University of Missouri

Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211
PHONE 573-882-4211
WEB murr.missouri.edu

August 05, 2021

Executive Director for Operations (EDO)
ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

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

SUBJECT: Reportable Event Report Pursuant to § 20.2203(a)(2)(iv)

The University of Missouri Research Reactor (MURR) submits this letter to report a condition pursuant to § 20.2203(a) regarding the dose limit for an individual member of the public as stated in § 20.1301(a)(2).

On July 14, 2021 at approximately 2:25 PM, a routine health physics technician survey was conducted for the loading dock area external to the MURR Industrial Building (MIB). In response to previous external building dose rates (see communication from MURR to NRC dated 3/19/2021), the survey was conducted to include areas not generally surveyed (elevated heights). During this survey a low dose rate was noticed in the area of the building wall above the technician's head level. To complete a detailed investigation, the technician then retrieved a ladder to investigate further and determined that the peak dose rate was approximately 10-12 feet above ground level and was localized on the wall. This is not an area easily accessible by a member of the public nor is it routinely accessed by persons working at or near MURR. This dose rate was more than the 2 mrem/hr limit (10 CFR § 20.1301(a)(2)) for a member of the public (See Attachment 1). However, MURR is not aware of any member of the public actually receiving a dose. The technician immediately contacted a health physicist for assistance. Together they determined the source of the elevated dose rate was from a glovebox within the I-131 quality control suite that was storing material behind lead shielding. The two worked together to add more shielding to the glovebox and to reduce the dose rate external to the building to < 2 mrem/hr. MURR was able to lower the dose rate to below regulatory limits within one hour.

Following this discovery, it was determined that this issue only existed on the days that QC processing of I-131 occurs. I-131 QC processing occurred once per week (typically on Fridays). Similar to this discovery, MURR does not believe that any member of the public has been affected by this dose rate during previous weeks as no member of the public would be at approximately 10-12 feet up the wall where the dose was discovered.

From an extent of condition perspective, MURR also performed similar elevated surveys when other processes were being conducted in the MIB to determine if potential dose rates existed. The surveys also encompassed elevated heights to ensure any streaming paths coming from inside the building are not exceeding the 2 mrem/hr limit (10 CFR § 20.1301). These surveys were completed within two weeks of

the initial discovery. During these surveys and as discussed below, Health Physics did identify additional elevated dose rates.

On July 21, 2021 a survey external to the Lu-177 autoclave suite (MIB) was conducted during maximum activity use in the area. This survey also showed dose rates external to the building in excess of the 2 mrem/hr limit (See Attachment 1). The largest dose rate was found approximately 15 feet above ground level during the time vials were moved from "pigs" into the autoclave (~2 minutes). After the vials were loaded into the autoclave, the dose rate was reduced roughly in half. Upon noticing these dose rates, the Health Physics Manager was immediately contacted and assisted in further measurements. Dose rates were measured inside the building near the autoclave and it was discovered that a streaming path existed at the door of the autoclave shielding box at an approximately 45-degree angle out of the top front of the box. This streaming path created a high radiation area (HRA) at or above head level and does not occur at the designed working location in the room occupied by staff (behind lead glass wall). At the time the dose rates were recorded, no staff were working in the space and HP was always present. By procedure, Health Physics staff were present while staff worked in the space (~5 minutes during loading and ~10 minutes during unloading autoclave) to ensure that no elevated doses were received. All staff working in the room were wearing electronic dosimetry and no elevated dose rates were observed in the working spaces. Upon discovery of the elevated dose rate, the room was posted as an HRA and monitored by health physics until the dose rate was lowered at the end of the process.

No additional areas of concern were found during follow-on surveys of the MIB building external walls.

The following is a description of the event per 10 CFR § 20.2203(b):

(i) Estimates of each individual's dose:

The external to building dose rates were all measured at locations higher than humans would physically be, without the use of ladders or equipment. MURR does not believe such access has occurred as MURR personnel would be aware of such activities based on security protocols and maintenance planning due to close proximity to the building. Also, the areas in which a dose field was present on the exterior of the building is within the gated perimeter of the research reactor facility and monitored by security cameras. Lastly, there were no members of the public within this production area of the facility during these events. Based on no knowledge of such activity by a member of the public in the area of these dose rates, MURR reasonably concludes that no member of the public was exposed at any time due to external to building dose.

All radiation workers who were present in the area during the events were monitored with electronic dosimetry and none exceed any level of exposure beyond normal work conditions.

(ii) The levels of radiation and concentrations of radioactive material involved:

Two separate events were measured as part of this investigation. The first event involved the use of I-131 (two vials of approximately 150 mCi each) for quality control activities on 7/14/21. The dose rate was measured to be approximately 20 mrem/hr on contact with the building at 10-12 feet above ground level. The dose rate dropped to approximately 10 mrem/hr at 30cm from the wall (also 10-12 feet high). At the height where personnel could be exposed while standing near the building (at ground level) the dose rate was < 2 mrem/hr at all times. Once additional shielding was added, all dose rates external to the building were reduced to < 0.5 mrem/hr. Dose rates were also measured inside the building and were found to be approximately 20 mrem/hr in the working space, which is consistent with expectations.

The second event involved approximately 100 Ci of Lu-177 being autoclaved on 7/21/21. Measured dose rates were approximately 30 mrem/hr roughly 15 feet above ground level external to the building. The largest dose rates occurred during the time vials were removed from lead pigs and added to the autoclave. This period of time lasted approximately 1-2 minutes before the material was shielded by the lead autoclave enclosure. Once all vials were in the shielded autoclave enclosure, the dose rate external to the building at 15 feet above ground level dropped to approximately 15 mrem/hr. At the time of the incident, dose rates were taken within the posted radiation work area and were recorded as approximately 1000 mrem/hr on contact with the shielding box, and approximately 450 mrem/hr at 30 cm away. These dose rates were coming out of the front of the shielded box at an angle putting the dose rate at or above head height.

In both events the dose rates inside the building were entirely contained within a posted radiation laboratory in which badge access is required and all personnel wear both monthly-read dosimetry and instantaneous electronic dosimetry.

(iii) The cause of the elevated exposure levels:

The apparent cause of the elevated exposure was the lack of understanding of the shielding necessary to prevent excessive dose rates in the area that this event occurred. Particularly, previous measurements of dose rates at elevated heights both inside of the building and outside of the building were only measured at average personnel height. These measurements did not consider potential streaming paths at higher elevations. In both cases, the shielding was not adequate in all directions regarding anticipated activities that was in the area. This problem was compounded by the fact that the equipment (I-131 glovebox and Lu-177 autoclave enclosure) were positioned on exterior facility walls. The elevated dose rates occurred on the exterior wall of the building directly adjacent to the use area, and at elevations matching angled streaming paths.

A contributing factor to the elevated dose rates of the second event on 7/21/21 was that the shielding was not being used in its designed configuration. The lead door was not able to physically close all the way based on the positioning of the autoclave itself. This was being done based on ease of operation and reducing manipulator use time. However, this inadvertently led to the door being cracked approximately one inch allowing for a larger than designed streaming path. Also, a lack of communication/training by radiation workers in this part of the facility led to a misunderstanding of the true design function of the shielding.

The final factor was an inadequate survey of the space. Emphasis was put on surveying the areas where staff members typically stand. This did not allow for an adequate survey of all streaming paths within the building, leading to dose rates external to the building above regulatory limits.

(iv) Corrective steps taken or planned to ensure against a recurrence:

- Initial action taken upon discovery of the event on 7/14/21 included adding additional shielding inside the I-131 QC glove box to reduce dose rate out the back of the unit. This corrective action immediately lowered dose on the outside of the building below the regulatory limits.
- Initial action taken upon discovery of the event on 7/21/21 included posting the room as a high radiation area, notifying all staff involved, and posting an HP in the area to ensure that no person was exposed either inside or outside of the building. The postings and HP involvement were not removed/reduced until the material was removed from the area and the dose rates were lowered.
- Procedures will be evaluated in the areas to determine if additional surveying detail should be added. This corrective action will prevent future instances of inadvertently creating high dose rate areas by increasing immediate knowledge of dose rates from items as they are used.
- The autoclave was reconfigured back to its original shielding design behind the shielding door. This allowed for proper closure of the shielding door and lowered the dose rate from streaming paths external to the building. Continual evaluations are underway to determine where additional shielding can be added to reduce dose and remove the high radiation area inside the room. The room will continue to be posted and monitored/secured as a high radiation area until the dose rate is no longer in this range.
- Additional surveys were taken during the following two weeks on the exterior of the building during use of the equipment involved in this event. Those additional surveys were taken during worst case routine use of the space (largest activity using the device's primary function). These surveys demonstrated that dose rates external to the building remained lower than the 2 mrem/hr limit.
- Members of the I-131 QC and Lu-177 autoclave teams and HP Technician staff were informed of the events as well as the issues created. The same staff will be retrained on all the above corrective actions. The retraining will emphasize the following items:
    - Ensuring all activities related to elevated dose rates are performed under the supervision of HP and that dose rate measurements are performed (baselines measured during first of a kind operations).
    - Understanding of HRA and what should be done if an HRA is created.
    - Understanding how dose rates inside of the building could affect external building dose rates.
    - Facility design and functionality.
    - Procedure revisions.

If there are any questions regarding this report, please contact me at (573) 882-5204. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Daniel Doenges
Reactor Health Physics Manager

ENDORSEMENT:
Reviewed and Approved,

J. David Robertson, PhD
Reactor Facility Director

cc: Reactor Advisory Committee
Reactor Safety Subcommittee
Isotope Use Subcommittee
Dr. Thomas Spencer, Interim Vice Chancellor for Research and Economic Development
Mr. Geoffrey Wertz, U.S. Nuclear Regulatory Commission
Mr. Craig Bassett, U.S. Nuclear Regulatory Commission

Attachments:
1. External Building Survey

State of Missouri
County of Boone

Subscribed and sworn before me this
5th day of August, 2021.

JACQUELINE L. MATYAS, Notary Public
My Commission Expires: March 26, 2023

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JACQUELINE L. MATYAS
My Commission Expires
March 26, 2023
Howard County
Commission #15634308

Attachment 1 - External Building Survey