PURDUE
UNIVERSITY

Environmental Health and Safety

September 18, 2023

Nuclear Regulatory Commission
Fuel Facility Licensing Branch
Mail Stop E-2-C40M
11555 Rockville Pike
Rockville, MD 20852

70-152

To Whom it May Concern:

Enclosed is the license renewal for SNM-142 which expires on September 25, 2023. **This submission is a revised submission of the SNM-142 Renewal Package sent July 21st 2023**. Including in the renewal submission are the renewal application form, application submission document, and supporting materials listed in the appendices. This submission contains information that has been designated as "Security Related for Office Use Only", "Safeguard Information - Not for Public Distribution", or "Personal Identifiable Information." The reason as to this security and/or safeguard designation is due to the desire to withhold public distribution of amounts and locations of various special nuclear material inventory items, and to not disclose specific security and safeguard features of the facilities. Within the submission there will be a redacted and unredacted copy. We request that only the redacted copy be the version used for public distribution. The attached appendices are labeled as to whether they are designated as safeguard/security information. The appendices designated as follows:

Appendix A.1 - Emergency Plan for the Purdue University Reactor PUR-1. **(Security Related - For Office Use Only)**
Appendix A.2 - Security Plan for the Purdue University Reactor, the Fast Breeder Blanket Facility, and Nuclear Fuel Storage Areas. **(Safeguard Information - Not for Public Distribution)**
Appendix A.3 – Technical Specifications for the Purdue University Reactor, PUR-1 **(No Designation)**
Appendix A.4 - The PUR-1 Operating Principles and Core Characteristics Manual. **(Security Related – For Office Use Only)**
Appendix A.5 - Safety Analysis Report for the Purdue University PUR-1 Reactor. **(Security Related – For Office Use Only)**
Appendix A.6 - Calibration of Equipment and Measurement of Ar-41 Effluent. **(Security Relation – For Office Use Only)**
Appendix A. 7 - Fuel Inventory Example **(Safeguard Information – Not for Public Distribution)**

A035
NMSS01
NMSS

550 Stadium Mall Drive ■ West Lafayette, IN 47907-2051 ■ (765) 494-6371

Appendix A.8 - Purdue University Research Reactor (PUR-1) ALARA Program – **(No designation)**
Appendix A.9 – Resumes of Radiation Safety Staff **(Personal Identifiable Information)**

If you should have any questions regarding this information, please contact my office at 765- 494-2721, my mobile phone at 207-608-3655, or by email at young127@purdue.edu. Thanks for your attention to this matter.

Sincerely,

Joshua A. Young, MS
Radiation Safety Officer
Young127@purdue.edu

NRC FORM 313 (05-01-2023) 10 CFR 30, 32, 33, 34, 35, 36, 37, 39, and 40

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIALS LICENSE

APPROVED BY OMB: NO. 3150-0120 EXPIRES: 05/31/2023

Estimated burden per response to comply with this mandatory collection request: 4.3 hours. Submittal of the application is necessary to determine that the applicant is qualified and that adequate procedures exist to protect the public health and safety. Send comments regarding burden estimate to the FOIA, Library, and Information Collections Branch (T-6 A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by email to Infocollects.Resource@nrc.gov, and the OMB Reviewer at: OMB Office of Information and Regulatory Affairs, (3150-0120), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street NW, Washington, DC 20503; email: oira_submission@omb.eop.gov. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

INSTRUCTIONS: SEE THE CURRENT VOLUMES OF THE NUREG-1556 TECHNICAL REPORT SERIES ("CONSOLIDATED GUIDANCE ABOUT MATERIALS LICENSES") FOR DETAILED INSTRUCTIONS FOR COMPLETING THIS FORM: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1556/. SEND TWO COPIES OF THE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

MATERIALS SAFETY AND TRIBAL LIAISON BRANCH
DIVISION OF MATERIALS SAFETY, SECURITY, STATE AND TRIBAL PROGRAMS
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

ALABAMA, CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, FLORIDA, GEORGIA, KENTUCKY, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, NORTH CAROLINA, PENNSYLVANIA, PUERTO RICO, RHODE ISLAND, SOUTH CAROLINA, TENNESSEE, VERMONT, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA,

SEND APPLICATIONS TO:

LICENSING ASSISTANCE TEAM
DIVISION OF RADIOLOGICAL SAFETY AND SECURITY
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD, SUITE 102
KING OF PRUSSIA, PA 19406-1415
R1DRSSMail.Resource@nrc.gov
*Note: The preferred method to submit NRC Form 313 is email. Any other document (e.g., financial assurance documents) should be sent via mail.

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352
R3-DRSSMail.Resource@nrc.gov
*Note: The preferred method to submit NRC Form 313 is email. Any other documents (e.g., financial assurance documents) should be sent via mail.

IF YOU ARE LOCATED IN:

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MISSISSIPPI, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING,

SEND APPLICATIONS TO:

MATERIALS LICENSING BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
1600 E. LAMAR BOULEVARD
ARLINGTON, TX 76011-4511
r4licensingactionsubmittals@nrc.gov
*Note: The preferred method to submit NRC Form 313 is email. Any other document (e.g., financial assurance documents) should be sent via mail.

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [ ] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER
- [x] C. RENEWAL OF LICENSE NUMBER SNM-142

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include zip code)*

Purdue University
550 Stadium Mall Drive
West Lafayette, IN 47907

3. ADDRESS WHERE LICENSED MATERIALS WILL BE USED OR POSSESSED

Purdue University
550 Stadium Mall Drive
West Lafayette, IN 47907

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Joshua A. Young, Radiation Safety Officer

BUSINESS TELEPHONE NUMBER	BUSINESS CELLULAR TELEPHONE NUMBER
765-494-2721	207-608-3655

BUSINESS E-MAIL ADDRESS
young127@purdue.edu

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
   a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.
6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.
8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9. FACILITIES AND EQUIPMENT.
10. RADIATION SAFETY PROGRAM.
11. WASTE MANAGEMENT.

12. LICENSE FEES (Fees required only for new applications, with few exceptions*) *(See 10 CFR 170 and Section 170.31)*
*Amendments/Renewals that increase the scope of the existing license to a new or higher fee category will require a fee.

FEE CATEGORY: NA AMOUNT ENCLOSED $:

PER THE DEBT COLLECTION IMPROVEMENT ACT OF 1996 (PUBLIC LAW 104-134), YOU ARE REQUIRED TO PROVIDE YOUR TAXPAYER IDENTIFICATION NUMBER. PROVIDE THIS INFORMATION BY COMPLETING NRC FORM 531: https://www.nrc.gov/reading-rm/doc-collections/forms/nrc531info.html.

13. CERTIFICATION. *(Must be completed by applicant) THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.*

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 37, 39, AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.
WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER -- TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
CHRISTOPHER RUHL, CFO : TREASURER		5-23-23

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

APPLICATION FOR RENEWAL

OF

SPECIAL NUCLEAR MATERIAL LICENSE

#SNM-152

(As amended 11-15-2021)

Submitted to

U.S Nuclear Regulatory Commission

Fuel Facility Licensing Branch

Division of Fuel Management

Office of Nuclear Material Safety and Safeguards

By

Purdue University

Environmental Health and Safety

550 Stadium Mall Drive

West Lafayette, IN 47907

July 11, 2023

1 10 CFR 70.22(a)(1)

Eric Butt, Senior Director
Environmental Health and Safety, Purdue University
U.S Citizen

Joshua A. Young, MS, Radiation Safety Officer
Environmental Health and Safety, Purdue University
U.S Citizen

Nathan Claus, Health Physicist
Environmental Health and Safety, Purdue University
U.S Citizen

Seungjin Kim, Ph.D., Department Head of Nuclear Engineering/ Reactor Facility Director
Department Of Nuclear Engineering
U.S Citizen

True Miller, Reactor Supervisor
Department of Nuclear Engineering
U.S Citizen

Brian Jowers, Nuclear Electronics Technician
Department of Nuclear Engineering
U.S. Citizen

2 10 CFR 70.22(a)(2) Activity and Location for which Special Nuclear Material is Requested:

The Department of Nuclear Engineering at Purdue University uses special nuclear material for various research operations outlined in these sections of the renewal application. The use of special nuclear materials is associated with the PUR-1 research reactor at Purdue University under the granted Nuclear Regulatory Commission License (R-87) and the Purdue University License of Broad Scope (License No.: 13-02812-04).

The proposed use of U-235 enriched solid helices and discs is to measure the effects of rare earth additions on the thermal properties of UO2 and to measure the effects of elevated temperatures on the mechanical properties of UO2. Typical experimental procedures involve heating solid discs or helices of various U-235 enrichment (3-20%) to a maximum temperature of 500 degrees Celsius for differential thermal analysis and 1600 degrees Celsius for thermal diffraction measurements. Helices are typically

heated in a vacuum furnace for measurement of mechanical properties. The above procedures are not actively used at this time and it is expected that these will not be implemented in the near future. Other various samples of both enriched and natural uranium may be obtained for non-destructive testing, chemical and thermal analysis, and other analytical and developmental techniques.

The encapsulated PuBe neutron sources are employed in activation analysis studies, for instrument calibration, for neutron studies in a subcritical exponential pile, and for other research approved by the Radiation Safety Committee. (Note: The natural uranium subcritical pile is separately licensed under the Source Material License SUD-296).

Uranium-235 in the form of SPERT fuel rods enriched not to exceed 4.8 weight percent, fuel rods enriched not to exceed 1.3 weight percent, natural UO_2 pellets clad in aluminum, and californium in doubly encapsulated sources were possessed to be used in the operation of a subcritical [redacted] These operations have been suspended and this material will be stored in place until further notice. The [redacted] is a small subcritical facility in which blankets of fast reactors were simulated in a realistic geometrical configuration. [redacted] consists of a central region composed of 4.8% enriched fuel rods to provide the surrounding blanket mockup with a neutron spectrum typical of that found in the core blanket interface of a large LMFBR. Natural uranium fuel rods were used in the blanket mockup. The 1.3% enriched fuel rods were not used in [redacted] loading and remain stored [redacted] as will be described later. [redacted] is subcritical with K_{eff} of less than 0.43. [redacted] driven by Cf spontaneous fission neutron sources distributed along its centerline. Up to a maximum of 0.002g of Cf-252 possession is requested in order that the original sources may remain in place until the facility is decommissioned.

Procedures used in teaching, research, and decommissioning activities of the [redacted] will be reviewed for safety by the Radiation Safety Committee and the Radiation Safety Officer and/or his staff. All decommissioning activities with licensed material will be conducted in accordance with written procedures and will not commence until approval of decommissioning activities is granted by the Nuclear Regulatory Commission. Any active procedures will be approved by the Radiation Safety Committee and will be updated at least every two years. At this time, the only active procedures involve the use of PuBe sources for teaching purposes related to the subcritical pile licensed under Source Material License SUD-296. The Radiation Safety Committee is responsible for:

1. Reviewing plans, specifications, and procedures for activities of the [redacted] and taking appropriate action.

2. Reviewing any significant proposed changes in design, activities, or decommissioning of [redacted] Committee approval or Radiation Safety Officer approval is required in advance of initiating such changes.

3. Approving activities associated with [redacted]

4. Authorizing personnel to work in the facility.

5. Overseeing all radiation safety aspects of [redacted] including routine surveys, leak tests, personnel monitoring, instrument calibration, emergency procedures, and inventory.

U-233, Np-237, Pu-239, and Cm-244 (Sections e-h of Item 5) will be used as calibration sources and fission foils.

3 10 CFR 70.22(a)(3) Requested duration of license is for 10 years.

4 10 CFR 70.22(a)(4) Description of Special Nuclear Material:

Radioactive Material to be Possessed (from SNM-142 license Amendment 4):

Byproduct Source, and/or Special Nuclear Material	**Chemical and/or Physical Form**	**Maximum Amount that Licensee May Possess at Any One Time Under this License**
Uranium Enriched in U-235 Isotope	SPERT fuel rods, enriched ≤ 4.8 w/o	60,000 grams U-235
Uranium Enriched in U-235 Isotope	Fuel rods, enriched ≤ 1.3 w/o	150 grams
Uranium Enriched in U-235 Isotope	Solid helices, enriched ≤ 20 w/o	200 grams
Uranium Enriched in U-235 Isotope	Solid discs, enriched ≤ 3 w/o	10 grams
Uranium Enriched in U-235 Isotope	Samples, enriched ≤ 20 w/o	10 grams
Plutonium	Encapsulated PuBe neutron sources	80 grams
Natural Uranium	UO2 pellets clad in aluminum	23,000 grams U
Natural Uranium	Samples, any form	10,000 grams U
Californium	10 doubly encapsulated sources	0.002 grams
Uranium 233	Calibration Sources	0.1 uCi
Neptunium 237	Calibration Sources	100 uCi
Plutonium 239	Calibration Sources	100 uCi
Curium 244	Calibration Sources	100 uCi
Uranium, enriched in the Isotope U-235	Solid, Oxide or nitrate enriched ≤ 5 w/o in contaminated equipment	1 gram

Details on the special nuclear material beyond what is described in Section 2 of this submission can be found in the attached appendices under *Appendix A.7 Fuel* Inventory (a sample of a semiannual

inventory completed by the Reactor Team), and the *Appendix A.4 PUR-1 Operating Principles and Core Characteristics Manual*.

5 10 CFR 70.22(a)(6) Technical Qualifications of Applicant

Radiation Safety Officer (RSO)

The current RSO is Joshua Allan Young, M.S. Mr. Young received his M.S. degree in Health Physics (2017) Purdue University. He was employed at Purdue University as a Health Physicist, Columbia University Medical Center as a Senior Health Physicist, and consulting group Petrone Associates in New York City as a Medical Health Physics Consultant. His experience includes working with hundreds of millicurie amounts of open-source radioisotopes at a time in human use nuclear medicine operations, managing regulatory compliance in university and medical center use of radioisotopes in various departments, and working with kilo-curie amount of sealed source irradiators and ensuring compliance with all applicable regulations.

The primary duties of the RSO include but are not limited to the following:

Administration of the Radiation Safety Staff (RSS) with the overall responsibility of managing the radiation safety program.

Ensuring compliance of the radiation safety program with state and federal regulations and NRC license conditions.

Providing training and recommendations to individuals that use radioactive materials.

Act as the agent of the Radiation Safety Committee to ensure that use of radioactive material is consistent with recommendations and requirements of the committee.

Serve as representative of the University to regulatory agencies to act in licensing matters and providing corrective action when deficiencies are identified.

Review and approve minor deviations in work procedures (equivalent to "Radiation Work Permits").

Radiation Safety Staff (RSS)

Radiation Safety Officer (RSO). The qualifications and duties of the RSO are described above. The RSO should meet the requirements as described in the regulatory guide "Qualifications for the Radiation Safety Officer in a Large Scale , Non-Fuel Cycle Radionuclide Program."

Health Physicist (1). The Health Physicist are required to have a B.S degree in Health Physics or a related area such as Nuclear Engineering. If the degree is in a related area, experience in a medical or university health physics program is highly desirable.

Environmental Technicians (3). The Environmental Technicians are required to have a high school diploma but no other relevant experience. These individuals work under the supervision of the RSO and/or the Health Physicist.

Student Assistants. Work-Study students (for paid wages or course credits) and undergraduate/graduate interns are hired to perform basic health physics tasks or other related tasks under the supervision of various members of the RSS. No previous experience is required.

Resumes for various members of the Radiation Safety Staff and the Department of Nuclear Engineering related to the use of Special Nuclear Material and PUR-1 Reactor Operations are attached in Appendix A.9 Resumes for Reactor Team and Radiation Safety Staff.

6 10 CFR 70.22(a)(7) Facilities and Equipment for Handling Special Nuclear Material

6.1 Areas of Storage and Use

The main areas where SNM will be used and/or stored are in [redacted] on the Purdue University campus. The buildings are [redacted]. Their location is marked on the map of the Purdue University campus found in page 7 and page 8 of Appendix A.2 [redacted] In addition, other locations may be used from time to time when approved by the Radiation Safety Committee.

[redacted]

[redacted]

SNM are stored in this room of [redacted], which is a part of [redacted]. The storage room is approximately 5.6 m. by 9.35 m by 7.0 m high. The floor level is about 2.74 m below the outside ground level. The building is constructed of steel frame with concrete and brick and no window openings.

Enriched UO_2 fuel (1.3%) is stored [redacted] The 1.34 m long fuel rods (active fuel length 1.22 m) are stored in six steel cabinets arranged in two adjacent arrays of three cabinets each. The cabinets are designed to hold the rods vertically in a slab geometry and are fastened to the wall. The limit for controlling the k_{eff} for each array is the slab thickness. Using Figure 3 from ANSI/ANS-8.1-2007, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors", the maximum safe slab thickness for 1.3% uranium oxide is approximately 28 cm. The actual thickness of the storage geometries in these cabinets is 14 cm.

[redacted] also contains a natural uranium metal graphite subcritical assembly with a k_{eff} of 0.642. Any extra fuel from the graphite assembly is stored in a cabinet on the wall behind the subcritical facility and at least 4.5 m from the nearest cabinet containing the 1.3% fuel.

[redacted]

This storage room is approximately 2.75 m by 2.45 m and 2.7 m in height . Enriched UO_2 fuel (4.8%) with an active fuel length of 91cm is stored in metal racks designed to store the rods vertically in a slab geometry. The racks are fastened to the opposite walls of the fuel storage room and are separated by a distance of 1.98 m. The total inventory in [redacted] contains 87 19.72% enriched Uranium plates, and 4.8% Again, using Figure 3 from ANSI/ANS-8.1-2007, the maximum safe slab thickness for 4.8% uranium oxide is approximately 10 cm. The actual thickness of these arrays is less than 9 cm.

[redacted]

Building Construction Information

[redacted] The floor area of the basement, first and second floors is approximately 7,400 ft^2; the area of the ground floor mezzanine is approximately 2,600 ft^2. The construction drawings for [redacted] show the beams supporting the first floor were to be fireproofed. A shaft extends from the mezzanine through to the attic; ductwork is not protected with fire dampers, and a pair of doors opening from the mezzanine to [redacted] are not rated.

[redacted] is served at 12.47 kV by a three phase, 500 kVA, 139/240 V transformer and a single phase, 333 kVA, 120/240 V transformer located in a vault outside [redacted] there is no access from the vault to [redacted] The transformers were installed in 2007. Distribution switchgear is located [redacted] on the ground floor; this equipment was installed in the [redacted] The facility does not have an emergency generator, and emergency egress lighting is provided by wall mounted, battery back-up emergency lights.

Occupants on the first and second floor of [redacted] access to two (2) stair enclosures on the northeast and southeast ends of the structure. Note that the northern stair enclosure (which also serves the basement) opens into a corridor on the ground floor (mezzanine) leading to an exit on the east side of the building. Openings from the mechanical and electrical spaces on the mezzanine into the corridor do not have a fire resistance rating.

Occupants in the basement have access to the northern stair enclosure and can reach a stair leading into the [redacted] by moving through [redacted] The southern stair enclosure can be accessed through [redacted] however, access to [redacted] is restricted. There is a second route from [redacted] and then through a storage tunnel and a machine shop to a stair enclosure and corridor before finally exiting on the south side [redacted]

HVAC equipment for [redacted] is in a mechanical room on the ground floor mezzanine. The mechanical plans from [redacted] do not show fire dampers in any of the ductwork serving the [redacted]. There is not a dedicated lightning protection system for the [redacted]

Fire Protection Features

[redacted] is protected by an automatic sprinkler system designed in accordance with NFPA 13. [redacted] system was installed in 1995 with modifications made to the system in 1999. The space is not fully sprinkled; sprinklers were not installed in [redacted] because of concerns about criticality potential. The design density for the basement floor is 0.15 gpm / 1500 ft^2 and includes a 100 gpm standpipe allowance. There are no standpipes in [redacted]

The existing fire alarm system in the [redacted] was installed in 1987. Fire alarm initiating devices [redacted] are manual pull stations and waterflow switches; occupant notification is by audible and visual devices installed in accordance with NFPA 72. None of the walls in [redacted] appear to have been explicitly designed to provide a fire-resistance rating.

Fire Protection Equipment Inspection, Testing, and Maintenance

The building sprinkler system is tested semi-annually; tests include activation of flow switches at each floor zone as well as the building main flow switch. The dry pipe system is also tested on a semi-annual schedule. Fire alarm supervisory, initiating and notification devices are tested annually.

Combustible Loading

The contents of [redacted] are limited to the radioactive material stored in the space; this space does not have sprinkler protection. [redacted] is a sprinklered laboratory with two fume hoods and several lab benches. During our visit to the facility, approximately 10 liters of flammable liquid was in use in the laboratory. Mitigative controls in the space are the sprinkler system in [redacted] and the passive fire protection afforded by the non-combustible construction of the laboratory itself. Training staff and students to work safely with the materials present in the lab space also provides a degree of protection from the risk of fire. [redacted] do not have systems to limit the spread smoke or other products of combustion from a fire occurring in the space.

Housed Radioactive Material

The radioactive material for the license in question is stored in [redacted] The walls are constructed from 6" concrete blocks; the door to [redacted] is hollow metal and has an air transfer grill.

Hazardous Materials and Processes

No hazardous processes or hazardous chemicals in excess of the maximum allowable quantity per control area which may contribute to the fire hazards in radiological areas.

NFPA Code Compliance

The facility does not fully comply with either NFPA 45 or NFPA 801.

Fire Safety and Emergency Training for Facility Workers

Facility personnel complete fire extinguisher training upon initial employment. All personnel are provided with the Building Emergency Plan for the facility, which covers procedures on fire or other hazards and their evacuation plan, as well as shelter-in-place information.

Fire Department Support

The Purdue University Fire Department is located on campus and has an average response time of 2.3 minutes to [redacted]

The department is extensively trained in regard to fire suppression, as well as hazardous material emergency response. All the firefighters (currently staffed with 29 personnel) are trained to a minimum of Firefighter I/II - this certification is in compliance with the National Fire Protection Agency standard 1001- Standard for Firefighter Professional Qualifications. Additionally, all firefighters are trained to be a Hazardous Material Technician, in compliance with National Fire Protection Agency standard 472- Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents. All firefighters are expected to complete annual radiation safety training, as well as monthly Haz-Mat training regarding response, detection, monitoring and mitigation procedures.

Pre-fire plan coordination involves routine building walkthroughs, during which special hazards or concerns are identified. Roundtable discussions are conducted on response duties and responsibilities regarding these issues.

[redacted]

This laboratory is operated as part of the School of Nuclear Engineering. The laboratory is located in rooms in [redacted] on the Purdue Campus Map shown in Figure 2 on Page 8 of *Appendix A.2* [redacted] The building is constructed of steel frame with concrete and brick. The floor plan of the laboratory is shown on page 14 and 15 *of Appendix A.2* [redacted] The dimensions of [redacted] approximately 15.5 m. by 15.2 m by 6.1 m high. The floor level is about 2.4 m below the outside ground level and is about 76 cm above the floor level of the newer portion of the [redacted]

[redacted] is located in [redacted] as shown previously. The fueled portion of the facility is cylindrical with an outer diameter of 1.47 m and a height of 1.22 m. This includes natural uranium rods and an additional sealed converter with 4.8% enriched rods. The facility is set on a concrete base approximately 61 cm below the floor level of [redacted] The center of the facility is approximately 10 m from the center of the nearest steel storage cabinet [redacted] is a concrete housing constructed within [redacted] to enclose [redacted]. The walls and roof of [redacted] have been designed so that radiation levels outside of room [redacted] will be acceptably low.

[redacted] is provided with supply ventilation from the main supply plenum from the [redacted] basement hallway. This air is a mixture of outside air and recirculated air from other parts of the building. Approximately 500-600 cfm of air is exhausted from [redacted] by a fan located in the

attic. The ductwork contains a HEPA filter and the room is maintained at a net negative pressure of 0.05 in of water. The flow of air [redacted] is primarily around the door frame when the door is closed.

6.2 Shields, Equipment and Handling Devices

Fuel elements are handled using a 18ft aluminum fuel retriever, arranged with two hooks that link to the fuel element. There is no direct handling of fuel elements. The fuel elements will be handled in accordance with proper written procedures approved by the Committee on Reactor Operations and the Radiation Safety Committee. All other items allow for direct handling of the material and will be done only by individuals with proper radiation safety training and the concepts of "time, distance, and shielding."

6.3 Measuring and Monitoring Devices

Film badges or other devices such as TLDs or OSLDs are generally used as personnel monitors of radiation exposure. Any person working with SNM is required to wear personnel monitoring devices whenever entering a restricted radioisotope area under conditions where the individual is likely to receive a dose in excess of 10 percent of the limits specified in 10 CFR 20.1502. In addition, pocket dosimeters or digital dosimeters may be worn by personnel in addition to film badges in cases where exposures would reasonably be anticipated. Pocket dosimeters or digital dosimeters may be utilized in lieu of film badges for individuals entering restricted areas on an infrequent or temporary basis.

The film badges, TLDs and/or OSLDs are read monthly or bimonthly using a NVLAP accredited supplier. An annual review, not to exceed fourteen months, is made of personnel exposures. In cases where individual monthly doses exceed 100 millirem, the Radiation Safety Office will notify the individual (or his/her supervisor) of the exposure as a means of alerting the individual to the occurrence of the dose.

Individuals who infrequently enter restricted areas who are provided with a pocket dosimeter or a digital dosimeter, read out their dosimeters immediately upon leaving the restricted area. These results are recorded by the Reactor Team in a logbook and kept on file.

Several radiation area monitoring systems are in place in [redacted] These monitors include digital sodium iodide detectors for radiation area monitors, a continuous air monitor, and a radiation area monitor which has communication channels to dispatch at the local law enforcement. Details on these monitoring systems can be found in Appendix A.3: PUR-1 Reactor Technical Specifications.

6.4 Radioactive Waste Disposal

There is little to no radioactive waste associated with this license. The fuel assemblies are sealed and unirradiated and will not be unsealed or irradiated. If low-level waste were ever to be created, provisions through Environmental Health and Safety (EHS) to collect and dispose of the material.

All waste management operations at Purdue University are carried out by trained technicians. Technicians are responsible for picking up radioactive waste from all laboratories since researchers are prohibited from sink disposal or any other direct means of disposal unless specifically exempted from the requirements.

Containers for waste are supplied by EHS unless a PI has requested to use alternative equivalent containers. The containers that are delivered to investigators upon request include the following:

Plastic carboys: up to 20 liters

Plastic drums: 5 gallons

Bags: 5 and 30 gallon plastic

Prior to pick up by EHS, all containers must be properly labeled to include isotope, amount, authorization number, investigator name, date, and any solvents or hazardous materials present.

Waste is required to be separated into several different categories for disposal. Currently the categories for waste include:

Solid short half-life (< 30 days) is placed into drums or bags as appropriate.

Long half-life material is separated into combustible and non-combustible and placed into bags or drums.

Liquid waste is separated into short and long half-life. Any liquid waste containing hazardous or non-dispersible components is identified and handled separately.

Vials are required to be returned to their original carton to remain upright during transport or placed in a drum which is double-bagged to prevent leakage.

Biological waste is placed in plastic bags and kept frozen until pickup.

Sharps are required to be in a rigid or semi-rigid container so that handling the container would prevent cuts or punctures to the technicians.

When a PI is ready for a waste pickup EHS is called to schedule the pickup. Technicians verify the label to ensure that all information necessary is complete. The packages are all smeared, surveyed for exposure rate at the surface and at 1 meter, and checked to see that the enclosures are secure. Any labeling, marking, notices, shipping papers, and placarding requirements are observed pursuant to 49 CFR prior to transport on public highways.

Short half-life materials are commonly stored for 10 half-lives prior to disposal. Solid material is surveyed with an end-window GM survey meter and any material with radiation levels indistinguishable to background are disposed as normal trash. Prior to disposal all radioactive labels and markings are defaced or destroyed. A record of all radioactive material that has been disposed of by decay in storage (DIS) will be maintained. Liquid material will be sampled and analyzed for radioactivity by liquid scintillation counting. Any material less than 100 dpm/ml will be disposed in the sanitary sewer provided the material is readily dispersible and non-hazardous. If the activity is above this amount the material will be allowed additional decay time. If further sampling reveals that the activity is still present it will be treated as a long half-life material (see below).

Solid long half-life material will be disposed of using a licensed waste broker facility, and final disposal will be completed off-site. Currently waste is disposed of by Bionomics Inc.

Non-combustible long half-life waste (metal and glass) is compacted using Teledyne Industries compactor. The Teledyne compactor is equipped with an external air exhaust and HEPA filter which is monitored on an annual basis for activity and integrity.

No air sampling is done in the area since the most volatile compound undergoing compaction is I-125. Personnel bioassays, probably the most sensitive exposure indicator, have indicated a maximum dose equivalent of 13 millirem per year to the thyroid. This is less than 0.03% of the 50 rem occupational limit for the thyroid and falls well under our 100 mrem ALARA trigger level. Direct radiation surveys and wipe testing of the areas are performed on a regular basis.

Long half-life liquid is sampled and analyzed according to the radionuclide(s) present. The samples are analyzed by liquid scintillation counting. All long half-life radioactive waste is sent to our hazardous waste team to be blended as mixed waste. This blended waste is then picked up by a licensed waste vendor, currently Bionomics Inc.

Liquid waste may be disposed of by the sanitary sewer as provided in 10 CFR 20.2003. However, current procedures at Purdue do not allow the direct disposal of any radioactive material down the drain. All short half-life liquid waste must be indistinguishable from background before drain disposal, and liquid waste is sent out by a vendor as mixed waste (described above). Records for waste disposal methods for all waste inventory items are kept at EHS.

Scintillation vials are packaged in drums and shipped via a waste broker for treatment or disposal. All applicable DOT regulations regarding the shipment of hazardous materials are observed.

All waste shipments will be transferred to a licensed waste broker or facility. Currently waste is transferred to Bionomics for ultimate disposal or treatment at licensed facilities. Sealed sources may also be transferred to other licensees for disposal or reuse such as J.L. Shepherd and Associates. In all cases, we will follow Appendix F to 10 CFR 20.1001 to 20.2401 for land disposal of all wastes.

7 10 CFR 70.22(a)(8) Safety Procedures to Protect Health and Minimize Danger to Life or Property

7.1 Monitoring Procedures

Radiation Monitors and Alarms [redacted]

Two remote area monitors are positioned outside of the [redacted]. These area monitors are equipped with alarm capabilities. When the radiation alarm for [redacted] announces in the Central Communication Center, the University Police should notify personnel on the emergency call list of Nuclear Engineering and Radiation Safety. The University Police should respond to [redacted] but should not enter until the area is declared safe by one of the on-call personnel. Further information can be found in Appendix A.2 of this submission.

Radiation Monitors and Alarms [redacted]

The [redacted] is equipped with multiple Radiation Area Monitoring (RAMs) systems, with alarm capabilities, as well as a continuous air monitoring (CAM) system, also with alarm capabilities. In addition to the RAMs and CAM, there is a [redacted] radiation area monitoring system present in the space with alarm capabilities. These alarms will alert the Purdue University Police Department and trigger the procedure for on-call notifications for Nuclear Engineering and Radiation Safety personnel.

Details on the safety-related channels (Radiation Area Monitors) can be found in section 3-3 of Appendix A.3 *"Technical Specifications for the Purdue University Reactor, PUR-1" of* this submission. There are four safety-related channels:

Pool top monitor: with an alarm setpoint 30 mR/hr, and a 50 mR/hr trigger for a scram.

Water process: with an alarm setpoint of 3.0 mR/hr and a setpoint at 7.5 mR/hr which will trigger a scram.

Console Monitor: with an alarm setpoint of 3.0 mR/hr and a setpoint at 7.5 mR/hr which will trigger a scram.

Continuous Air Sampler (Monitor): Alarm setpoint at 2000 pCi/L which will trigger an alarm and a scram. This monitor is used for radiological characterization of air in the facility.

7.2 Operating Procedures

Currently, projects located in [redacted] involving special nuclear material have halted, and therefore the space is predominately used for storage of SNM. Furthermore, projects involving the U-235 helices have also halted and the sources now remain in storage. All uses of radioactive materials on campus must be approved by the Radiation Safety Officer, Radiation Safety Committee (RSC), or the Committee on Reactor Operations (CORO – if procedures specifically involve the PUR-1 reactor). A thorough review of all applications and research procedures are discussed with each committee. This ensures that only qualified and specifically trained personnel carry out work with radioactive material, in a manner that provides adequate safety measures within their procedures for protection of researchers and the general public.

7.3 Emergency Procedures

Emergency procedures are designed primarily to protect personnel from radiation and other physical hazards in the workplace. Secondarily, these procedures protect facilities and confine any contamination to the immediate area. All personnel are instructed in emergency procedures during initial training and are given copies of emergency procedures which appear in the Purdue Radiation Safety Manual. Radiation workers are encouraged to refer to this manual on a regular basis. Numbers for emergency response are posted on all laboratories that utilize radioactive material. The University has also developed an emergency procedures manual that includes the responses to various types of emergencies including tornados, bomb threats, etc.

The most credible accident scenario with release to the environment would be a facility fire. The following material and facility characteristics make the intake of 2 grams of soluble uranium or 1 rem effective dose equivalent highly unlikely. Uranium SNM is predominantly sealed in aluminum or stainless-steel cladding. This first level of containment would be resistant to fire and provides a barrier for release of material to the environment. Additionally other licensed material is in the form of sealed sources and would similarly prevent release of licensed material to the environment. All material is stored within a room in a building which would act to further contain any material that could be released. Some material is further contained within cabinets or in stainless-steel converters.

The building structures are composed of brick, block, concrete and other fire-resistant materials. The buildings except for the SNM storage areas are sprinkled and would prevent a fire from spreading easily. The ventilation system would be shut down as a precaution to minimize the air entering and exiting the building and as a result minimize the release of combustion products. Fire department and police personnel would also ensure evacuation of the building(s) and this would prevent exposure to members of the public (non-radiation workers).

One member of the radiation safety staff is always on call to respond to emergencies involving radioactive material (chiefly the Radiation Safety Officer). Other members of the staff are listed with the police department, so these individuals may be reached if further assistance is needed. The Purdue Fire Department is also trained in hazardous material response that includes radioactive material. Mutual aid agreements exist for additional assistance from other local municipalities.

Under the requirements of 10 CFR 70.22(i)(1), Purdue was required to submit either an emergency plan, or an evaluation showing that the maximum dose to a member of the public offsite due to a release of radioactive materials would not exceed 1 rem effective dose equivalent. By letter dated 16 February 1993, Purdue submitted such an evaluation, which was accepted in the 1994 license renewal, and again in 1999.Therefore, there is no specific emergency plan in place, and ANSI/ANS-8.23, which covers emergency planning, is not applicable.

Attached in Appendix A.1 *"Emergency Plan for the Purdue University Reactor PUR-1"* of the submission is the Emergency Plan for the PUR-1 Reactor Facility License (R-87), which covers reactor and non-reactor related emergencies related to the restricted areas [redacted] This emergency plan incorporates emergency response protocols related to areas using/storing SNM. This Emergency Plan covers the review, refresher training and emergency response drills that are to be conducted with local law enforcement and first responders in addition to the Reactor Team and Radiation Safety Staff. Details regarding the facility's response to emergencies can be found in the Emergency Plan in the appendices under Appendix A.1.

7.4 Training Program.

All radiation workers receive instruction in accordance with 10 CFR 19.12 prior to beginning work with licensed material. This instruction is web-based training followed by an exam covering the training information. Each user regardless of prior experience is required to attend this orientation and training session and review the Radiation Safety Manual (this manual is maintained online on the Purdue Environmental Health and Safety website at www.purdue.edu/rem, and is mentioned in the license application solely for informational purposes). If the individual uses material other than sealed sources a hands-on session on survey and waste procedures and contamination control is provided by a health physicist or radiation safety technician. Information covered by the training includes:

Purpose of Environmental Health and Safety

Principles of ALARA

Special Notices (e.g. Results from latest NRC inspection)

Instruction Regarding Prenatal Exposure (Regulatory Guide 8.13)

Discussion of 10 CFR Parts 19 and 20

Personnel Dosimetry and Exposure Limits

Hazards Associated with Commonly Used Isotopes

Decontamination and Accident Procedures

Waste Management Procedures

Marking and Labeling of Facilities and Equipment

Demonstration of Survey Techniques

Every year, a biennial refresher training is required for all individuals looking to continue work with radioactive material for both open-source and sealed source use. During Biennial Principal Investigator "authorization to work with radioactive material" renewal, trainings status of all personnel under the Principal Investigator is reviewed – renewal and the continuation of radioactive material use is placed on hold if expired trainings are not addressed.

7.5 As Low As Reasonably Achievable (ALARA) Program

Purdue University is committed to providing a working place relatively free of recognized hazards. Since any exposure to ionizing radiation is thought to incur some risk of cancer or genetic effects, the goal is to keep exposures low while allowing research with radioactive materials to proceed without undue hardship. The ALARA program uses the following methods to keep radiation exposures as low as reasonably achievable:

Training

All individuals are made aware of radiation effects and methods to keep exposures low. Laboratory demonstrations during training illustrate the principles of time, distance, and shielding through the use of actual sources and survey instruments. In addition, proper survey techniques are demonstrated so users can minimize any contamination that may have the potential to be inhaled or ingested.

Personnel Dosimetry

Although few individuals meet the requirement for external personnel dosimetry this service is provided to all users of energetic beta and gamma emitting radionuclides. This program allows Purdue to determine easily any problem areas that may be developing especially for users that lack extensive experience in handling radionuclides.

Exposure Notification

Exposure reports are usually reviewed by all members of the professional radiation safety staff. After that review any exposure exceeding 100 millirem in any bimonthly period is identified. Exposures to the extremities, skin, and those to the whole body are included in this process. Individuals receiving doses exceeding this trigger limit are identified and notified of the exposure. This alerts the individual of the dose and the location (whole body, hand, etc.) receiving the dose. The individual is required to sign and return a form to confirm his awareness of the dose. The individual must also indicate the reason for the dose and indicate actions that will be taken in the future to reduce those exposures.

Exposure Investigations

When exposures exceed greater than 25 percent of the limits specified in 10 CFR 20.1201 an investigation into the causes is initiated. Procedures are examined and recommendations are made by health physicists to assist in reducing exposure to the affected individual(s). In many cases investigations proceed when users request assistance in keeping their exposures as low as possible even prior to reaching 25 percent of the applicable limits.

Laboratory Audits

Routine laboratory audits are an ideal method to informally observe procedures and activities in the laboratory. Independent measurements in the lab can also identify areas where shielding and placement of radioactive storage areas can reduce exposures to lab occupants even further.

The Radiation Safety Committee (RSC) also acts as the ALARA Committee (see Section 2 of this application). All aspects of the ALARA program are reviewed on a continual basis by the RSC.

In addition to Purdue University Environmental Health and Safety ALARA Program, the PUR-1 research reactor had an additional specific ALARA program that can be referenced in Appendix A.8 of this submission. The scope of the ALARA program in Appendix A.8 is limited to the PUR-1 reactor.

8 10 CFR 70.53 and 70.54, Material Control and Accountability

Inventory of special nuclear material is completed by the Nuclear Engineering PUR-1 reactor team semiannually. An example of this inventory can be seen in Appendix A.7. Additionally, all sealed sources on inventory with any Purdue license issued by the NRC are inventoried and leak tested by the Radiation Safety Team in accordance with 10CFR 39.35 and Section 7.II on this application. At the end of each calendar year, the Radiation Safety Team sends out an "Inventory Reconciliation" to be completed by all Principal Investigators responsible for any licensed radioactive material. This inventory reconciliation serves the purpose of verifying/update all current inventory items, and associated radioactivity amounts, within the P.I's possession.

9 10 CFR 73, Physical Protection of Plants and Materials

Details on the physical protection of plants and materials can be found in Appendix A.2 [redacted] This plan describes the physical protection systems and security organization which will provide protection against radiological sabotage and detect the theft of special nuclear material at Purdue University. This plan demonstrates compliance with all applicable regulations under 10 CFR 73.

10 10 CFR 70.25 Financial Assurance and Recordkeeping for Decommissioning

All funds required for decommissioning will be requested from the State of Indiana by the Treasurer of Purdue University through the Purdue University Board of Trustees.

Records for laboratories that have been decommissioned are on the Purdue University campus will be kept on file until termination of the license.

APPENDICIES

APPLICATION FOR RENEWAL OF SPECIAL NUCLEAR MATERIALS LICENSE SNM-152

Table of Contents

Appendix A.1..... "Emergency Plan for the Purdue University Reactor PUR-1"

Appendix A.2..... [redacted]

Appendix A.3..... "Technical Specifications for the Purdue University Reactor, PUR-1"

Appendix A.4..... "PUR-1 Operating Principles and Core Characteristics Manual"

Appendix A.5..... "Safety Analysis Report for the Purdue University PUR-1 Reactor"

Appendix A.6..... "Calibration of Equipment and Measurement of Ar-41 Effluent"

Appendix A.7.....Fuel Inventory Example

Appendix A.8..... "Purdue University Research Reactor (PUR-1) ALARA Program"

Appendix A.9..... "Resumes for Reactor Team and Radiation Safety Staff"