NWMI
NORTHWEST MEDICAL ISOTOPES

ATTACHMENT 3

Northwest Medical Isotopes, LLC

Supplementary information supporting the license amendment application for the purpose of demonstrating ^{99}Mo production capability in the OSTR

Public Version

Information is being provided via hard copy

NWMI
NORTHWEST MEDICAL ISOTOPES

January 31, 2015
NWMI-LTR-002

Oregon State University
Steve Reese, Radiation Center Director
100 Radiation Center
Corvallis, OR 97331-5903

RE: TRANSMITTAL OF LOW ENRICHED URANIUM OFF-GAS RESULTS COMPLETED AT THE UNIVERSITY OF MISSOURI RESEARCH REACTOR

Northwest Medical Isotopes, LLC (NWMI) is pleased to transmit the results of the off-gas results resulting from the irradiation of low enriched uranium (LEU) at the University of Missouri Research Reactor. LEU [redacted] provided by NWMI , LEU Test #1 were irradiated in the MURR reactor from December 8 through 15, 2014. After irradiation, the target was punctured and off-gas analysis was performed. The irradiated target was then opened and the [redacted] of the target. The LEU [redacted]. The aluminum irradiation can inspected and no damage to the can [redacted]. The results of the off-gas analysis indicate that collected ^{133}Xe represents [redacted] of the ^{133}Xe produced in the sample.

If you have any questions, please contact me on 509-430-6921.

Sincerely,

Carolyn C Haass

Carolyn Haass
Vice President

cc: Todd Keller, OSTR

University of Missouri-Columbia
Research Reactor Center

1513 Research Park Dr.
Columbia. MO 65211

Phone: (573) 882-5287
Fax: (573) 882-6360
ManssonL@missouri.edu

January 29, 2015

To: Carolyn Haass
Northwest Medical Isotopes, LLC

From: Leo Manson
University of Missouri Research Reactor (MURR)

Re: Low Enriched Uranium (LEU) [redacted] Irradiation and Post Irradiation Evaluation (PIE) Results for [redacted] LEU [redacted] provided by Northwest Medical Isotopes, LLC.

Summary Comments: LEU [redacted] provided by Northwest Medical Isotopes, LLC (NWMI) ,LEU Test #1 were irradiated in the MURR reactor from December 8 through 15, 2014. After irradiation, the target was punctured and off-gas analysis was performed. The irradiated target was then opened and the [redacted] target. [redacted] The aluminum irradiation can inspected and no damage to the can or [redacted]. The results of the off-gas analysis indicate that collected ^{13} Xe represents [redacted] of the ^{133}Xe produced in the sample.

Detailed Report: [redacted] of low enrichment uranium (LEU) [redacted] supplied by NWMI was encapsulated in a specially designed [redacted] aluminum container and irradiated for 153.86 hours in position K2 in the graphite reflector region of the MURR reactor. The irradiation began on 08 December 2014 and ended at 2:00 AM on 15 December 2014.

The sample was transferred to Hot Cell 09 (HC-09) for processing at ~3:00 PM on 16 December 2014. An air monitoring system (Eberline AMS-4, Serial Number 1173, Calibrated on 10/10/14) was used to monitor for airborne radioactive material from the exhaust of HC-09. The AMS-4 sampled the exhaust ventilation after (downstream from) the two HEPA and three carbon filters on HC-09.

Target Piercing and Gas extraction: On 17 December 2014, the target was positioned in an instrument within HC-09 designed to create two sealed punctures in the outer aluminum wall of the target can providing a path for helium (He) purge gas to sweep any free fission gasses out of the can and into a cryogenically cooled gas trap for analysis. Helium (He) gas purged through the aluminum target can, and data was collected to determine determine the release of Xe-133 gas from the target can. Details of the design of the detector and collection trap and test results are presented in (Attachment 1).

The target was removed from the gas extraction apparatus, and the top of the target container was cut off, first cutting the [redacted].

The irradiated [redacted] glass vial for weight and observation, then into the [redacted] dissolution flask by inverting the glass vial into a [redacted] The mass of [redacted]

University of Missouri-Columbia
Research Reactor Center

1513 Research Park Dr.
Columbia, MO 65211

Phone: (573) 882-5287
Fax: (573) 882-6360
MansonL@missouri.edu

[redacted] Further, the irradiation can and can-lid were visually inspected and there was no indication of any [redacted] No elevation of the background reading on the AMS-4 was observed when the [redacted] the glass vial or the dissolution flask.

Attachments:

1. Fission Gas Extraction and Results

[redacted]

Attachment 1
Fission Gas Extraction Design, Calibration and Results

Design: A custom designed purge and trap system using an inert sweep gas flowing through the target cavity and into a cryogenic trap allowing immediate measurement of trapped fission gasses. Helium (He) is used to purge fission gasses from the target cavity, and transfer the gasses to a condenser/carbon-filter (gas trap) surrounded by isolating shielding and a cryogenic cooling which effectively traps the fission gasses.

A specialized puncturing device was designed to facilitate purging an aluminum target can with minimal or no loss of contained gasses. [redacted] while maintaining a seal to allow the fission gasses to be efficiently purged from the can. A photograph of the puncturing device is shown below in Figure 1.

Figure 1. Photograph of puncture device with outer can wall for testing.

[redacted]

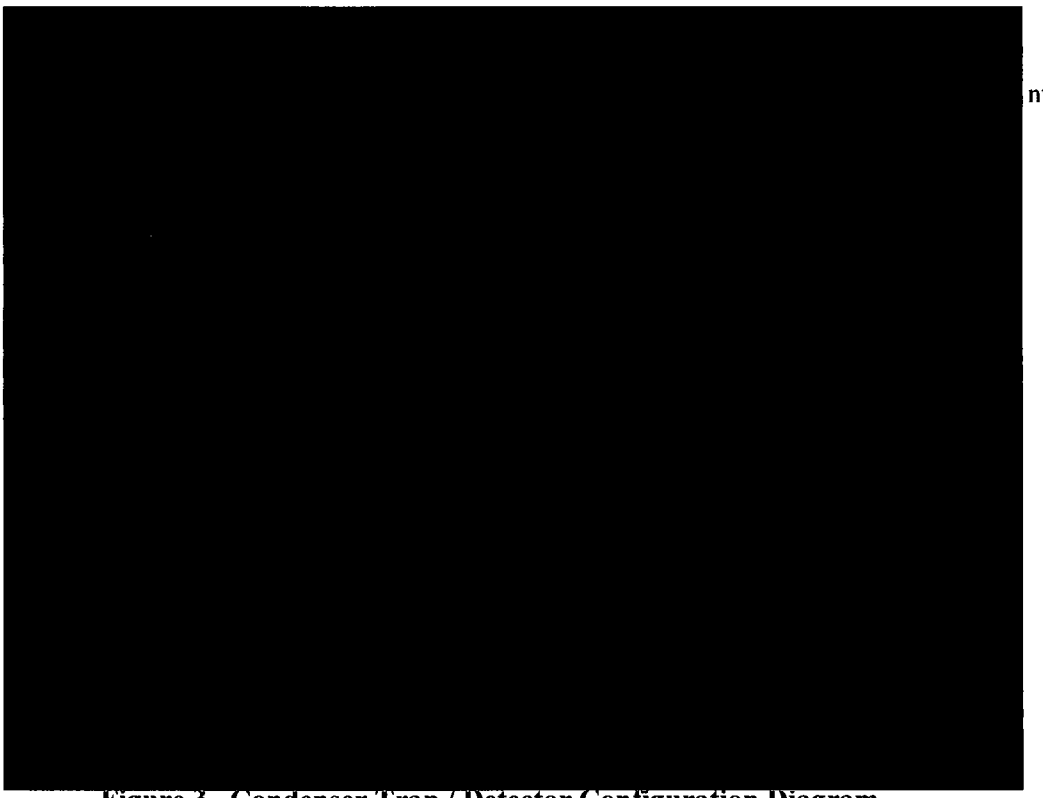
The fission gas trap (Figure 2), designed to condense and hold fission gasses during analysis, consists of copper tubing with a collection section loaded with activated carbon (NUSORB KITEG from NUCON International, Inc.). Approximately [redacted] of activated carbon is loaded into a [redacted] diameter, by [redacted] long section tube. While the carbon provides a high surface area for collection, the primary trapping of fission gas is conducted through cryogenic cooling. During use, the condenser/filter "trap" is submerged in liquid nitrogen which condenses and maintains fission gasses on the carbon during analysis. Heat tape, and an insulator are used to prevent early trapping of the gasses allowing the trapped gas to be concentrated on the carbon where it can be analyzed. Thermocouples (TC-1 and TC-2) used to monitor and allow adjustment of temperatures in both the chilled and heated ranges.

Figure 2. Diagram and Photo of Condenser/Trap

Calibration: Xenon, specifically ^{133}Xe, was chosen for quantifying fission gas release because it is inert and provides a countable gamma ray emission at 81 keV and is readily available in medical dose quantities that are ideal for our calibration comparison work. The overall efficiency of the system for collecting and measuring Xe-133 was determined using known ^{133}Xe sources from Lantheus Medical Imaging Inc. (LMI), (Lot XG-2236).

The ^{133}Xe activity collected on the liquid nitrogen cooled activated carbon was measured using a HPGe detector (Canberra Model GC2018) and Inspector 2000 digital signal processor configured as presented in Figure 3.

[redacted]



nt 1

Figure 3. Condenser Trap / Detector Configuration Diagram

Helium gas (flow rate of [redacted].) was used to purge the ^{133}Xe from the glass vial calibration sources transferring it to the trap where flow of liquid nitrogen was adjusted to maintain a constant temperature of approximately [redacted] on the copper housing of the trap to hold the gas on the trap during assay. Five minute gamma spectrum counts were repeatedly taken as the gas collected on the trap until an accumulation plateau was achieved, Figure 4. After approximately 10 minutes, count rates plateaued and remained stable until the carbon trap was allowed to warm. The detector with trap was calibrated with [redacted] of ^{133}Xe calibrated for Noon 10 December 2014 (LMI, Lot XG-2236). The calibration response factor for the detector/trap system was [redacted] ^{133}Xe.

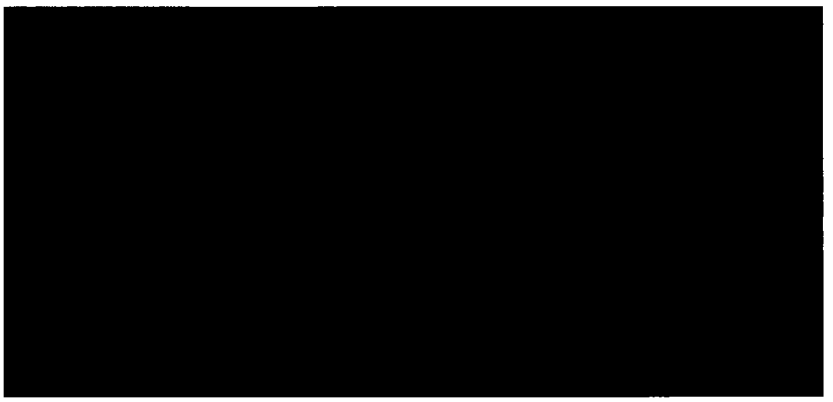


Figure 4. NWMI LEU Test #1 Gas Calibration Plot ^{133}Xe (counts/300 seconds vs count #)

[redacted]

Testing Results: Helium (He) gas purged through the aluminum target can, containing irradiated LEU [redacted], efficiently transferred various fission gasses from the target to a cryogenically cooled carbon filter where the ^{133}Xe is counted and quantified.

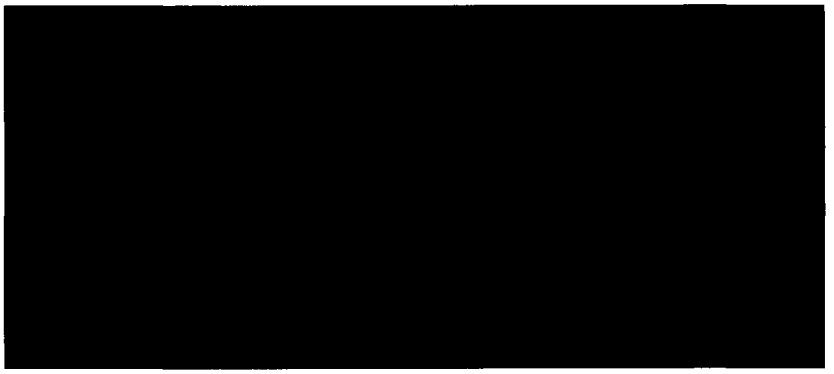


Figure 3. NWMI LEU Test #1 ^{133}Xe for LEU [redacted] (counts/300 seconds. vs count #)

Using the calibration determined response factor and the counts recorded during the LEU [redacted] purge, [redacted] of ^{133}Xe was collected from the LEU [redacted]. Using ^{133}Xe production calculations from ORIGEN, and assays of dissolved LEU [redacted] solution, the measured activity of the collected ^{133}Xe represents [redacted] of the Xe produced by the irradiation of the [redacted] of LEU [redacted].

[redacted]