PennState

**Andrew F. Read**
Senior Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802-1589

814-865-6332
a.read@psu.edu
www.research.psu.edu

June 23, 2025

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: License Amendment Request to Add Nuclide Possession Limits for Research

Reference: License Number SNM-95; Docket Number 70-0113

To whom it may concern,

This letter is to request your approval of proposed changes to the SNM-95 Special Nuclear Materials license. The proposed changes convey updates to the license and also reflect planned research with additional radionuclides that meet the definition of Special Nuclear Material.

Your approval of these changes would support research and development at Penn State University.

Detailed supporting information for the requested change is included in the attachments to this letter.

Feel free to contact Aaron Wilmot (Manager, Radiation Protection Office & University Radiation Safety Officer) at adw154@psu.edu or 814-863-3976 if you have any questions or require additional information.

Sincerely,

Andrew F Read

Andrew Read, Ph.D.
Senior Vice President for Research,
The Pennsylvania State University

CC: James Crandall, Senior Director, Environmental Health and Safety

Aaron Wilmot, Manager, Radiation Protection Office & University Radiation Safety Officer

Stephen Poy, US NRC, Office of Nuclear Material Safety and Safeguards (stephen.poy@nrc.gov)

**Document transmitted herewith contains sensitive unclassified information. When separated from attachment(s), this document is decontrolled.**

**References:**

1. Leavey, J., Penn State University letter dated August 1, 2014, "Resubmittal of license renewal application originally dated 09/23/13 in reply to NRC letter dated November 18, 2014"

**Attachments:**

A. Justification of Requested Change
B. Penn State University Radiation Safety Evaluation of Requested Change (Change 1)
C. Penn State University Radiation Safety Evaluation of Requested Change (Change 2)
D. Depiction of Requested Modifications to the SNM-95 License

# Attachment A. Justification of Requested Change

## Summary of Proposed Changes

Penn State University is requesting two changes to the special nuclear materials license SNM-95, currently approved at Amendment 3. The first change ("Change 1") proposes to remove a possession limit on the license that is not currently used or needed, and which is not expected to be needed at any time in the future. The second change ("Change 2") proposes to add possession limits [redacted] of three different plutonium nuclides. These possession limits support research planned to take place at University Park. A depiction of one possible implementation of the proposed change is included in Attachment D for consideration and illustration of the changes being requested.

## Justification of Proposed Changes

### Change 1

Change 1 is being requested to remove an unnecessary line item and possession limit on the University's SNM-95 license. Specifically, line item 6E is no longer needed and can be removed from the license. The University currently holds no sources under this particular line item. Removing this possession limit would streamline and clarify the University's possessions and licensing requirements.

### Change 2

This amendment request for Change 2 is being submitted to support funded research in the area of Mossbauer spectroscopy of actinide sources, including plutonium. A system employing the Mossbauer technique on actinides would rely on the recoilless resonance emission and absorption of gamma rays that occurs for excited state transitions to ground state for select actinide isotopes, including $^{237}$Np, and $^{234}$U, $^{236}$U, and $^{238}$U. Mossbauer spectroscopy requires a source for the excited state of the isotope to be measured, usually in the form of the radioactive parent of that isotope. [redacted]

Mossbauer spectroscopy provides many benefits and has several applications. Its usage is based on the Mössbauer effect discovered by Rudolf Mössbauer and is a technique that can be used to characterize materials by analyzing the interactions of gamma rays with the nuclei present in the material. Generally, the minimal sample preparation requirements, high spatial resolution, low detection levels (often in the ppb range), and short data collection timeframes (often in the seconds to minutes range) make it highly desirable and useful technique from a research perspective. Its application amongst actinides is a frontier that may yield many useful scientific discoveries.

The technique is not without its challenges, however, and this is especially true when applied to actinides. Currently, there are very few actinide Mossbauer spectrometer systems in the world (including two at ITU in Karlsruhe, Germany). The small number of users also coincides with a shrinking or loss of knowledge about this technique and also means there are only very limited

[redacted]

commercial applications or support. In addition, there have been no previous demonstrations of Mossbauer spectroscopy involving multiple isotopes. Given these challenges alongside the potential use, this is a technique and area that may see large benefits from expanded research and development.

# Attachment B. Penn State University Radiation Safety Evaluation of Requested Change (Change 1)

This Attachment describes the request to remove a licensed line item that currently appears on Amendment 3 of the SNM-95 license.

Specifically, line item E covers the possession of [redacted] plutonium isotopes (238, 239, 240, 241, and 242). Penn State has never received or possessed any sources under this line item. Even in the renewal application (2014), the University requested that this line item be removed (see ML1431/ML14314A043 page 7). A review of recent history confirms this and shows that no sources currently are or have been possessed under this line item. There are also no plans to procure or possess sources within this line item.

Therefore, Penn State University requests that line item E be removed from the license. A depiction showing the suggested markup is included in Attachment D.

# Attachment C. Penn State University Radiation Safety Evaluation of Requested Change (Change 2)

This Attachment summarizes the results of the initial radiation safety evaluation of the requested amendment to add possession limits for three plutonium isotopes [redacted] to Penn State University's SNM-95 license.

Penn State University Environmental Health & Safety (EHS) concludes that the risks and hazards posed by the requested amendment to add possession limits corresponding to [redacted] Mossbauer spectroscopy are within the University's ability to manage and control, and not substantially different from those that currently exist at the University associated with SNM-95 licensed materials. This conclusion is based on a radiation safety review and evaluation, much of which is described below.

## I. Description of Planned Use

### A. Source Description

The physical sources [redacted] involve [redacted] plutonium isotopes (plutonium-238, 240, and 242 specifically) used for Mossbauer spectroscopy of actinides. [redacted] While it is expected that only one source of each isotope would need to be procured, this amendment requests asks for twice the expected quantity plus approximately two percent. This increase is to account for uncertainties and unanticipated issues that may arise from received sources (e.g., source not satisfactory, or does not meet research expectations, etc.). In this way, if this amendment request is approved, the PI (Dr. Jon Schwantes, see Section IV.A of this document), would be authorized by the University's Radiation Safety Committee (the University Isotopes Committee) to possess sources in his lab [redacted] Should a source arrive and not meet expectations, this source would be transferred to the radiation safety organization while it was being prepared for shipment or disposal. In this fashion, Dr. Schwantes could then proceed with acquiring a replacement source without having to wait for the first source to be dispositioned. Experience has shown such margin and planning to be useful in facilitating research, and this approach is frequently used with other research activities at the University when allotting possession limits.

***Table 1. Requested Possession Limit Allowances and Expected Source Usage Associated with this Amendment Request.*** *The table below summarizes the activities and masses of various sources being requested as part of this amendment request.*

| **Nuclide** | [redacted] |
|---|---|
| Pu-238 | |
| Pu-240 | |
| Pu-242 | |
| **Total** | |

A relevant observation is that, as indicated on the current SNM-95 license, Penn State University is currently approved to possess each of the nuclides requested in this document (plutonium-238, plutonium-240, and plutonium-242, each listed under line item E, which is requested to be removed as part of Change 1). [redacted] the nuclides are the same.

## B. Facility Description

The research described in this amendment request would take place [redacted] at the Radiation Science & Engineering Center (RSEC) on Penn State's University Park campus. The RSEC is a currently approved location listed on the existing SNM-95 license (Amendment 3). The RSEC facilities include a variety of nuclear and radiochemistry laboratory and research areas, including the Breazeale Nuclear Reactor. A dedicated and secured laboratory for this work [redacted] is currently being established within the RSEC. The RSEC is a secured facility itself, operating under a class 104(c) license of 10 CFR Part 50.

## C. Handling Procedures

The sources associated with this request will be [redacted] capable of producing a significant localized external dose rate. These sources will also be SNM and shall be treated as such.

Specifically, this means that the sources will only be handled in the designated lab in the RSEC, and only by individuals who are trained as radiation workers and authorized to work under the Principal Investigator's authorization. All source operations are required to be conducted in accordance with written procedures and an authorization that will be approved by the University's radiation safety committee (University Isotope Committee).

When not in use, sources must be secured within the lab in a shielded location. Sources will always be either under the direct supervision of a trained worker in the laboratory, or will be secured with a tamper-indicating seal. If being stored in a safe or cabinet within the lab, the safe or cabinet may be affixed with the tamper-indicating seal. This, coupled with other security measures (see Section III.C of this attachment) provides for an assurance of security for the sources.

Based on the potential for significant extremity doses for individuals working with the sources, long-handled tools (tongs, tweezers, etc.) will be required when manipulating, handling, or moving sources. Sources are not to be handled directly by hand (even if gloved). The general

measurement procedure will involve only performing measurements with one source at a time. If multiple sources are required for a specific spectroscopy measurement, then additional safety precautions will be employed. These additional precautions will include posting the room as a radiation area prior to source handling; performing radiation surveys before, during, and after source handling; and employing additional precautions (pre-planning or pre-job briefs). These requirements will be codified in the user's authorization and in the work procedure.

## II. Safety Considerations

### A. Fire Safety & Fire Protection

No changes to the existing RSEC facility fire safety design or procedures are proposed with this amendment request. The existing fire safety features and procedures in place at the RSEC are judged sufficient to afford an adequate degree of protection and safety for the individuals involved in the research described in this amendment request.

### B. Exposure Review and Evaluation

One of the hazards identified associated with this work was the external hazard associated with handling [redacted] For each source in question, the dose rate at ½ inch (using point-source relationships – see Figure 1) was calculated [redacted] Even though the on-contact dose rate was rather high, the dose rate at 30 centimeters was below 5 mrem/hr and around 2 mrem/hr [redacted]

For these reasons, shielding the sources will be an important part of the work controls for this research. In addition, ensuring that individuals do not handle the sources will be another critical aspect of the safety precautions when working with these sources. Both measures are described in this document.

## Approximated Point Source Dose Rates as a Function of Distance

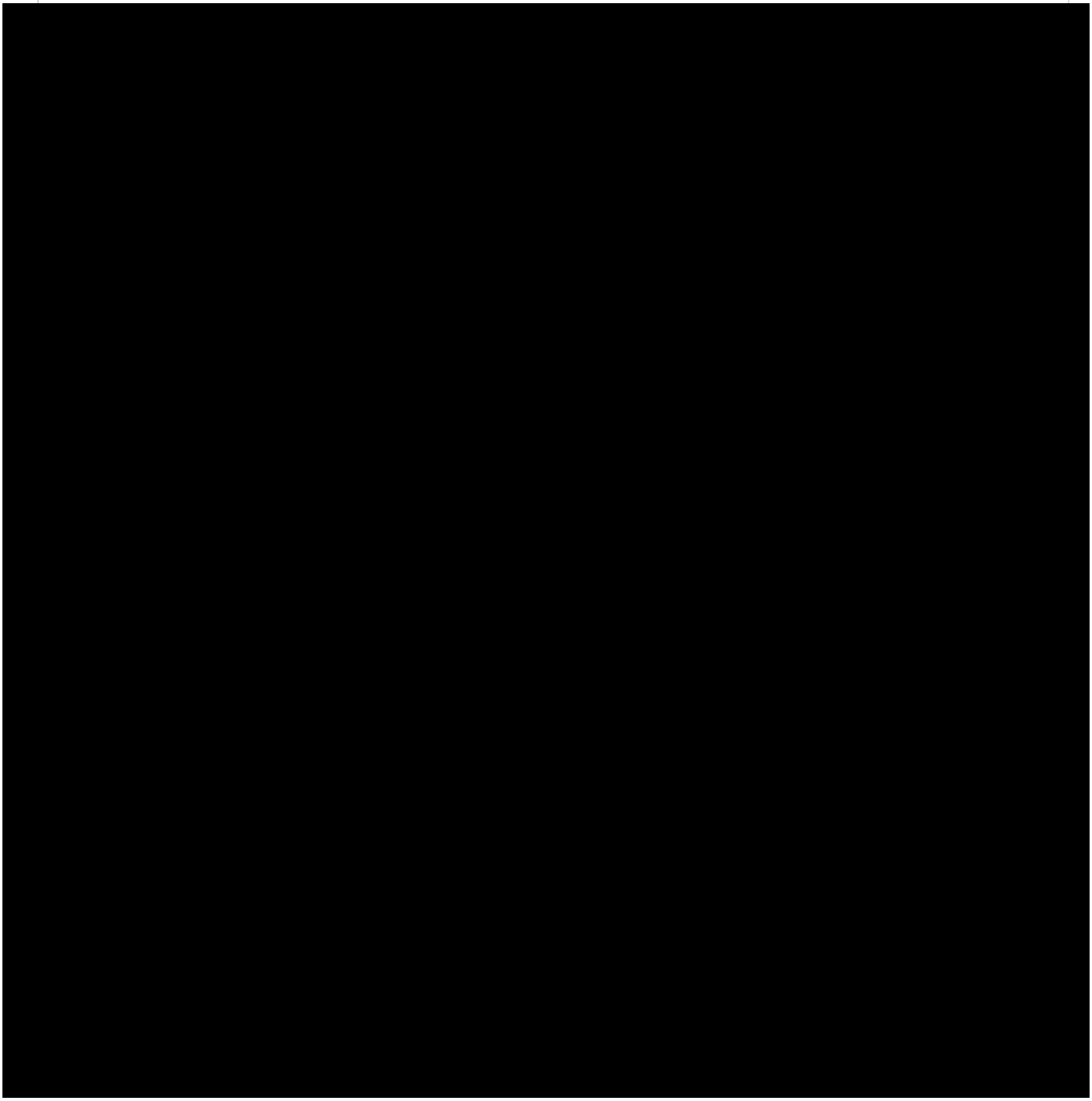

***Figure 1. Approximate Dose Rates from Point Sources of Various Actinide Sources as a Function of Distance.*** The plots above were constructed using gamma constant data taken from Peplow, Douglas E.. Specific Gamma-Ray Dose Constants with Current Emission Data. Health Physics 118(4):p 402-416, April 2020. | DOI: 10.1097/HP.0000000000001136 and expanded using an $r^2$ relationship with no allowance for attenuation. This is expected to give rise to generally conservative data.

Internal dose hazards were considered but found to be negligible [redacted]

Based on the potential external exposure hazards from these sources for workers in the lab, all individuals working in the Mossbauer spectroscopy laboratory will be required to wear extremity and whole body dosimetry when in the laboratory. The assigned dosimetry will be handled within the existing dosimetry program at Penn State University, which includes approximately 175 badged individuals at the current time. Results will be processed quarterly and reviewed by EHS radiation safety staff.

### C. Ventilation and Airborne Radioactivity Evaluation

The Mossbauer laboratory space is afforded adequate ventilation. Airborne radioactivity is not expected [redacted]

### D. Public Dose

Apart from the exposure considerations for radiation workers (discussed in the previous sections), possible dose considerations for members of the public were also evaluated. Generally, controls to prohibit members of the public from handling the sources and accessing the lab during source movement are expected to sufficiently control doses to within 2 mrem in any given hour and 100 mrem in a year, in accordance with 10 CFR 20.1301 limits. Therefore, members of the public will be prohibited from being present in the lab when any source transfer or handling operations are conducted. When not in use, sources will be required to be stored in a secured, shielded arrangement, which will be sufficient to control doses to individuals outside of the laboratory.

To help demonstrate compliance with public dose limits, area monitors (dosimeters) will be installed in the public areas adjacent to the Mossbauer laboratory.

### E. Criticality Safety

The masses of plutonium requested with this amendment [redacted] are much less than a critical mass. As a whole, Penn State University currently [redacted] material under the SNM-95 license. Thus, this request does not alter the criticality status of materials licensed under SNM-95 (even including proposed additions, which would total less than 450 gr), and thus the materials do not meet the definition of a critical mass. Therefore, no criticality safety program or controls are necessary.

## III. Process Controls and Checks

[redacted]

[redacted]

## B. Radiation & Contamination Monitoring

The RSEC has an ample supply of radiation detection equipment with adequate capabilities and recent calibrations. This includes both instruments designed to detect radiation, such as ion chambers, as well as instruments designed to detect contamination, including Geiger Mueller survey meters. When surveys for alpha-emitting nuclides are required, EHS radiation safety staff have available to them a plastic scintillator which is maintained in a calibrated state. For the Mossbauer spectroscopy laboratory, a dedicated, calibrated radiation monitor will be required to be present in the laboratory at all times.

Radiation monitoring, involving a calibrated ion chamber, is performed on a monthly basis by EHS radiation safety staff in areas where SNM is used or stored. Results are documented in survey reports and retained.

Weekly checks for contamination in general areas of the RSEC (including the hallway outside of the Mossbauer spectroscopy laboratory) are also performed, documented, and retained.

Contamination monitoring of incoming radioactive material packages is also performed upon receipt in order to comply with NRC and DOT requirements. EHS radiation safety staff who receive and check-in packages wear extremity and whole body dosimetry during the receipt and check-in process.

## C. Security

Radioactive materials will only be stored in the secured areas, in this case, [redacted] a Controlled Access Area (CAA).

Establishing and maintaining security of radioactive materials will be critical for the spaces and materials discussed in this submittal. [redacted]

Penn State maintains an onsite response force as part of the University Police and Public Safety (UPPS). UPPS includes a full-service police agency with sworn police officers who have full law enforcement authority. The EHS – RPO has a continuously growing relationship with UPPS, and the RSO provides annual training – along with personnel from the RSEC – to police officers regarding radiation safety and police response to CAAs and other secure radiological spaces.

[redacted]

Penn State University agrees to retain copies of response procedures as a record for three years after the close of the period for which SNM is possessed.

### D. Strategic Significance

The facility that will host the Mossbauer work is the RSEC at Penn State's University Park. The facility is currently listed on the University's SNM-95 license [redacted] This proposed amendment does not represent a change in the strategic significance of the facility.

## IV. Personnel Considerations

### A. Qualifications of Supervising Principal Investigators

The responsible PI for this research work will be Dr. Jon Schwantes, and the activities will be carried out at the RSEC facilities under Director Dr. Kenan Unlu. A description of Dr. Schwantes' experience is included below, and a brief description of Dr. Unlu's experience can be found within ML11294A215 on the US NRC's ADAMs repository.

Dr. Jon Schwantes is a Professor and the Acting Department head for the Ken and Mary Alice Lindquist Department of Nuclear Engineering at Penn State University working in areas related to aqueous environmental radiochemistry, super-heavy element chemistry and physics, astrophysical nucleosynthesis, science-based stockpile stewardship, nuclear material science, and nuclear forensics. Before joining the Penn State faculty in 2022, Dr. Schwantes worked as a Senior Research scientist for the Department of Energy's Pacific Northwest National Laboratory and served as a member of the Washington State Academy of Science. He has authored or co-authored 122 publications (79 peer-reviewed), was part of the confirmatory team for the discovery of element 111 (subsequently named Roentgenium), and lead a team of researchers in 2009 that identified the oldest known reactor-produced plutonium in the world. In addition to his research endeavors, Dr. Schwantes served on two DOE response teams to the 2011 Fukushima Daiichi disaster, and was appointed by the Secretary of Energy to the technical Assessment Team that investigated the cause of the 2014 radioactive contamination event at the Waste Isolation Pilot Plant, and led the forensic examination in 2019 of a breached 3,000 Ci radioactive sealed source at the Harborview Medical Facility in downtown Seattle.

Dr. Schwantes' area of expertise is nuclear and radiochemistry, with a strong focus on the development, exploitation and evaluation of radioanalytical techniques supporting nuclear science and engineering. Currently Dr. Schwantes' research group is funded by NA-22 as part of the Consortium for Nuclear Forensics to develop the first Actinide Mossbauer Spectral Imager. In addition, Dr. Schwantes is setting up a Time Of Flight Inductively Coupled Plasma Mass Spectrometer with a Laser Ablation capability for detailed analysis of nuclear structural materials and environmental samples containing radionuclides. A third area of research by Dr. Schwantes' group includes basic actinide research that often couples laboratory basic experiments and model simulations of chemical interactions.

Dr. Schwantes has over 30 years of experience managing and safely handling a variety of radionuclides representing a range of radiological hazards, (alpha, beta, gamma, and neutron

emitters, including fissionable materials), half-lives (from $10^{-3}$s to $10^{10}$ yrs), and activities ($10^{-23}$ to $10^{3}$ Ci). His experiences have included handling and manipulating radionuclides in solid, liquid and gas form, both in the field and within ultra-trace radiological to Category III Nuclear Facilities. He has worked with dispersible and hard-to-detect radionuclides on the benchtop and within engineered Contamination Areas including radiological hoods, nuclear grade shielded and actinide gloveboxes, radiological "greenhouses" and remote handling hot cell facilities.

### B. Training of Personnel

Penn State University trains employees, students, and visitors who need to use radioactive material at Penn State University Campus. All users of radioactive material for whom training is required must complete Penn State's initial radioactive material safety training program that covers the basics of radiation safety before work with licensed radioactive material begins. This training includes hands-on, in-person instruction in monitoring for contamination and other basic radiation protection principles. Anyone working with special nuclear materials at the University is required to complete this training before beginning work.

## V. Waste Management Considerations

No significant change to the waste management process or approach is included with this amendment request. [redacted] If waste is generated (e.g., from an unsatisfactory, leaking, or failed source), EHS radiation safety staff will be available to manage and handle this waste in accordance with established procedures. Such waste would then be transported back to the secured, centralized waste facility in the Academic Projects Building for storage, any necessary processing, and preparation for disposal.

## VI. Shipping & Transport Considerations

No significant change to the general radioactive material transportation process or approach is requested with this amendment request.

While the Mossbauer spectroscopy project is not expected to involve or require the University to ship radioactivity or radioactive material to another entity, should such activities need to take place, all transport would take place within Penn State's radioactive material shipping program. This program includes individuals qualified in accordance with 49 CFR 172.704, and ensures shipment and transport of materials are in accordance with requirements in 10 CFR and 49 CFR. Separately, EHS requests and reviews copies of the radioactive material license(s) for any facilities receiving radioactive materials from the University prior to shipment.

A discussion of the response to potential incidents during shipping is included in the following section.

For entities shipping radioactive materials to Penn State University, Penn State requires notification prior to shipment. Those shipping radioactive materials to Penn State are provided the appropriate address for shipment along with the contact information of the Radiation Safety Officer. Before agreeing to accept a shipment, EHS radiation safety staff review the shipment details to ensure the University is capable of safely handling the materials and that the materials fall within existing license possession limits.

If the University receives one gram or more of SNM [redacted] then staff will notify the shipper of receipt of the material and complete and submit a computer-readable format Nuclear Material Transaction Report and Material Balance report in accordance with 10 CFR 74.15, 10 CFR 73.67(g)(2)(ii), and 10 CFR 74.15(a).

Contamination monitoring of incoming radioactive material packages is also performed upon receipt in order to comply with NRC and DOT requirements. For packages containing SNM, EHS staff will check and evaluate the package for container integrity and the integrity of any applied seals upon receipt.

A discussion of response to incidents and potential events during transportation of SNM is included in the following section.

## VII. Responses to Incidents, Accidents, and Emergency Situations

All individuals trained to work with radioactive materials at the University receive training in spill or incident responses involving radioactive materials (as part of the training mentioned in Section IV). In addition to initial incident response, responders are encouraged to contact EHS for assistance with any non-trivial spill or incident. EHS staff are equipped to respond to spills and incidents, and have access to additional PPE and equipment necessary to assist with spill and incident response.

[redacted]

## VIII. Decommissioning Funding Plan Considerations

[redacted] Penn State University has concluded that the current self-guarantee agreement has allocated adequate funds for the disposal of any additional radioactive materials associated with this proposed change. This is due mainly to the 25% contingency included in the approved Decommissioning Funding Plan which is considered to be more than adequate for this request, based on the information presented in Table 2 (on the following page).

[redacted]

Pursuant to 10 CFR 30.35(g), and 10 CFR 40.36 (f), Penn State University maintains records of information important to the decommissioning of facilities and will transfer these records when licensed activities are terminated.

[redacted]

## IX. Conclusions

PSU has evaluated the proposed change and with restrictions on access, handling, and operations, and has determined that the proposed changes to the license fit within the processes and procedures already in place at RSEC and the University. The PI is very experienced and knowledgeable in handling nuclear materials. Therefore the radiological risks associated with these materials for radiation workers are found to be commensurate with those of other sources currently on campus and are able to be adequately controlled within the scope of the Penn State radiation protection programs. Additionally, the evaluation found that there is no expected increase in the radiological risk to members of the public due to the additional materials.

# Attachment D. Depiction of Requested Modifications to the SNM-95 License

Note that the depiction below is intended for illustration only. Proposed, conceptual changes are highlighted and underlined. Information not shown or shown without highlighting is not intended to change from Amendment 3 of SNM-95. Penn State University recognizes that the changes depicted below, or a version thereof, are not effective unless approved by the US NRC and communicated in writing to the University.

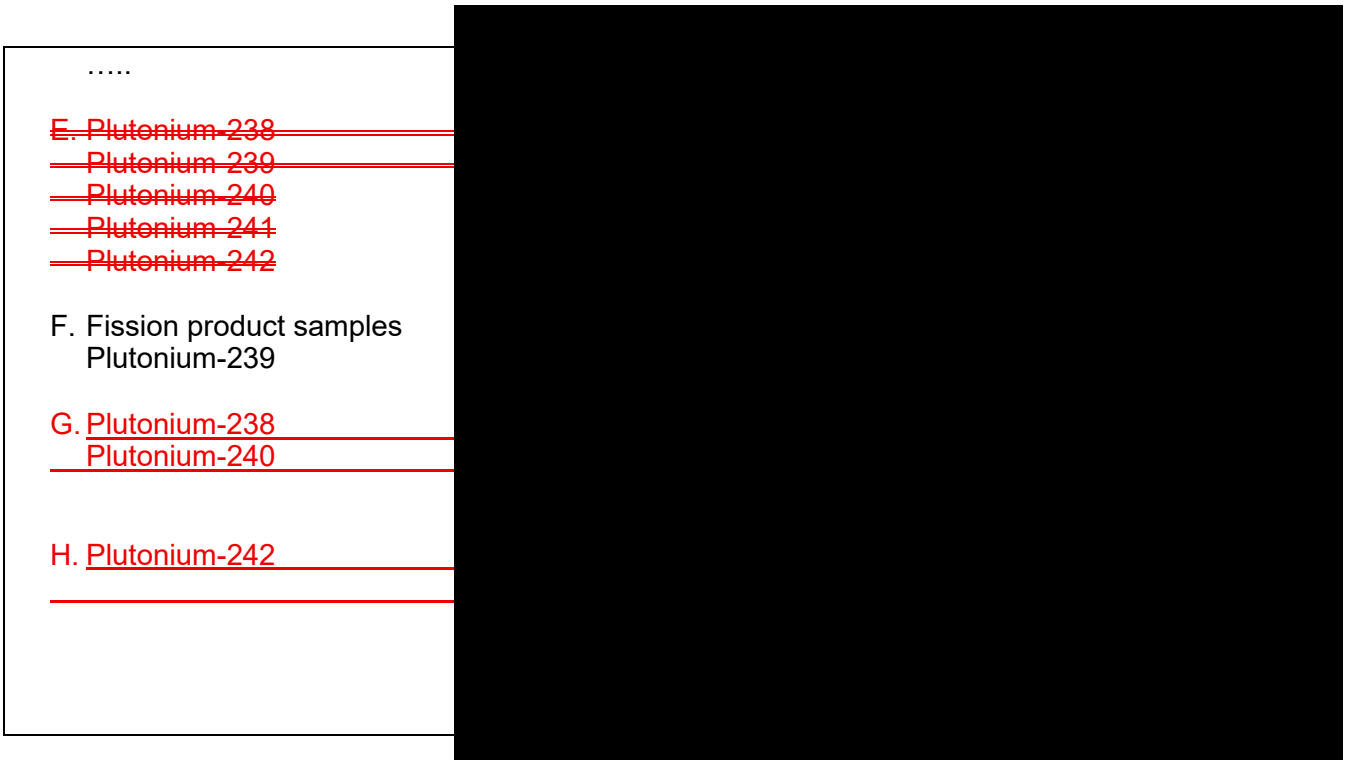


***Figure 9. Depiction of This License Amendment Request in the form of a Proposed Markup to an excerpt of SNM-95, Amendment 3.*** *This markup depicts both Change 1 (removal of line item E) and Change 2 (addition of proposed line item G).*