UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 30, 2018

Dr. David J. Robertson
Reactor Facility Director
University of Missouri-Columbia
Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211

SUBJECT: UNIVERSITY OF MISSOURI – COLUMBIA RESEARCH REACTOR – U.S. NUCLEAR REGULATORY COMMISSION ROUTINE INSPECTION REPORT NO. 50-186/2018-201

Dear Dr. Robertson:

From April 10-12, 2018, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection at your University of Missouri-Columbia Research Reactor. The enclosed report presents the results of that inspection, which were discussed on April 12, 2018, with members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspector reviewed selective procedures and records, observed various activities, and interviewed personnel. Based on the results of this inspection, no findings of significance were identified. No response to this letter is required.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390, "Public inspections, exemptions, requests for withholding," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's document system (Agencywide Documents Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, please contact Mr. Johnny Eads at 301-415-0136 or by electronic mail at Johnny.Eads@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-186
License No. R-103

Enclosure:
As stated

cc: See next page

cc:

Les Foyto, Associate Director
Reactor and Facilities Operations
University of Missouri – Columbia
Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211

Homeland Security Coordinator
Missouri Office of Homeland Security
P.O. Box 749
Jefferson City, MO 65102

Planner, Dept of Health and Senior Services
Section for Environmental Public Health
P.O. Box 570
Jefferson City, MO 65102

Deputy Director for Policy
Department of Natural Resources
1101 Riverside Drive
Fourth Floor East
Jefferson City, MO 65101

A-95 Coordinator
Commissioner's Office
Office of Administration
P.O. Box 809
State Capitol Building, Room 125
Jefferson City, MO 65101

Planning Coordinator
Missouri Department of Natural Resources
1101 Riverside Drive
Jefferson City, MO 65101

Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611

SUBJECT: UNIVERSITY OF MISSOURI – COLUMBIA RESEARCH REACTOR – U.S. NUCLEAR REGULATORY COMMISSION ROUTINE INSPECTION REPORT NO. 50-186/2018-201 DATE: AUGUST 30, 2018

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No.:	50-186
License No.:	R-103
Report No.:	50-186/2018-201
Licensee:	University of Missouri – Columbia
Facility:	University of Missouri – Columbia Research Reactor
Location:	Research Park Columbia, Missouri
Dates:	April 10-14, 2018
Inspectors:	Johnny Eads William Schuster
Approved by:	Anthony J. Mendiola, Chief Research and Test Reactors Oversight Branch Division of Licensing Projects Office of Nuclear Reactor Regulation

Enclosure

EXECUTIVE SUMMARY

University of Missouri – Columbia
University of Missouri – Columbia Research Reactor Facility
NRC Inspection Report No. 50-186/2018-201

The primary focus of this routine, announced inspection was the onsite review of selected aspects of the University of Missouri – Columbia (the licensee's) 10 megawatts Class I research reactor safety program, including: (1) effluent and environmental monitoring, (2) experiments, (3) review and audit and design change functions, (4) procedures, (5) radiation protection, and (6) transportation of radioactive material since the last U.S. Nuclear Regulatory Commission (NRC) inspection of these areas. The licensee's program was acceptably directed toward the protection of public health and safety and in compliance with the NRC requirements.

Effluent and Environmental Monitoring

- Effluent monitoring satisfied license and regulatory requirements.

- Releases were within the specified regulatory and technical specification (TS) limits.

Experiments

- The program for reviewing and conducting experiments satisfied TSs and current procedural requirements.

- Changes/amendments to existing experiments were reviewed and approved as required.

Review and Audit and Design Change Functions

- The Reactor Advisory Committee (RAC) acceptably completed the review, audit, and oversight functions required by TS 6.2.

- Design changes were reviewed and approved in accordance with TS requirements and the licensee's written procedures.

Procedures

- The procedure review, revision, control, and implementation program satisfied TS requirements.

Radiation Protection

- Surveys were completed and documented as specified by procedure and were outlined in the Annual Report.

- Postings and notices generally met regulatory requirements.

- Staff personnel were wearing dosimetry as required and recorded doses were within the regulatory limits.

- Radiation survey and monitoring equipment was being maintained and calibrated as required.

- The Radiation Protection Program (RPP) and as low as reasonably achievable (ALARA) Program satisfied regulatory requirements.

- Annual reviews of the RPP were being completed by the licensee as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20.

Transportation of Radioactive Material

- Radioactive material was being shipped in accordance with the applicable regulations.

REPORT DETAILS

Summary of Facility Status

The University of Missouri – Columbia Research Reactor (MURR) continued to be operated in support of isotope production, silicon irradiation, reactor operator training, and various types of research. During the inspection, the reactor was operated continuously, following the weekly maintenance shutdown, to support laboratory experiments and product irradiation.

1. Effluent and Environmental Monitoring

a. Inspection Scope (Inspection Procedure (IP) 69004)

The inspector reviewed the following to verify compliance with the requirements of 10 CFR Part 20, TS 3.7, and the environmental monitoring program outlined in various procedures:

- Quarterly reports of environmental thermoluminescence dosimeter (TLD) results
- Results of the analyses of environmental vegetation, soil, and water samples
- MURR Reactor Operations Annual Report for the period from January 1, 2017, through December 31, 2017

b. Observations and Findings

(1) Gaseous and Liquid Releases

The inspector determined that gaseous releases continued to be monitored as required, were acceptably analyzed, and were documented in the annual operating reports. Airborne concentrations of gaseous releases were noted to be within the concentrations stipulated in 10 CFR Part 20, Appendix B, Table 2 and the limits stipulated in the TS. The dose rate to the public, as a result of the gaseous releases, was below the dose constraint specified in 10 CFR 20.1101(d).

The liquid releases from the facility to the sanitary sewer also continued to be monitored as required, were acceptably analyzed, and were documented in the annual reports. The inspector reviewed the analyses of the liquid that had been released and noted that the releases were within the limits specified in 10 CFR Part 20, Appendix B, Table 3.

(2) Environmental Soil, Water, and Vegetation Samples

The inspector reviewed the results of the environmental soil, water, and vegetation samples that were collected, prepared, and analyzed during 2017. These samples had all been collected and analyzed as required and within the time frame established by procedure. No significant issues were identified.

(3) Environmental Monitoring using TLDs

On-site and off-site gamma radiation monitoring was completed using the reactor facility stack effluent monitor and various environmental TLDs in accordance with the applicable procedures. Review of the data indicated that there were no measurable doses above any regulatory limits.

c. Conclusion

Effluent monitoring satisfied license and regulatory requirements and releases were within the specified regulatory and TS limits.

2. Experiments

a. Inspection Scope (IP 69005)

The inspector reviewed the licensee's program for conducting experiments and selected aspects of the following to verify compliance with TSs 3.8 and 6.5:

- Listing of current experiments
- Current list of reactor utilization requests (RURs)
- MURR Reactor Operations Annual Report for the period from January 1, 2017, through December 31, 2017

b. Observations and Findings

The experiments conducted at the facility were required to be evaluated and reviewed using MURR administrative procedure AP-RO-135, "Reactor Utilization Requests." The procedure required that all experiments be reviewed and approved by the Reactor Manager and the Reactor Health Physics (HP) Manager. An individual proposing a new experiment was required to evaluate the irradiation of the target material to determine that, if performed within the limitations stated in the RUR safety evaluation (SE), the irradiation experiment would remain within the TS limits for experiments. The SE included a review of: (1) thermal effects, (2) possible sample decomposition and pressure effects, (3) experiment failure, (4) loss of coolant flow, (5) failure of other experiments, (6) corrosive effects of the sample, and (7) possible explosive potential. The evaluation was also required to address post-irradiation sample handling procedures, detection of radioactivity produced, radiation hazards, and reactivity worth. If the experiment under review did not involve a new class of experiment or a question pursuant to 10 CFR 50.59, the Reactor Manager would then approve the RUR. Any RURs involving a new class of experiment or a safety question were required to be reviewed by the Reactor Safety Subcommittee. These RURs were then reviewed and, if properly analyzed and found to be acceptable, were approved by the RAC.

The inspector noted that the RURs most commonly used at the facility were for product or sample irradiation. The inspector reviewed various recently approved RURs or amendments to previously approved RURs that had been submitted for review and approval. The experiments had been evaluated in accordance with TS requirements and the accompanying data sheets indicated that they were

within reactivity limits. The safety analysis for each had been performed and the reviews and approvals completed.

The inspector noted that the experiments in progress during the inspection were conducted with the cognizance of the reactor manager and the licensed senior reactor operator, and in accordance with TS requirements (e.g., reactivity limitations). The experiments reviewed by the inspector were being conducted in accordance with procedure and the materials produced were handled and transferred as required.

c. Conclusion

The program for reviewing and conducting experiments satisfied TS and procedural requirements. Changes/amendments to existing experiments were reviewed and approved as required.

3. Review and Audit and Design Change Functions

a. Inspection Scope (IP 69007)

In order to verify that the licensee had established and conducted reviews and audits as required by 10 CFR Part 20 and TS 6.2 the inspector reviewed:

- RPP/materials license audits for 2017
- Other selected audits and reviews completed by management and HP personnel
- Selected subcommittee meeting minutes from April 2017 to the present, including the Isotope Use Subcommittee, the Reactor Safety Subcommittee, and the Reactor Procedure Review Subcommittee
- MURR RAC meeting minutes and related documents, from April 2017 to the present
- MURR Administrative Policy, POL-3, “MURR Radiation Protection Program,” Revision 16, issued June 5, 2017
- MURR Reactor Operations Annual Report for the period from January 1, 2017, through December 31, 2017

b. Observations and Findings

The inspector reviewed the meeting minutes of the RAC from April 2017 to the present and the meeting minutes of various subcommittees from April 2017 to the present. The minutes and associated documents indicated that the RAC met at the required frequency and that a quorum was present. The topics considered during the committee meetings and during the subcommittee meetings were appropriate and as stipulated in the TS.

The inspector reviewed the 2017 audit of the licensee’s RPP. No significant issues were identified during the audit, but several areas for improvement were noted. The inspector also reviewed the HP Manager’s response to the audit findings to address each of the areas for improvement. The audits and responses to the audits appeared to be acceptable.

The inspector also reviewed the dose to target charts and ALARA reviews for 2017. These documents were prepared by the HP Manager for an annual review of the RPP. They provided an overview of the dosimetry results and exposure goals for each separate group working at MURR. The data was also used to establish new exposure goals for the various groups. The charts and reviews illustrated and documented the licensee's continued efforts to reduce personnel dose and maintain doses ALARA.

The licensee has an established design change review function implemented at the facility through MURR procedures AP-RR-003 and AR-RO-115. The procedures address changes to the facility hazards summary report (HSR), modifications to the facility, changes to MURR procedures, new tests or experiments not described in the HSR, revisions to NRC approved analysis methodology, and/or proposed compensatory actions to address degraded or non-conforming conditions. It includes the screening and safety review of changes, tests, or experiments to determine if, pursuant to 10 CFR 50.59, a change required the NRC approval prior to being implemented. The inspector found procedures in place to control the review process and evidence of adherence to the procedures.

c. Conclusion

Review, oversight, audit functions required by the TS were acceptably completed by the RAC. Design changes were reviewed and approved in accordance with TS requirements and the licensee's written procedures.

4. Procedures

a. Inspection Scope (IP 69008)

To verify compliance with TSs 6.4.b and 6.4.c, the inspector reviewed selected portions of the following procedures:

- MURR Procedure AP-RR-003, "10 CFR 50.59 Evaluations," Revision 11, issued March 8, 2017
- MURR Procedure RP-HP-125, "Modification and Documenting a Survey," Revision 5, issued February 19, 2018

b. Observations and Findings

Procedures can be created by any subject matter expert, making them the owner. The annual reviews were completed by the owners, as required, but changes can be made at any point during the year. TS 6.4.b requires written procedures for the preparation and shipping of byproduct material and radiological control procedures for shipments. The inspectors reviewed the procedures and observed them properly being used.

TS 6.2.a (2) require review from the RAC for changes and modifications. The inspector reviewed the associated procedures as well as the RAC reviews and generally found them being implemented appropriately.

c. Conclusion

The procedure review, revision, control, and implementation program satisfied TS requirements.

5. Radiation Protection

a. Inspection Scope (IP 69012)

The inspector reviewed the following to verify compliance with 10 CFR Parts 19 and 20 and the applicable licensee TS requirements and procedures:

- MURR dosimetry records for 2017 and 2018 to date
- Dose report review forms for 2017
- Selected radiation and contamination survey records for the past year
- Radiological signs and posting in various facility laboratories and in the Laboratory Building Basement area
- Calibration and periodic check records for selected radiation survey and monitoring instruments for the past 2 years
- MURR Administrative Policy, POL-3, "MURR Radiation Protection Program," Revision 16, issued June 5, 2017
- MURR Reactor Operations Annual Report for the period from January 1, 2017, through December 31, 2017

The inspector also toured the MURR facility and observed the use of dosimetry and survey meters.

b. Observations and Findings

(1) Surveys

Daily, monthly, and other periodic contamination and radiation surveys, outlined in the licensee's Reactor Operations Annual Report for 2016, were completed by HP staff members. Any contamination detected in concentrations above established action levels was noted and the area or item was decontaminated. Results of the surveys were typically documented on survey maps and posted at the entrances to the various areas surveyed so that facility workers and visitors would be aware of the radiological conditions that existed therein.

(2) Postings and Notices

Copies of current notices to workers were posted in appropriate areas in the facility. The copies of NRC Form 3 noted at the facility were the latest issue, as required by 10 CFR Part 19, and were posted in various areas throughout the facility such as the main bulletin board, the main hallways, and at the entrance to the beam port floor area. The inspector determined that appropriate radiological signs, as well as current copies of the survey maps (as noted above), were typically posted at the

entrances to controlled areas. Other postings also showed the industrial hygiene hazards that were present in the areas.

(3) Dosimetry Use and Results

Through direct observation, the inspector determined that dosimetry was acceptably used by facility and contractor personnel. The inspector determined that, last year, the licensee used optically stimulated luminescent (OSL) dosimetry for whole body monitoring and TLDs in the form of finger rings and wrist badges for extremity monitoring. An examination of the OSL and TLD results indicating radiological exposures at the facility for the past year showed that the highest occupational doses, as well as doses to the public, were within 10 CFR Part 20 limits.

(4) Radiation Monitoring Equipment

Examination of selected radiation monitoring equipment indicated that the instruments had the acceptable up-to-date calibration sticker attached. A review of selected instrument calibration records indicated that the calibration of swipe counters and portal monitors was typically completed by licensee staff personnel. Other instruments, such as portable survey meters, friskers, and neutron detectors were shipped to vendors for calibration. Calibration frequency met procedural requirements and records were maintained as required. The inspector noted that area radiation monitors, as well as air monitors and stack monitors, were also being calibrated as required. These monitors were also typically calibrated by licensee staff personnel.

(5) Radiation Protection and ALARA Programs

The licensee's RPP and ALARA Program continued to be established and described in the MURR Administrative Policy, POL-3, "MURR Radiation Protection Program," and implemented through the various HP procedures that had been reviewed and approved. The programs contained instructions concerning organization, training, monitoring, personnel responsibilities, and audits. The programs, as outlined and established, appeared to be acceptable. The inspector verified that annual reviews of the RPP were being completed by the licensee as required by 10 CFR Part 20.

The MURR management ALARA efforts were well organized and continued to produce dose reduction results. ALARA goals were set and performance indicators were established. Each group in the MURR organization had an established ALARA goal for the year, and the facility dose was tracked by group, as well as for each individual.

The ALARA Program provided instructions and guidance for keeping doses ALARA and was consistent with 10 CFR Part 20 requirements. MURR management and staff continued their efforts to maintain personal doses ALARA.

(6) Radiation Work Permit Program

The inspector reviewed selected radiation work permits that had been written, used, and closed out during 2017. It was noted that the instructions specified in MURR Procedure AP-HP-105, Attachment 7.1, and those on the associated forms (e.g., Form FM-17, "Radiation Work Permit Instructions") had been followed. Appropriate review by management and HP personnel had been completed. The controls specified in the radiation work permits were acceptable and applicable for the type of work being done.

(7) Facility Tours

On various occasions during the inspection, the inspector toured the hot cell area and selected support laboratories with licensee representatives. The inspector noted that facility radioactive material storage areas were properly posted. Radiation and high radiation areas were posted and properly controlled as required.

c. Conclusion

The inspector determined that the RPP and ALARA Program, as implemented by the licensee, generally satisfied regulatory requirements. Specifically, (1) surveys were generally completed and documented acceptably to permit evaluation of the radiation hazards present; (2) postings met regulatory requirements; (3) personnel dosimetry was being worn as required and recorded doses were within the NRC's regulatory limits; (4) radiation survey and monitoring equipment was being maintained and calibrated as required; and (5) the RPP was acceptable and was being reviewed annually as required.

6. Transportation of Radioactive Material

a. Inspection Scope (IP 86740)

To verify compliance with regulatory and procedural requirements for transferring or shipping licensed radioactive material, the inspector reviewed the following:

- Selected records of various types of radioactive material shipments for 2017 and to date in 2018
- Selected training records for staff personnel authorized to ship radioactive material

b. Observations and Findings

During the inspection, the inspector reviewed selected records of various types of radioactive material shipments for 2017 and to date in 2018. The inspector noted adherence to procedures and attention to maintaining radiation doses ALARA. Shipping personnel reviewed the irradiation records and the contents of the packages were verified using gamma spectroscopy. Shipping papers were prepared by one person and reviewed for accuracy and completeness by a second staff member. The licensee verified consignee information (i.e.,

possession of a license to receive radioactive materials, address, and contact information). Throughout the shipping process, it was noted that MURR staff members were knowledgeable of their duties and conducted a thorough review of all documentation.

The inspector verified that the licensee maintained on file copies of consignees' licenses to possess radioactive material as required. As noted above, the license of each specific consignee was verified to be current prior to initiating a shipment. Some licensees had received timely renewal extensions. The amount of radioactive material being shipped was compared to that amount authorized by the license. The inspector also verified that the licensee staff members who were designated as "shippers" had received training within the last 3 years.

c. Conclusion

Radioactive material was generally being shipped in accordance with the applicable regulations.

7. Exit Interview

The inspection scope and results were summarized on April 12, 2018, with members of licensee management and staff. The inspector described the areas inspected and discussed in detail the inspection findings. The licensee acknowledged the results of the inspection.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

R. Dobey	Interim Health Physics and Safety Manager
C. Schnieders	Health Physics Supervisor

INSPECTION PROCEDURES USED

IP 69004	Class 1 Research and Test Reactor Effluent and Environmental Monitoring
IP 69005	Class 1 Research and Test Experiments
IP 69007	Class 1 Research and Test Reactor Review and Audit and Design Change Functions
IP 69008	Class 1 Research and Test Reactor Procedures
IP 69012	Class 1 Research and Test Reactor Radiation Protection
IP 86740	Inspection of Transportation Activities

ITEMS OPENED, CLOSED, AND/OR DISCUSSED

Opened

None

Discussed

50-186/2017-202-01 Violation: Failure to meet operability requirements of TS 3.10 related to charcoal bank efficiency (TS 3.10.d)

Closed

None

LIST OF ACRONYMS USED

ALARA	As low as reasonably achievable
10 CFR	Title 10 of the *Code of Federal Regulations*
HP	Health Physics
HSR	Hazards Summary Report
IP	Inspection Procedure
MURR	University of Missouri – Columbia Research Reactor
NRC	U.S. Nuclear Regulatory Commission
OSL	Optically stimulated luminescent (dosimeter)
RAC	Reactor Advisory Committee
RURs	Reactor Utilization Requests
SE	Safety Evaluation
TLD	Thermoluminescence dosimeter
TS	Technical Specification