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

SUBJECT: Supplemental information to the written communication previously  
submitted to the U.S. Nuclear Regulatory Commission by the University  
of Missouri Research Reactor on February 17, 2017

The attached document provides supplemental information concerning the root cause, corrective actions, and safety analysis for the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) No. 17-03 that was previously submitted to the U.S. Nuclear Regulatory Commission (NRC) for the February 3, 2017 event that resulted in a deviation from MURR Technical Specification 3.7.b.

If you have any questions regarding this supplemental report, please contact Bruce Meffert, the facility Reactor Manager, at (573) 882-5118.

Sincerely,

 (ACTING DIRECTOR)

Ralph A. Butler, P.E.  
Director

RAB:jlm

Enclosures

xc: Reactor Advisory Committee  
Reactor Safety Subcommittee  
Isotope Use Subcommittee  
Dr. Mark McIntosh, Vice Chancellor for Research, Graduate Studies and Economic  
Development  
Mr. Geoffrey Wertz, U.S. NRC  
Mr. Johnny Eads, U.S. NRC

A020  
NRR

**Supplemental Information to Licensee Event Report No. 17-03 – February 3, 2017**  
**University of Missouri Research Reactor**

**Introduction**

The following information provides the root cause, corrective actions, and safety analysis to Licensee Event Report (LER) No. 17-03. For a detailed description of the event, please refer to LER No. 17-03, that was submitted to the U.S. Nuclear Regulatory Commission (NRC) on February 17, 2017.

**Supplement to LER No. 17-03 Root Cause**

As stated in LER No. 17-03, two (2) potential root causes were being evaluated:

1. Failure of the reducing diffuser traps resulting in elevated quantities of methyl iodide being released to the hot cell; and
2. Charcoal filter bypass resulting in unfiltered flow bypassing the exhaust filters to a degree sufficient enough to result in elevated releases.

Since LER No. 17-03 was submitted, continued investigations have determined that the actual root cause was installation of deficient filters that contained substandard quality media and had a significant potential for internal filter bypass around the media. Upon recommendation from a third party hired for their technical expertise in the use of charcoal filters, MURR sent three (3) Camfil filters that were representative of the filters installed in Filter Banks 1 through 3 to NUCON International, Inc. (NUCON) for testing.

NUCON tested the charcoal media found in the Camfil filters per ASTM D3803-1991(2014), "Standard Test Method for Nuclear-Grade Activated Carbon," and determined the filter media to have an efficiency of 96%. The tested media was virgin, new charcoal. These results are inconsistent with MURR's understanding of the filter media quality. MURR was under the impression each filter had an efficiency of greater than 99.9% based on the manufacturer specifications sheets.

NUCON also tested a total of nine (9) filters from a lot of 36 filters purchased from Camfil to determine if internal bypass occurs as suspected based on a visual inspection by MURR of the filter design. Of this representative sample, one (1) of the nine (9) filters failed the test indicating more than 2% bypass of the filter media. The other eight (8) filters had less than 0.1% bypass, the sensitivity limit for the test.

If a Technical Specification (TS)-required filter had an efficiency of 96% instead of the required 99%, the decontamination factor (DF) per filter would be 25 instead of a required  $DF \geq 100$ . The combined DF of three (3) TS-required filters at 96% efficiency each would only be  $DF = 15625$  instead of TS-required  $DF \geq 1 \times 10^6$ . Therefore, just the substandard charcoal media would

significantly affect the overall ability of the Iodine-131 hot cell exhaust ventilation system to remove iodine from the flow stream. Using an overall DF = 15625, the amount of iodine released to the hot cell upstream of all filter banks would be 4.3 Curies based on the 274  $\mu\text{Ci}$  exhaust stack release on February 3<sup>rd</sup>.

The potential combination of 96% efficient filter media and 2% bypass on each filter would reduce the single filter DF to less than 17, and the overall three-filter system DF would be reduced to 4913 or less. Using an overall DF = 4913, the amount of iodine released to the hot cell upstream of all filter banks would be 1.3 Curies based on the 274  $\mu\text{Ci}$  exhaust stack release on February 3<sup>rd</sup>.

The combination of the substandard filter media and potential flow bypass in the filters resulted in the MURR iodine processing hot cell charcoal filter banks being inoperable during the duration of the release, which lead to the MURR TS violation. It is MURR's belief that the system is designed adequately. If adequate filters were installed, then the Iodine-131 hot cell exhaust ventilation system would have performed its intended function, and the February 3<sup>rd</sup> release would have been mitigated.

#### **Supplement to LER No. 17-03 Corrective Actions**

Based on the root cause of installation of substandard filters, MURR intends to implement the following corrective action. Development and implementation of a "Material and Document Control Program for Carbon Adsorbers Used in Association with Radioiodine (I-131) Production." This program will outline measures taken to inspect absorbers upon their receipt and control these materials and their associated documentation at MURR. Upon receipt, carbon filters will be quarantined until specific test criteria are confirmed and documented on designated material specification sheets. Specifically, during every filter receipt, a documentation inspection will ensure the charcoal media in the filter has been tested by ASTM D3803-1991(2014) standards indicating a 99.1% or greater efficiency for capturing iodine. The documentation inspection will also ensure each filter has been tested to prove it has less than 0.1% internal bypass. Upon successful confirmation of these test criteria, carbon adsorbers will be released for use in the I-131 filtration system. Completed material specification sheets and any associated documentation (e.g. test reports, certificates of compliance, etc.) will be maintained through MURR's Document Control program.

#### **Opportunities for Improvement**

Though not root causes for the event, two (2) contributing factors were 1) an increased amount of iodine in the hot cell atmosphere in the February 3<sup>rd</sup> process compared to previous processes due to the degradation of the existing reducing diffuser traps, and 2) the inability for MURR personnel to quickly assess the movement of I-131 through the I-131 hot cell exhaust ventilation system.

For the sake of completeness, the additional actions are included below and will also be implemented to enhance the Iodine-131 process:

1. Enhancement of the reducing diffuser trap design to afford the greatest potential for capture and retention of elemental and methyl iodide from the process. The enhancements include 1) a flow rate reduction to increase residence time in the trap and reduce methyl iodide production and 2) an expansion of the trap from four (4) components to 12 components. This action is being taken to ensure ALARA effluents from the process.
2. Installation of two (2) additional filter banks, Filter Banks 5 and 6, to provide increased bed depth such that MURR will have additional time to respond, mitigate, and contain effluent releases to ensure ALARA.
3. Installation of radiation monitors on Filter Banks 4 and 6 to provide real-time indications of adsorption and desorption of process effluents to help MURR personnel assess the movement of I-131 through the exhaust ventilation system.
4. Implementation of a radiation monitoring data review between batch processes to ensure any adverse trends are promptly identified.

Additionally, this event has been entered into the MURR Corrective Action Program entry No. 17-0021, and any additional improvements or corrective actions will be considered and documented in the CAP entry.

#### **Supplement to LER No. 17-03 Safety Analysis**

Since the event, there has been no indication of radiological consequences to the MURR Staff or public. Also, the results from the 46 TLD environmental monitors processed after the event were received and are consistent with historical averages.

#### **MURR Iodine Processing Startup Plan**

1. Install Filter Banks 5 and 6. (complete)
2. Receive new filters with charcoal media tested per ASTM D3803-1991(2014) with a 99.1% or greater efficiency for capturing iodine and each filter tested to ensure it has less than 0.1% internal bypass.
3. Replace all charcoal filters in the I-131 exhaust ventilation system downstream of the hot cells with the new, tested filters.
4. Have a third party perform a one-time test of the Iodine-131 hot cell exhaust ventilation system including filters using a non-radioactive halogen gas and an aerosol as a measure of total I-131 exhaust system mechanical efficiency and system flow bypass.
5. Upon successful completion of all cold testing, MURR will perform two (2) low activity runs prior to full process activities to ensure the effectiveness of all implemented corrective actions.

If there are any questions regarding this LER, please contact me at (573) 882-5118. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

*Bruce A. Meffert*

Bruce A. Meffert, CHP  
Reactor Manager

ENDORSEMENT:

Reviewed and Approved,

*Matt Sanford (ACTING DIRECTOR)*

Ralph A. Butler, P.E.  
Director

State of Missouri  
County of Boone  
Subscribed and sworn to before me this  
18 day of May 2017  
*Jacqueline L. Matyas*  
JACQUELINE L. MATYAS, Notary Public  
My Commission Expires: March 26, 2019



JACQUELINE L. MATYAS  
My Commission Expires  
March 26, 2019  
Howard County  
Commission #15634308