with the means to transfer resin beds to and from various tanks as needed to facilitate replacement of resin beds. Certain of these transfer evolutions require draining waste water at high flow rates (up to 50 gpm) into a floor drain. Due to the implementation of Modification Record 04-3, "Radioactive Liquid Waste," this floor drain no longer has the capacity to accept these high flow rates. A new alternate path, which allows the waste water to go directly into waste tank No. 2, has been installed.

SECTION V

NEW TESTS AND EXPERIMENTS

January 1, 2005 through December 31, 2005

New tests or experiments developed during this period are as follows:

RUR 219, as amended: Germanium

Description: This amended RUR authorizes the irradiation of up to 150 grams of high purity germanium for use in research and development activities.

RUR 409, as amended: Enriched Xenon

Description: This amended RUR authorizes the irradiation of enriched xenon seeds for use in therapeutic applications.

RUR 413: Dysprosium Nitrate

Description: This RUR authorizes the irradiation of up to 5 milligrams of enriched dysprosium nitrate for use in research and development activities.

RUR 414: Enriched Barium Carbonate

Description: This RUR authorizes the irradiation of up to 75 grams of enriched barium carbonate for use in medical applications.

Project Authorization RL-65: Prompt-Gamma Activation Analysis of BoroBond Samples

Description: This Project Authorization authorizes the use of a Pu-Be neutron source to characterize the boron content of shield materials used in commercial applications.

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. In the case of RL-65, the Isotope Use Subcommittee also reviewed the project.

SECTION VI

SPECIAL NUCLEAR MATERIAL AND REACTOR PHYSICS ACTIVITIES

January 1, 2005 through December 31, 2005

Inspections:

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

Reactor Characteristic Measurements:

Sixty (66) refueling evolutions were completed in 2005. Excess reactivity verifications were performed for each refueling. The largest measured excess reactivity value was 3.62%. MURR Technical Specification 3.1(f) requires excess reactivity to be less than 9.8%.

Reactivity Measurements:

Two (2) reactivity measurements were made to determine the reactivity worth of all samples loaded in the flux trap region experimental sample holder.

Nine (9) measurements were made to determine the reactivity worth of several different types of sample materials irradiated in either the flux trap or graphite reflector regions.

One (1) measurement was made to characterize the reactivity worth of two new graphite reflector elements installed in the GH and No. 9 positions.

Four (4) differential blade-worth measurements and one (1) primary coolant temperature coefficient measurement were also performed.

SECTION VII

RADIOACTIVE EFFLUENT

January 1, 2005 through December 31, 2005

TABLE 1
SANITARY SEWER EFFLUENT

January 1, 2005 through December 31, 2005

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

Nuclide	Activity (Ci)
H-3	9.287E-02
S-35	6.646E-03
Lu-177	2.480E-03
Ca-45	1.365E-03
Co-60	1.360E-03
Zn-65	5.848E-04
Ag-110m	3.715E-04
As-77	3.574E-04
Lu-177m	3.146E-04
Tl-201*	1.669E-04
Cr-51	1.405E-04
W-181	9.180E-05
Mn-54	7.363E-05
Re-188	4.026E-05
P-32	3.718E-05
Sc-46	1.848E-05
Total H-3	9.287E-02
Total Other	1.405E-02

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

*Tl-201 effluents comply with Missouri Department of Health, Division 10; Chapter 20 regulations.

TABLE 2
STACK EFFLUENT

January 1, 2005 through December 31, 2005

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration µCi/ml	Total Release Ci	TS Limit Multiplier	% TS
Ar-41	2.68E-06	1.24E+03	350	76.6876
C-14	2.33E-11	1.06E-02	1	0.7770
I-131	1.84E-13	8.54E-05	1	0.0921
Co-60	4.26E-14	1.98E-05	1	0.0853
H-3	2.56E-08	1.19E+01	350	0.0732
I-125	6.44E-14	2.98E-05	1	0.0215
Os-191	2.25E-14	1.05E-05	1	0.0011
Cs-137	1.35E-15	6.28E-07	1	0.0007
Zn-65	2.06E-15	9.54E-07	1	0.0005
Se-75	3.98E-15	1.85E-06	1	0.0005
Au-196	1.60E-15	7.43E-07	350	0.0005
Hf-181	2.45E-15	1.14E-06	1	0.0004
Ce-141	2.53E-15	1.17E-06	1	0.0003
I-133	1.06E-12	4.92E-04	350	0.0003
Hg-203	2.41E-15	1.12E-06	1	0.0002
Br-82	3.20E-12	1.48E-03	350	0.0002
Ce-139	1.26E-15	5.85E-07	1	0.0001
Ru-103	4.69E-16	2.17E-07	1	0.0001

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

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

Stack Flow Rate = 30,500 cfm

Stack effluent releases are in compliance with University of Missouri-Columbia Research Reactor, License R-103 Technical Specifications.

SECTION VIII

ENVIRONMENTAL MONITORING AND HEALTH PHYSICS SURVEYS

January 1, 2005 through December 31, 2005

Environmental samples are collected two times per year at eight (8) locations and analyzed for radioactivity. Soil and vegetation samples are taken at each location. Water samples are taken at three (3) of the eight (8) locations. Analytical results are shown in Tables 1 and 2.

Table 3 lists the radiation doses recorded by the environmental monitors deployed around MURR in 2005. All doses are approximately 20 mRem/year or less, except monitor numbers 9 and 15. These monitors are located near the loading dock where packages containing radioactive material are loaded on transport vehicles. The doses recorded by these monitors are considered to be the result of exposure to packages in transit. The environmental monitoring program confirms that no environmental impact exists from the operation of the MURR facility.

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

TABLE 1

Summary of Environmental Set 67

May 2005

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.15 pCi/L	1.74 pCi/L	177.58 pCi/L	5.61 pCi/mL of sample
Soil	0.70 pCi/g	1.64 pCi/g	0.86 pCi/g	N/A
Vegetation	0.30 pCi/g	3.07 pCi/g	1.80 pCi/g	5.65 pCi/mL of distillate

*Gamma and tritium analyses are based on wet weights while alpha and beta analyses are based on dry weights.

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V67	< 0.30	16.97	< 1.80	< 5.65
2V67	< 0.30	10.98	< 1.80	< 5.65
3V67	< 0.30	14.97	< 1.80	< 5.65
4V67	< 0.30	13.73	< 1.80	< 5.65
5V67	< 0.30	28.20	< 1.80	< 5.65
6V67	0.60	16.22	< 1.80	< 5.65
7V67	0.60	20.46	< 1.80	< 5.65
10V67	< 0.30	26.70	< 1.80	< 5.65

TABLE 1 (Cont'd)

Summary of Environmental Set 67
May 2005

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S67	0.90	15.97	4.54
2S67	< 0.70	15.35	4.71
3S67	1.05	18.47	4.27
4S67	< 0.70	7.49	2.01
5S67	1.35	17.22	5.25
6S67	< 0.70	11.23	2.48
7S67	< 0.70	11.98	4.31
10S67	0.90	19.72	5.03

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W67	< 0.15	4.49	< 177.58	< 5.61
6W67	0.15	4.49	< 177.58	< 5.61
10W67	< 0.15	20.46	< 177.58	< 5.61

TABLE 2

Summary of Environmental Set 68
October 2005

Detection Limits**

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.15 pCi/L	2.37 pCi/L	178 pCi/L	5.29 pCi/mL of sample
Soil	0.15 pCi/g	2.51 pCi/g	0.77 pCi/g	N/A
Vegetation	0.30 pCi/g	4.58 pCi/g	1.76 pCi/g	5.42 pCi/mL of distillate

**Gamma and tritium analyses are based on wet weights while alpha and beta analyses are based on dry weights.

TABLE 2 (Cont'd)

Summary of Environmental Set 68
October 2005

Activity Levels - Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/mL)
1V68	< 0.30	8.14	< 1.76	< 5.42
2V68	< 0.30	8.65	< 1.76	< 5.42
3V68	< 0.30	10.18	< 1.76	< 5.42
4V68	< 0.30	8.14	< 1.76	< 5.42
5V68	< 0.30	6.11	< 1.76	< 5.42
6V68	< 0.30	5.09	< 1.76	< 5.42
7V68	< 0.30	5.60	< 1.76	< 5.42
10V68	< 0.30	6.11	< 1.76	< 5.42

Activity Levels - Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S68	0.80	14.25	3.13
2S68	0.53	15.27	4.15
3S68	0.53	19.85	3.84
4S68	0.27	12.47	2.26
5S68	1.07	15.52	5.30
6S68	0.27	9.42	4.85
7S68	1.34	14.89	3.70
10S68	0.27	21.12	5.70

Activity Levels - Water

Sample	Alpha (pCi/L)	Beta (pCi/L)	Gamma (pCi/L)	H-3 (pCi/mL)
4W68	0.27	6.87	< 178	< 5.29
6W68	0.27	8.65	< 178	< 5.29
10W68	0.27	22.40	< 178	< 5.29

TABLE 3
Environmental TLD Summary

January 1, 2005 through December 31, 2005

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 2005 Net mR	2nd Qtr. 2005 Net mR	3rd Qtr. 2005 Net mR	4th Qtr. 2005 Net mR	Total 2005 Net mR
1	Unassigned	N/A	N/A	N/A	N/A	N/A	N/A
2	Unassigned	N/A	N/A	N/A	N/A	N/A	N/A
3	WSW	N/A	2.4	-1.3	-7.1	-5.9	0.0
4*	Unassigned	N/A	N/A	N/A	N/A	N/A	N/A
5**	Unassigned	N/A	N/A	N/A	N/A	N/A	N/A
6	N	34	2.1	0.8	-4.1	-3.1	0.0
7	NE	57	4.1	2.6	-0.3	-2.8	3.6
8	SW	27	1.1	3.5	5.4	7.2	17.2
9	S	27	23.0	19.6	26.9	25.9	95.4
10	NE	149	0.1	-2.3	-4.7	-7.6	0.0
11	NW	149	-0.8	-2.7	-2.8	-4.5	0.0
12	ENE	301	5.1	3.9	2.7	-1.6	10.1
13	NNE	316	2.3	-0.5	-2.3	-4.3	0.0
14	S	156	1.4	3.1	-1.7	-1.4	1.4
15	S	65	18.5	19.9	19.9	13.2	71.5
16	SE	107	absent	absent	-6.4	-7.4	0.0
17	E	293	-3.4	-5.2	-6.0	-8.7	0.0
18	NE	476	-1.8	-5.3	-6.0	-7.3	0.0
19	NNE	606	-5.8	-7.1	-9.5	-9.8	0.0
20	NE	907	-5.8	-8.5	absent	-11.2	0.0
21	SE	236	-1.2	-1.1	-1.9	-4.3	0.0
22	ESE	168	absent	-3.9	-5.9	-8.0	0.0
23	NW	110	1.7	0.7	-0.4	-4.2	0.0
24	SSW	328	-2.7	-5.5	-7.3	absent	0.0
25	SSW	480	-0.5	-2.8	-1.7	-5.6	0.0
26	SW	301	0.1	-0.2	-3.1	-6.7	0.0
27	WSW	141	-3.7	-5.7	-8.9	-11.2	0.0
28	WNW	210	0.2	1.4	absent	absent	1.6
29	NW	255	0.6	0.2	-0.6	-1.2	0.0
30	NNW	328	-2.2	-5.2	-5.1	-10.5	0.0
31	NNW	671	1.7	0.3	-0.7	-4.7	0.0
32	NNW	724	-0.8	-0.9	-2.3	-6.3	0.0
33	E	671	-2.4	-9.4	-7.3	-10.9	0.0
34	ENE	587	-5.3	-7.4	absent	-12.4	0.0
35	SSE	499	-2.6	-5.1	-7.7	-7.7	0.0
36	SE	419	0.4	-1.4	-2.6	-7.8	0.0
37	NE	690	-0.5	-3.1	-9.8	-7.5	0.0
38	NW	556	0.7	-2.0	-2.6	-7.2	0.0
39	W	491	-3.0	absent	-7.9	-9.0	0.0
40	N	514	-3.3	-0.8	absent	absent	0.0
41	NNE	137	-3.3	-5.8	-5.5	-8.4	0.0
42	In Building	N/A	3.9	3.1	0.4	-3.0	4.4
43	In Building	N/A	5.9	6.1	6.2	0.3	18.5
44	Spare	N/A	4.1	3.8	-0.8	-0.6	6.5
45	S	65	-16.9	1.1	-1.6	-3.1	0.0

*TLD No. 4 moved from spare to fence outside shipping area.

**TLD No. 5 moved from spare to outside wall of shipping area.

TABLE 4
Number of Facility Radiation and Contamination Surveys

January 1, 2005 through December 31, 2005

	Radiation	Surface Contamination*	Air Samples**	RWP's
January	50	50	49	8
February	61	61	50	6
March	45	45	57	6
April	77	77	53	15
May	58	58	57	9
June	57	57	59	3
July	35	35	51	8
August	49	49	54	10
September	43	43	58	8
October	57	57	52	13
November	83	83	53	10
December	48	48	57	7
TOTALS	**663**	**663**	**650**	**103**

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

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

Miscellaneous Notes

Manual Diaz was hired as a Health Physics Technician in February 2005.

Dan Nickolaus was promoted to Health Physics Technician in June 2005.

Shaun Kelley was promoted to Health Physics Technician II in June 2005.

During calendar 2005, MURR shipped 737.55 cubic feet of low-level radioactive waste.

SECTION IX

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

January 1, 2005 through December 31, 2005

TOTAL PERSONNEL DOSE (MREM) BY DOSIMETRY GROUP

Month	AC	DO	FSO	HC	RAG	IRR	NA	NS	OPS	PRO	RP	SH	SIL	TCI	Total
January	38	2	355	262	157	51	15	32	1607	47	96	76	44	0	2782
February	34	12	146	153	130	72	10	27	1366	49	110	109	78	18	2314
March	10	11	133	169	165	45	8	33	1374	106	63	76	45	7	2245
April	13	1	447	158	208	51	10	40	1455	88	24	119	51	0	2665
May	11	8	294	235	173	72	15	20	1282	67	58	148	52	2	2437
June	6	74	40	221	179	58	6	21	1282	72	61	115	128	0	2263
July	77	4	95	290	175	82	12	12	1442	75	95	127	81	0	2567
August	14	16	112	290	279	86	14	31	1748	47	38	138	93	0	2906
September	30	19	112	346	257	100	4	39	1465	38	85	189	102	3	2789
October	14	19	251	245	299	119	16	7	2070	37	47	150	73	0	3347
November	8	7	120	224	129	173	12	17	1413	31	66	200	65	4	2469
December	14	34	60	188	220	33	16	20	1683	50	43	255	207	1	2824
Total to Date	**269**	**207**	**2165**	**2781**	**2371**	**942**	**138**	**299**	**18187**	**707**	**786**	**1702**	**1019**	**35**	**31608**
Monthly Ave	**22**	**17**	**180**	**232**	**198**	**79**	**12**	**25**	**1516**	**59**	**66**	**142**	**85**	**3**	**2634**
Highest WB	**49**	**28**	**128**	**201**	**115**	**146**	**7**	**40**	**275**	**37**	**21**	**101**	**124**	**18**	
Highest EXT	**200**	**100**	**2210**	**660**	**150**	**270**	**260**	**100**	**1490**	**970**	**490**	**220**	**450**	**60**	

AC - Analytical Chemistry
DO - Director's Office
FSO - Shops
HC - Hot Cell
RAG - Health Physics
IRR - Irradiations
NA - Nuclear Analysis
NS - Neutron Scattering
OPS - Operations
PRO - Isotope Production
RP - Radiophariceutical
SH - Shipping
SIL - Silicon
TCI - Special Project

WB = Whole Body
EXT = Extremities

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

Analysis of personnel exposure levels indicates that exposures are significantly below the limits of 10 CFR 20.1201 and are generally maintained ALARA. Radiation workers who are not full time staff members have radiation exposures which are generally lower than full time radiation workers.