



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

June 28, 2021

Dr. Joseph Graham, Director  
Missouri University of Science and  
Technology Nuclear Reactor Facility  
250 West 13th Street  
Rolla, MO 65409-0630

SUBJECT: BOARD OF CURATORS OF THE UNIVERSITY OF MISSOURI – U.S.  
NUCLEAR REGULATORY COMMISSION ROUTINE INSPECTION  
REPORT NO. 05000123/2021201 AND NOTICE OF VIOLATION

Dear Dr. Graham:

From May 17-19, 2021, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an inspection at the Missouri University of Science and Technology Research Reactor facility. The enclosed report documents the inspection results, which were discussed on May 19 and May 26, 2021, with you and 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 selected procedures and records, observed various activities, and interviewed personnel.

Based on the results of this inspection, the NRC has determined that a Severity Level IV violation of NRC requirements occurred. The violation was evaluated in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at <https://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html>. The violation is cited in the enclosed Notice of Violation (Notice) and the circumstances surrounding it are described in detail in the subject inspection report. The violation is being cited in the Notice because it constitutes a failure to meet regulatory requirements that has more than minor safety significance and the licensee failed to identify the violation.

You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. If you have additional information that you believe the NRC should consider, you may provide it in your response to the Notice. The NRC review of your response to the Notice will also determine whether further enforcement action is necessary to ensure compliance with regulatory requirements.

In accordance with Title 10 of the *Code of Federal Regulations*, Section 2.390, "Public inspections, exemptions, and requests for withholding," a copy of this letter, its enclosures, 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 <https://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room). To the extent possible, your response should not include any personal privacy or proprietary information, so that it can be made available to the Public without redaction.

If you have any questions concerning this inspection, please contact Phil O'Bryan at 301-415-0266, or by electronic mail at [Phil.O'Bryan@nrc.gov](mailto:Phil.O'Bryan@nrc.gov).

Sincerely,

William Shuster *For* /RA

Travis L. Tate, Chief  
Non-Power Production and Utilization Facility  
Oversight Branch  
Division of Advanced Reactors and Non-Power  
Production and Utilization Facilities  
Office of Nuclear Reactor Regulation

Docket No. 50-123  
License No. R-79

Enclosures:  
As stated

cc w/enclosures: See next page

cc:

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

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

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Section for Environmental Public Health  
930 Wildwood Drive  
Jefferson City, MO 65102-0570

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Department of Natural Resources  
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A-95 Coordinator  
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Test, Research and Training  
Reactor Newsletter  
Attention: Amber Johnson  
Dept of Materials Science and Engineering  
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4418 Stadium Drive  
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SUBJECT: BOARD OF CURATORS OF THE UNIVERSITY OF MISSOURI – U.S.  
NUCLEAR REGULATORY COMMISSION ROUTINE INSPECTION  
REPORT NO. 05000123/2021201 AND NOTICE OF VIOLATION  
DATED: JUNE 28, 2021

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**NRC-002**

<b>OFFICE</b>	NRR/DANU/UNPO/RI	NRR/DANU/UNPO/LA	NRR/DANU/UNPO/BC
<b>NAME</b>	PO'Bryan	NParker	TTate
<b>DATE</b>	06/09/2021	06/10/2021	06/28/2021

**OFFICIAL RECORD COPY**

## NOTICE OF VIOLATION

Board of Curators of the  
University of Missouri

Docket No. 50-123  
License No. R-79

During a U.S. Nuclear Regulatory Commission (NRC) inspection conducted May 17-19, 2021, a violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

Missouri University of Science and Technology Research Reactor technical specifications Section 4.6.2, "Radioactive Effluents," states, "An experimental verification of calculated release values shall be performed every 5 years and when a change in licensed power occurs."

Contrary to the above, a valid experimental verification of calculated Argon-41 release values has not been performed since 2007. Specifically, experimental verifications of calculated Argon-41 release values were performed incorrectly due to multiple procedural errors, thus invalidating the verifications.

This is a Severity Level IV violation (Section 6.1).

Pursuant to the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 2.201, "Notice of violation," Board of Curators of the University of Missouri is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation," and should include: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken; and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an Order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (Agencywide Documents Access and Management System), accessible from the NRC Web site at <https://www.nrc.gov/reading-rm/adams.html>, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information.

If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

In accordance with 10 CFR 19.11, "Posting of notices to workers," you may be required to post this Notice within two working days of receipt.

Dated this 28<sup>th</sup> day of June, 2021.

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

Docket No.: 50-123

License No.: R-79

Report No: 05000123/2021201

Licensee: Board of Curators of the University of Missouri

Facility: Missouri University of Science and Technology Research Reactor

Location: Rolla, MO

Dates: May 17-19, 2021

Inspector: Phil O'Bryan

Approved by: Travis L. Tate, Chief  
Non-Power Production and Utilization Facility  
Oversight Branch  
Division of Advanced Reactors and Non-Power  
Production and Utilization Facilities  
Office of Nuclear Reactor Regulation

## EXECUTIVE SUMMARY

Board of Curators of The University of Missouri  
Missouri University of Science and Technology Research Reactor  
NRC Inspection Report No. 05000123/2021201

The primary focus of this routine, announced inspection, was the on-site review of selected aspects of the licensee's Class II research reactor facility safety program including: (1) organization and staffing; (2) procedures; (3) experiments; (4) health physics; (5) committees, audits and reviews; and (6) transportation activities. The inspector found that the licensee's program was acceptably directed toward the protection of public health and safety and in compliance with U.S. Nuclear Regulatory Commission (NRC) requirements, except where noted below.

### Organization and Staffing

- The inspector found that the licensee's organization and staffing complied with the technical specifications (TS).

### Procedures

- The inspector found that written procedures were maintained in accordance with the TS and licensee administrative procedures.

### Experiments

- The inspector found that reactor experiments were performed in accordance with the requirements of the TS and the applicable licensee procedures.

### Health Physics

- The inspector found that surveys, postings, and personnel dosimetry met regulatory requirements.
- The inspector found that radiation monitoring equipment was maintained and calibrated as required by TSs.
- The inspector found that calculations of effluents released from the facility did not satisfy license and regulatory requirements. See Section 4 of this report for details.

### Committees, Audits and Reviews

- The inspector found that the Radiation Safety Committee (RSC) met as required by TSs.
- The inspector found that audits and reviews were conducted by designated individuals and reviewed by the RSC in accordance with the requirements specified in the TS.



### Transportation Activities

- The inspector found that radioactive material was transferred to the campus radioactive material license in accordance with the applicable regulations and licensee procedures.

## REPORT DETAILS

### **Summary of Facility Status**

The Board of Curators of the University of Missouri (the licensee) 200-kilowatt pool-type research reactor was operated in support of graduate and undergraduate instruction, laboratory experiments, reactor operator training, and research. The Missouri University of Science and Technology Reactor (MSTR) was not operated during this inspection.

#### **1. Organization and Staffing**

a. Inspection Scope (Inspection Procedure [IP] 69001, Section 02.01)

The inspector reviewed the following documents to ensure that the requirements of Section 6.1 of the TS were met:

- management responsibilities
- qualifications of facility personnel
- reactor operations history
- RSC meeting minutes for 2019 through the present

b. Observations and Findings

The inspector found that shift staffing and the MSTR organization met TS requirements.

c. Conclusion

The inspector found that the organization and staffing of MSTR was maintained in accordance with TS Section 6.1.

#### **2. Procedures**

a. Inspection Scope (IP 69001, Section 02.03)

The inspector reviewed the following documents to ensure that written instructions for those activities specified in TS Section 6.4 were in effect:

- select MSTR Standard Operating Procedures (SOPs) and forms for 2018 to the present including: SOP-600, "General Health Physics," SOP-601, "Handling of Radioactive Samples," SOP-700, "Experiments," SOP-655, "Radiation Area Monitor Calibrations," and SOP-654, "Measurement of Argon-41 Concentration in the Reactor Building Air"
- RSC meeting minutes for 2019 to the present

b. Observations and Findings

Section 6.4 of the TS requires that operating procedures be prepared for specific activities. It also specifies a means for making minor and substantive changes to procedures. The inspector determined that the licensee complied with the TS guidance for making changes to procedures. The inspector verified that the RSC minutes reflected review and approval of procedure changes.

c. Conclusion

The inspector found that procedures were established in accordance with TS Section 6.4 and were maintained, reviewed, updated, and approved as required by the TS.

**3. Experiments**

a. Inspection Scope (IP 69001, Section 02.06)

The inspector reviewed the following documents to ensure that the requirements of TS Sections 3.7 and 6.5 were met:

- MSTR SOP-702, "Irradiation Request Forms (IRF)"
- completed IRFs for 2019 to the present
- RSC meeting minutes for 2019 through the present

b. Observations and Findings

The inspector found that experiments were initiated using previously written and approved IRFs or by filling out new request forms. The inspector noted that new IRFs were completed in accordance with the appropriate procedure, SOP 702, "Irradiation Request Forms," and TS Sections 3.7 and 4.7. The inspector did not note any problems or discrepancies.

c. Conclusion

The inspector determined that reactor experiments were performed in accordance with the requirements of TS and the applicable procedure.

**4. Health Physics**

a. Inspection Scope (IP 69001, Section 02.07)

To verify compliance with TS Section 3.6, TS Section 4.6, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," and 10 CFR Part 20, "Standards for Protection against Radiation," the inspector reviewed selected aspects of:

- personnel dosimetry records for 2019, 2020, and to date in 2021
- environmental dosimetry records for 2018, 2019, and to date in 2021
- radiological signs and postings at the facility

- SOP-600, "General Health Physics"
- SOP-601, "Handling of Radioactive Samples"
- SOP-602, "Entry into High Radiation Area"
- SOP-603, "Release of Radioactive Material on Campus"
- SOP-604, "Radioactive Waste Handling"
- SOP-615, "Radiation Work Permit"
- SOP-654, "Measurement of Argon-41 Concentration in the Reactor Building Air,"
- SOP-655, "Radiation Monitor Calibrations"
- MSTR Annual Report for the period of April 2019 – March 2020
- RSC meeting minutes for 2019 to the present
- annual as low as reasonably achievable (ALARA) audits for 2019 and 2020
- radiation and radioactive contamination surveys for 2019 to the present
- health physics monthly audit reports for 2019 to the present
- Argon-41 measurement and calculation results for 2005 to the present

b. Observations and Findings

(1) Surveys

The inspector reviewed monthly radiation and contamination surveys of licensee-controlled areas for the past 2 years. The inspector determined that the results of these surveys were documented, reviewed, and evaluated, and corrective actions were taken when readings or contamination results exceeded set action levels.

(2) Postings and Notices

During tours of the facility, the inspector observed that postings and controls established for radiation, high radiation, contamination, and radioactive storage areas met the requirements of 10 CFR Part 20, Subpart J, "Precautionary Procedures." The inspector confirmed that personnel complied with the signs, postings, and controls.

(3) Dosimetry

The inspector determined that the licensee used appropriate dosimetry for monitoring personnel radiation dose. Through direct observation the inspector determined that dosimetry use by facility personnel was in accordance with the university radiation protection requirements. Examination of the dosimetry results, indicating radiological exposures at the facility for the past 2 years, showed that all occupational doses were within 10 CFR Part 20 limits.

(4) Radiation Monitoring Equipment Use and Calibration

The use and calibration of radiation monitoring equipment was reviewed by the inspector. The inspector reviewed calibration records and determined that records were maintained as required, and that calibration frequencies met the requirements established in the applicable

surveillance procedures. Through observations of activities at the MSTR facility, the inspector determined that monitoring equipment was used in accordance with facility procedures.

(5) Radiation Worker Training

The inspector determined that licensed operators at MSTR were tested annually on principles of health physics, and that MSTR personnel authorized to work with radioactive material under the campus material license received annual refresher training.

The inspector reviewed documentation of the training provided to MSTR staff members and the documents indicated that all current staff members received the required training. The inspector determined that the personnel training program satisfied requirements in 10 CFR 19.12, "Instruction to workers."

(6) Environmental and Effluent Monitoring

i. Observations

The inspector reviewed the area radiation monitors (ARMs) and the continuous air monitor (CAM) calibration records. The inspector verified that the ARMs and CAM were calibrated annually by licensee staff in accordance with procedures.

The inspector verified that there were no liquid releases from the facility to the sanitary sewer within the past 2 years. It was noted by the inspector, that solid waste was transferred from the facility to the campus Radiation Safety Officer (RSO).

The inspector noted that onsite and off-site gamma radiation monitoring was completed using environmental dosimetry in accordance with the applicable university procedures. The data indicated that there were no unusual dose rates in the areas surrounding the MSTR facility and that there were no measurable doses above any regulatory limits. These results were also appropriately reported in the facility annual reports

ii. Inspector Follow-up Item (IFI) 50-123/2019-201-01, Use of the Environmental Protection Agency (EPA) COMPLY Code to Calculate Off Site Releases.

IFI 50-123/2019-201-01 was opened in 2019 to track the licensee's review of the requirements for calculating off site airborne radioactivity releases. During the current inspection, the inspector found that the licensee has completed its review and determined that use of the EPA COMPLY code is not mandatory and hand calculations are acceptable. This IFI is closed.

- iii. Notice of Violation (NOV) 05000123/2021-201-01 of TS 4.6.2, “Radioactive Effluents,” Due to Testing and Calculation Errors.

Section 4.6.2(1) of the TS states, “An experimental verification of calculated release [of radioactive effluent] values shall be performed every 5 years and when a change in licensed power occurs.”

Contrary to the above, due to errors in experimental verification methodology, the licensee failed to conduct a valid experimental verification of airborne radioactive effluent values since 2007.

The inspector found that the methodology employed for the experimental verification of airborne releases from the MSTR facility from 2008 to 2019 did not establish a ventilation configuration that was consistent with assumptions in the airborne radioactivity calculations used to determine the magnitude of MSTR airborne radioactive effluents. This error resulted in the licensee underestimating the amount of airborne radioactivity released from the MSTR facility.

However, after the inspector identified this error, the licensee performed an in-depth review of the testing methodology and found additional errors (see MSTR event notification 55266 follow-up reports, Agencywide Documents Access and Management System Accession Nos. ML21153A432 and ML21153A433). The cumulative effect of the errors is that airborne radioactive effluents were significantly underestimated between 2008 and 2019. The inspector noted that, despite the inaccurate testing results, once corrections to data were applied, it is reasonable to assume that the airborne radioactive effluents from the MSTR facility were within the limits established in 10 CFR 20.1101, “Radiation protection programs,” paragraph (d) and 10 CFR Part 20, Appendix B, Table 2.

(8) Facility Tours

The inspector toured the reactor building and found that control of radioactive material and control of access to radiation and high radiation areas were acceptable and in accordance with the regulations. As noted earlier, the postings and signs for these areas were appropriate. No problems were noted.

c. Conclusion

With the exception noted above, the inspector determined that the licensee’s radiation protection program satisfied regulatory requirements.

## 5. Committees, Audits and Reviews

### a. Inspection Scope (IP 69001, Section 02.09)

The inspector reviewed the following documents to ensure that the requirements of TS Section 6.2 were met:

- annual independent audits conducted for MSTR by University of Missouri-Columbia Research Reactor staff members for 2019 and 2020
- RSC meeting minutes for 2019 to the present
- annual ALARA audits conducted in 2019 and 2020

### b. Observations and Findings

The inspector found that RSC membership satisfied TS Section 6.2.2 requirements and that the committee provided oversight for the reactor as required by the TS. The inspector noted that RSC minutes and audit records showed that safety reviews and individual audits were completed at the required frequency for the functional areas specified by TS Sections 6.2.3 and 6.2.4.

### c. Conclusion

The inspector found that the RSC continued to perform independent oversight in accordance with TS requirements.

## 6. Transportation Activities

### a. Inspection Scope (IP 86740)

The inspector interviewed personnel and reviewed the following to verify compliance with regulatory and procedural requirements for transferred licensed material:

- records of radioactive material shipments and transfer for 2019 and 2020
- SOP-604, "Radioactive Waste Handling"

### b. Observations and Findings

The inspector verified that radioactive material waste generated at the MSTR and was transferred to the Missouri University of Science and Technology campus material license. The inspector found that these transfers were performed in accordance with RSO and facility guidelines.

### c. Conclusion

The inspector determined the radioactive material transfers were made in accordance with the applicable procedures and regulatory requirements.

**7. Exit Meeting**

The inspection scope and results were summarized on May 19, 2021, and May 26, 2021, with members of licensee management and staff. The inspector described the areas inspected and discussed the inspection results.



**PARTIAL LIST OF PERSONS CONTACTED**

Licensee Personnel

E. Tabor	Reactor Manager
M. Bresnahan	Director of Environmental Health and Safety
J. Graham	Facility Director
A. Skye	Reactor Operator

**INSPECTION PROCEDURE USED**

IP 69001	Class II Non-Power Reactors
IP 86740	Inspection of Transportation Activities

**ITEMS OPENED, CLOSED, AND DISCUSSED**

Open

05000123/2021-201-01	NOV	TS 4.6.2, "Radioactive Effluents," Due to Testing and Calculation Errors
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Closed

50-123/2019-201-01	IFI	Use of the Environmental Protection Agency (EPA) COMPLY Code to Calculate Off Site Releases
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