DOCKET: 70-152

LICENSEE: Purdue University

SUBJECT: SAFETY EVALUATION REPORT - LICENSE RENEWAL APPLICATION FOR PURDUE UNIVERSITY MATERIALS LICENSE NO. SNM-142

I. INTRODUCTION

By letter dated July 30, 2009, Purdue University (Purdue) in West Lafayette, Indiana, submitted an application (Agencywide Documents Access and Management System [ADAMS] Accession No. ML092170372) to the U.S. Nuclear Regulatory Commission (NRC) requesting renewal of its Special Nuclear Material License (SNM) No. SNM-142, as well as a Statement of Intent and Decommissioning Funding Plan (ADAMS Accession No. ML092170373). The request was made pursuant to the requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Sections 70.33 and 70.38(a). As described in the License Renewal Application (LRA), and as discussed in more detail below, Purdue is requesting continued authorization to possess and use SNM for training and educational purposes. Purdue supplemented its application with a complete resubmittal dated March 15, 2010 (ADAMS Accession No. ML100780121). Purdue has requested a renewed license term of 10 years.

As documented in this Safety Evaluation Report (SER), the NRC staff conducted its safety and safeguards review in accordance with 10 CFR Part 20, "Standards for Protection Against Radiation;" and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

The NRC staff used guidance in NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility" (NRC, 2002) (NUREG-1520) and other applicable guidance documents to conduct its safety review. The NRC staff's safeguards examination included a review of Purdue's Emergency Plan.

On September 24, 2010, the NRC staff sent Purdue a Request for Additional Information (RAI) (ADAMS Accession No. ML102571553). Purdue responded to this RAI in a letter dated February 8, 2011 (ADAMS Accession No. ML120550503). On December 1, 2011, the NRC staff sent Purdue another RAI (ADAMS Accession No. ML11327A032). Purdue's response to this RAI was received on January 31, 2012 (ADAMS Accession No. ML12033A076).

On August 6, 2012, Purdue submitted a request (ADAMS Accession No. ML12221A323) to allow the U.S. Department of Energy to package and ship 8750 Special Power Excursion Reactor Test (SPERT) fuel rods described in the existing license. The NRC approved this request via Amendment 3 dated August 16, 2012 (ADAMS Accession No. ML12227A392). The [REDACTED] rods which remain are limited to storage only, in the safe slab arrangement discussed below in SER section III(d). Shipment of the 8750 SPERT fuel rods was completed on September 16, 2012.

Under License No. SNM-142, SNM at Purdue is stored in the form of fuel rods at [REDACTED]. Within the [REDACTED], a total of [REDACTED] rods as well as [REDACTED] have been retained for future use in non-destructive testing. These rods are secured in a safe geometry configuration for both storage and transportation.

Other remaining material is as follows: A [REDACTED]. The [REDACTED]. These fuel rods are authorized for storage only.

Each converter (assembly) is welded closed with the material in a sub-critical configuration, and cannot be configured in a different manner. A third converter (assembly) houses [REDACTED] and remains inside [REDACTED] and is authorized for storage only. The converters were used [REDACTED] in tests to examine a neutron spectrum closely matching that of a breeder reactor.

A description of the final quantity and storage locations of the remaining fuel was submitted by Purdue in a letter dated November 8, 2012 (ADAMS Accession No. ML12326A544). Because some fuel rods have been retained for future testing, the NRC staff requested additional information on criticality safety in a letter dated November 29, 2012 (ADAMS Accession No. ML12335A321). Purdue responded to the RAI on December 28, 2012 (ADAMS Accession No. ML13002A210). Purdue provided responses to additional clarifying requests explaining how subcriticality will be maintained during any movement of the remaining fuel in a letter dated May 8, 2013 (ADAMS Accession No. ML13149A295).

Purdue has a research reactor, which operates independently under NRC Reactor License No. R-87. In addition, Purdue has a Source Material License, SUD-296, for a natural uranium subcritical pile. The activities associated with these licenses are independent of the SNM license and are not discussed in this SER. In addition, Purdue has Broad Scope (Agreement State) license 13-02812-04 for possession of Byproduct material, which was renewed on May 10, 2005, for a period of 10 years.

A Notice of Opportunity to Request a Hearing on the LRA was published in the *Federal Register* on September 30, 2009 (74 FR 50258). No hearing requests were received.

II. PERFORMANCE HISTORY

License SNM-142 was originally issued in December 1957. There have been no major concerns identified in inspections since that time. Since the license was last renewed in 1999, the NRC's Region III Office has performed two safety inspections. The first inspection was conducted on October 21, 2005. The second inspection was conducted November 13-14, 2008, and completed on December 5, 2008. This is the normal inspection schedule for licensees authorized to hold greater than a critical mass of SNM. No violations were observed during either of these inspections.

III. DISCUSSION

a) General Information

Purdue uses SNM to supplement its training and instruction programs in the field of nuclear engineering. Specifically, the licensed materials, except for materials authorized for storage only, are to be used in experiments at various university buildings.

Purdue is requesting authorization to continue storing SNM, and to possess and use SNM for: (a) measurement of effects on thermal properties of UO_2, and (b) measurement of effects on mechanical properties of UO_2. The LRA describes the characteristics and composition of the SNM to be used in these applications, and includes acceptable drawings illustrating where the licensed activities would continue to take place.

The NRC staff reviewed the LRA to determine whether Purdue was required to provide Integrated Safety Analysis (ISA) Summary information, pursuant to the provisions in 10 CFR Part 70, Subpart H, "Additional Requirements for Certain Licensees Authorized to Possess a Critical Mass of Special Nuclear Material." The NRC staff notes that the proposed activities for which the license would be renewed do not meet the subpart H applicability criteria in 10 CFR 70.60, because Purdue does not seek authorization to process, fabricate, or enrich SNM. Therefore, 10 CFR Part 70, Subpart H, is not applicable to the LRA, and Purdue is thus not required to submit an ISA Summary in support of its LRA.

Purdue is requesting approval to use SNM for its educational programs, as described below:

MATERIAL	FORM	QUANTITY	AUTHORIZED USE
Uranium enriched to [REDACTED]	Solid helices	[REDACTED]	Research Programs
Uranium enriched to [REDACTED]	Solid disks	[REDACTED]	Research Programs
Uranium enriched to [REDACTED]	Samples	[REDACTED]	Research Programs
Plutonium	Sealed Plutonium-Beryllium Neutron Sources	[REDACTED]	Research Programs
Natural uranium	UO_2 pellets clad in aluminum	[REDACTED]	Research Programs
Natural uranium	Samples (any form)	[REDACTED]	Research Programs
Californium	Up to 10 double encapsulated sources	[REDACTED]	Research Programs
Uranium-233	Calibration sources	[REDACTED]	Research Programs
Neptunium-237	Calibration sources	[REDACTED]	Research Programs
Plutonium-239	Calibration sources	[REDACTED]	Research Programs
Curium-244	Calibration sources	[REDACTED]	Research Programs
Uranium enriched up to or less than [REDACTED]	SPERT fuel rods	[REDACTED]	Research Programs
Uranium enriched up to or less than [REDACTED]	SPERT fuel rods	[REDACTED]	Research Programs

b) Organization and Administration

The governing body for all programs involving radioactivity or radiation-producing devices at Purdue is the Radiation Safety Committee (RSC). The RSC was created by Executive Memorandum B-14 dated August 1, 2001 (Attachment 7-2 of the LRA), and is directed by the senior director of Environmental Health and Public Safety. The Radiation Safety Officer (RSO) and the laboratory director serve as ex-officio members of the RSC. The LRA describes the qualifications (e.g., education requirements and professional experience) of the individuals in the Radiation Safety Staff positions such as health physicists, environmental technicians, and student assistants in the Nuclear Engineering Department.

Individuals responsible for storage and use of the SNM authorized by the license are appointed by the laboratory director and assistant laboratory director in the Department of Nuclear

Engineering. The LRA also provided an acceptable organizational chart illustrating the reporting relationship of the different functional groups at Purdue.

The NRC reviewed the duties of the RSO using the guidance in Section 8.7.1 of NUREG-1556, Vol. 7, "Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope Including Gas Chromatographs and X-Ray Fluorescence Analyzers" (NRC, 1999a). In this regard, Purdue stated that the RSO is responsible for managing the radiation safety program, and reviews, evaluates, approves, and audits activities and procedures associated with the radioactivity or radiation-producing devices at Purdue. The RSO's area of responsibility includes all activities involving the university's nuclear reactor, use of SNM, nuclear criticality safety (NCS), radiological operations in the facility, and general safety standards.

The NRC staff reviewed the LRA and concludes that Purdue has an acceptable organization; administrative policies; and sufficient, competent resources that provide reasonable assurance of adequate safety for the proposed activities during the license renewal term. Therefore, the NRC staff concludes that the information provided by Purdue meets the applicable requirements in 10 CFR 70.22 and 10 CFR 70.33 and is, therefore, acceptable.

c) Radiation Protection

Radiation Protection Roles and Responsibilities

In its LRA, Purdue provided a description of the radiation protection (RP) program it uses to meet the requirements of 10 CFR Parts 19, 20, and 70. The RP program includes personnel monitoring and training practices, commitments for leak-testing sources, commitments for maintaining doses as low as is reasonably achievable (ALARA), and waste disposal practices. The LRA also discussed the roles and responsibilities of the different individuals implementing the RP program. The information provided concerning the roles and responsibilities in the RP program is adequate to demonstrate compliance with the applicable regulatory requirements.

ALARA Commitment

Purdue has committed to maintaining radiation doses ALARA, and its RSC has ALARA responsibilities. Maintaining radiation doses ALARA is achieved, in part, through consideration of radiation safety program audit results, laboratory survey results (which includes contamination evaluations), and radiation exposure reports for personnel. In meeting its ALARA responsibilities, the RSC has the authority to mandate action, should it determine a need for further restrictions or procedural changes to achieve and maintain doses at ALARA levels. The RSC approves all new authorized use of radioactive materials and reviews authorizations at least biannually. In addition, the RSC reviews RP audit findings and makes recommendations to staff for appropriate action. All users of radioactive materials are instructed in proper methods to keep their exposures low—including the principles of time, distance, and shielding. Radiation doses to staff, students, and visitors are reviewed by the RP staff; and if an individual's occupational exposure exceeds 100 millirem in a 2-month reporting period, a report is sent to the individual requiring response indicating actions taken to reduce exposures. Exposures greater than 25 percent of the regulatory limits are investigated for causes. Recommendations are made by health physicists to reduce exposures.

The RSC's periodic review of doses and the RP program is consistent with the regulatory requirements in 10 CFR 20.1101(b).

Organization and Personnel Qualifications

The regulations in 10 CFR 70.22(a)(6) require that any 10 CFR part 70 license application include the technical qualifications, training and experience of the personnel who will be performing licensed activities. The administration of the RP program in support of activities at Purdue is the responsibility of the Office of Radiological and Environmental Management (REM). Purdue management personnel supporting the RP program includes the executive vice-president and treasurer, the senior director of Environmental Health and Public Safety, and members of the RSC. The REM office consists of the RSO and staff, which includes health physicists, technicians, and student assistants.

The current RSO is James F. Schweitzer, Ph.D, who has held this position since 1987. Dr. Schweitzer received his M.S. degree in Health Physics (1981) and Ph.D. in Environmental Toxicology (1985) from Purdue. He was employed at the Illinois Department of Nuclear Safety from 1986-87 where he worked in the environmental monitoring and radon section. His experience includes using millicurie amounts of unsealed byproduct and source material, and multi-curie amounts of sealed sources for teaching and research, calibration, and in self-shielded irradiators.

Health physicists are required to have a bachelor degree in Health Physics or a related area. Technicians are required to have a high school diploma, and must work under the supervision of the RSO or health physicist. Student assistants perform basic tasks under the supervision of various RP staff. Other university personnel not directly associated with the REM office also have defined responsibilities for overseeing radiation safety while working with radioactive materials. These include individuals within the Nuclear Engineering Department authorized by the RSC, principal investigators (PIs), authorized users and radiation workers. These individuals all work together to ensure a robust RP program that complies with internal procedures and regulatory requirements. The qualifications, training and experience of licensee personnel as discussed above meets the requirements in 10 CFR 70.22(a)(6).

Written Procedures

The regulations in 10 CFR 70.22(a)(8) require that any 10 CFR Part 70 license application include a description of the procedures used to protect health and minimize danger to life or property. Purdue maintains written procedures pertaining to performing, in a safe manner, activities involving radioactive materials. Procedures used in teaching, research, and decommissioning activities are reviewed for safety by the RSC and the RSO, and are approved by the RSC and updated at least every 2 years.

The university has a Radiation Safety Manual/Procedure (submitted as Attachment 8-1 to the LRA) that is maintained online. The NRC staff reviewed this manual, and finds that it addresses authorized use of radioactive materials, training, user responsibilities, procurement and transfer of radioactive material, waste handling, monitoring of exposures, postings, personnel exposure records, and emergency response activities required by 10 CFR 70.22. Radiation workers at Purdue must review this manual.

Emergency procedures provide instructions to protect personnel from radiation and other hazards in the workplace, and to contain contamination. An emergency procedures manual has been developed in addition to the instruction provided in the Radiation Safety Manual.

Authorization documents and forms are required to be submitted when an individual requests use of radioactive materials as a PI. These forms describe the isotopes and amounts, proposed uses, procedures, associated hazards, and techniques to prevent contamination and keep exposures ALARA. All PIs are approved by the RSC, which must also approve any major changes to the authorization.

Purdue's program to conduct licensed activities in accordance with approved, written procedures and authorization documentation provides reasonable assurance of adequate worker safety and meets the requirements in 10 CFR 70.22(a)(8).

Training Program

Training for individuals in restricted areas is dependent on factors such as responsibility of the individual, duties in the area, and frequency in the area. Support staff are not allowed in these areas unless accompanied by an individual who has authorized, unescorted access. Radiation workers receive instruction consistent with 10 CFR 19.12 prior to beginning work with licensed materials. Each user is required to take Web-based training and take an exam over the material, as well as review the Radiation Safety Manual. Refresher training is conducted on an annual basis. If the individual uses material other than sealed sources, a hands-on session on survey procedures, waste procedures, and contamination control is provided by a health physicist or radiation safety technician. Radiation worker training covers:

- Purpose of Radiological and Environmental Management
- Principles of ALARA
- Special Notices (e.g., results for latest NRC inspection)
- Instruction Regarding Prenatal Exposure (Regulatory Guide 8.13 [NRC, 1999b])
- 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

Purdue requires that a PI be a permanent Purdue staff member with a college degree at the bachelor level, or have equivalent training and experience and attend the radiation safety training. In addition, the PI must have at least 40 hours of training and experience in the safe handling of radioactive materials, and in the characteristics of ionizing radiation; units of radiation dose and quantities; radiation detection instrumentation; and biological hazards of exposure to radiation appropriate to the type and forms of material to be used.

The training program is described in the Radiation Safety Manual. The NRC staff finds that the training program meets the 10 CFR 19.12 and 10 CFR 70.22(a)(6) requirements.

Radiation Surveys and Monitoring Programs

Personnel monitoring for radiological exposures is conducted using film badges or other devices such as Thermo Luminescent Dosimeters. In addition, pocket dosimeters may be utilized in lieu of film badges for individuals entering restricted areas on an infrequent or temporary basis. Dosimeters are read monthly or bimonthly using a National Voluntary Laboratory Accreditation

Program accredited supplier. No internal exposure monitoring is conducted, as there is no handling of dispersible material that could result in an intake. Bioassay procedures would be developed, if needed, for workers involved with decommissioning that have a potential for contact with SNM. Personnel monitor hands, feet, and clothing for contamination whenever that potential is present. Laboratory clothing and protective clothing are monitored routinely during use and when work with radioactive materials is completed.

Comprehensive surveys of laboratories are conducted by the REM and are performed on a regular basis according to the hazard classification of the laboratory. These surveys include checks for contamination, direct exposure surveys, verifying the operation of survey instruments, the correct utilization of protective garments, waste disposal practices, and verification that personnel dosimetry is being utilized properly. The NRC staff finds that Purdue meets the general survey requirements of 10 CFR 20.1501.

Contamination Control and Waste Handling

Currently, the use of licensed materials under SNM-142 is limited to storage of uranium and use of Pu-Be sources for activation analysis studies. Some additional materials will also be used for calibration and activation/fission studies. Some operations identified in the initial 2009 LRA involving SNM have since been suspended and could not be resumed during the license renewal term without a license amendment. Because of the limited use of SNM under the renewed SNM-142 license, there is minimal potential for radioactive contamination during the renewal term. Surface contamination surveys will nonetheless continue to be conducted every month.

Additionally, Purdue has general rules for the use of radioactive material that include the use of hoods or glove boxes and personal protective equipment such as gloves and lab coats, if there is a potential to utilize dispersible material. Laboratory work surfaces with the potential for contamination must be covered with absorbent paper that is changed on a regular basis. Work involving large volumes of material must be done in a spill tray. Surveys would be performed by the user of the radioactive materials at appropriate intervals with contaminated items identified for decontamination or disposal as radioactive waste.

Leak tests are conducted every 6 months on sealed sources used at Purdue. Tests use a methodology capable of detecting the presence of 0.005 uCi of material. Corrective actions and reports will be generated if greater than 0.005 uCi of material is detected.

Purdue maintains instrumentation for the determination of contamination, exposure rates, and radioactivity in solid and liquid samples. Survey instruments are required to be calibrated at least annually. Purdue commits to following the guidance in “Instrument Specification and Model Survey Instrument and Air Sampler Calibration Program,” in Appendix O of NUREG-1556, Vol. 11, “Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Licenses of Broad Scope” (NRC, 1999c).

Radiation Protection Findings

Purdue has committed to maintaining an acceptable RP program that includes: practices ensuring that occupational radiological exposures are kept at ALARA levels; established qualification requirements for the RP personnel; approved, written RP procedures for RP activities; RP training for all personnel who have access to restricted areas; a radiation survey and monitoring program for controlling radiological contamination and monitoring radiation

exposures; and the record-keeping programs required by 10 CFR 20.2103 and 10 CFR 20.2106 to support them. The NRC staff finds that the RP program is acceptable.

d) Nuclear Criticality Safety

The NRC staff reviewed the material and possession limits in Purdue's license to determine whether there was a nuclear criticality safety (NCS) concern. The NRC staff also reviewed previous SERs for Purdue under SNM-142 (July 30, 1999 and December 22, 2009) to determine if the safety conclusions needed a re-evaluation based on the information in the current license renewal application.

The SNM in the form of helices, discs, samples, or sources does not pose a criticality hazard. The type, form, and small quantity of material ensures that it remains subcritical under all normal and credible abnormal conditions.

The SNM in the form of fuel rods is stored in [REDACTED]. The room layouts are provided in attachments 9-2 through 9-8 of the license application. The [REDACTED] has a criticality accident alarm system (CAAS) as depicted in attachment 9-6.

[REDACTED] Rods

In [REDACTED], the SNM is stored in [REDACTED]. In [REDACTED] are stored vertically in six steel cabinets such that they are maintained in a slab thickness of less than 14 centimeters (cm). A natural uranium metal graphite subcritical assembly with a keff of 0.642 is stored in this room. No handling or use of the fuel rods is permitted, other than a small subset of [REDACTED] which may be used elsewhere for non-destructive evaluation and testing as separately discussed below. [REDACTED] does not have a sprinkler system and under normal conditions, there are no other sources of moderator. Based upon Figure 3 of ANSI/ANS-8.1, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," the subcritical slab thickness for [REDACTED] fuel lattices with an optimal water-to-fuel ratio, infinite in two directions, and fully reflected in the third direction is approximately 28 cm. Exceeding the subcritical slab thickness, and attaining optimum moderation and reflection conditions in [REDACTED] would require multiple upsets, which is extremely unlikely. Since the fuel rods are maintained in a slab thickness less than the subcritical limit given in ANSI/ANS-8.1, and multiple upsets would be required to exceed the subcritical limit, the staff has no NCS concerns regarding these rods.

[REDACTED] Rods

In room [REDACTED], fuel rods [REDACTED] are stored vertically in metal racks along two opposite walls such that they are maintained in a slab thickness of less than 9 cm. The spacing between the two racks is approximately 190 cm (1.9 meters) which minimizes neutronic interation between the two racks. No handling or use of the fuel rods is permitted, other than a small subset of [REDACTED] which may be used elsewhere for non-destructive evaluation and testing as separately discussed below. [REDACTED] does not have a sprinkler system and under normal conditions, there are no other sources of moderator. Based upon Figure 3 of ANSI/ANS-8.1, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," the subcritical slab thickness for [REDACTED] fuel lattices with an optimal water-to-fuel ratio, infinite in two directions, and fully reflected in the third direction is approximately 10 cm. Exceeding the subcritical slab thickness, and attaining optimum moderation and reflection conditions would require multiple upsets, which is extremely unlikely. Since the fuel

rods and storage racks are maintained in a slab thickness less than the subcritical limit given in ANSI/ANS-8.1, with sufficient spacing between the two storage racks, and multiple upsets would be required to exceed the subcritical limit, the staff has no NCS concerns regarding these rods.

The applicant was previously granted an exemption from the provisions of 10 CFR §70.24(a) for [REDACTED] (SERs dated July 30, 1999, and December 22, 2009) and requests continuation of that exemption. Since the conditions under which the NRC staff granted that exemption have not changed (i.e., storage in racks and cabinets in a safe slab geometry/constraint), the staff recommends granting the exemption request for the [REDACTED]. Because the SNM in these fuel rods will be kept in safe slab geometry, an inadvertent criticality is not possible. Accordingly, the NRC staff finds under 10 CFR 70.17(a) that granting a continuation of this exemption is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest. Purdue agrees that the following license condition will be added to license number SNM-142 to reflect the exemption being granted here:

> "The licensee is exempted from the requirements of 10 CFR §70.24 insofar as such requirements apply to the SNM in any fuel rods in [REDACTED] that are authorized for storage only."

In the [REDACTED]. [REDACTED]. In [REDACTED] stored in a cage within two sealed converters. One additional converter with [REDACTED]. No handling or use of the fuel rods is permitted. This area does have a sprinkler system. The SNM in [REDACTED] was previously evaluated by the NRC staff (SERs dated July 30, 1999, and December 22, 2009) and staff determined that there was reasonable assurance that a criticality accident would not occur (i.e., k_{eff} of 0.74 or less when the room is flooded with water). Because no changes have been requested under this application, the staff continues to find the storage operations acceptable.

The applicant had also requested an exemption from the provisions of 10 CFR §70.24 [REDACTED]. However, in its response dated January 31, 2012 (ML12033A076), to the staff's RAIs, the applicant withdrew this request. The staff reviewed the monitors used [REDACTED] and find that these area monitors meet the requirements of 10 CFR 70.24.

SNM in Fuel Rods Available for Non-Destructive Evaluation and Testing

As noted above, Purdue holds [REDACTED], all of which are available for potential future use in non-destructive evaluation and testing. Both sets of these rods are secured in a safe geometry configuration during their storage in the [REDACTED]. These rods would be kept in the safe geometry configuration during any transportation to campus locations to be approved by the RSC where any non-destructive evaluation and testing would be conducted.

In the May 8, 2013, response (ML13149A295) to staff RAIs, the applicant requested exemption from the provisions of 10 CFR §70.24 to cover the time when any of these [REDACTED] would need to be transported to and used at the RSC-approved locations. All of these fuel rods would be returned to storage in the [REDACTED] following testing. The reasons provided for this exemption are (1) the mass of SNM that will be utilized is less than a critical mass as noted in TID-7016, figure 2.15, also known as NUREG/CR-0095, "Nuclear Safety Guide;" (2) the rods will be kept in a subcritical geometry during transport/interim storage; (3) the tubes containing the rods are less than 3 inches in diameter; and (4) the SNM is in a non-moderated state. Staff verified that the mass of [REDACTED] to be utilized at these locations will be less than a critical mass of SNM as this term is defined in 10 CFR §70.4 (i.e., less than [REDACTED]), and that

the geometry during transport will be subcritical (i.e., less than 8.6 inches diameter cylinder), consistent with ANSI/ANS-8.1-1998, Figure 2.

Based on the above, the NRC staff finds under 10 CFR 70.17(a) that granting Purdue's May 8, 2013, exemption request is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest. Purdue agrees that the following license condition will be added to license number SNM-142 to reflect the exemption being granted here:

> "The licensee is exempted from the requirements of 10 CFR §70.24 insofar as the section applies to fissionable material in individual unrelated work areas in which the inventory of the material does not exceed 700 g of $_{235}$U, 520 g of $_{233}$U, 450 g of $_{239}$Pu or 450 g of any combination of these three isotopes. One half of such quantities if massive moderators or reflectors made of graphite, heavy water, or beryllium may be present."

The NRC staff previously requested additional information regarding NCS training and procedures that ensure the NCS program is adequate to protect against NCS hazards. In its May 8, 2013, response letter, Purdue stated in this regard that any material movement will be in accordance with written procedures for the movement of fuel, and that any material procedures will be reviewed biennially by the staff as well as the reactor oversight committee. Purdue in its response further committed to develop these procedures using ANSI/ANS-8.1 and ANSI/ANS-8.7 guidance which are industry standard guidance. The applicant also committed to follow ANSI/ANS-8.20 to train personnel that have access to or responsibility for the storage of SNM. The staff finds these commitments to be acceptable.

Accordingly, the NRC staff finds that the NCS program, including the commitments discussed above, will continue to adequately protect against NCS hazards during the renewed license term. The NRC staff concludes that there is reasonable assurance that the applicant has provided adequate protection against criticality hazards, and that the regulatory requirements in 10 CFR §70.22(a)(7), (a)(8), and §70.24, as applicable, will continue to be met.

e) <u>Fire Protection</u>

Purdue complied with the applicable editions of the Indiana Building and Fire Code in effect at the time its buildings containing licensed material were constructed in the 1940s, and those in effect at the time of the various additions to such buildings thereafter. In accordance with the Indiana Building Code, the buildings are of type IIB construction. The building portions containing NRC-licensed materials are fabricated of non-combustible building materials. A lightning arrestor system is not required; however, the building is grounded in accordance with the applicable edition(s) of National Fire Protection Association (NFPA) 70, "National Electrical Code." Building renovations and operations are reviewed by the senior administration, with oversight by the RSC to ensure adequate safety of the building.

The installed fire protection systems include a fire alarm system and a sprinkler system. The fire alarm system—installed in accordance with the 1987 edition of NFPA 72, "Standard for the Installation, Maintenance, and Use of Protective Signaling Systems," consists of audible and visual devices, initiated by pull stations and the sprinkler flow switch. The sprinkler system, installed in accordance with the 1994 edition of NFPA 13, "Standard for the Installation of Sprinkler Systems," protects the entire building, excluding areas with moderator exclusion for criticality concerns. The fire protection systems interface with the university police dispatch and local 911 emergency systems. No additional fire protection, other than hand-held fire

extinguishers, is needed given the low combustible loading present in the storage rooms. Combustible loading, overall, is minimal.

Portable fire extinguishers are deployed within the buildings in accordance with industry standards and facility personnel with complete fire extinguisher training upon initial employment. Fire hydrants are located throughout the Purdue campus in accordance with industry standards.

Fire prevention, inspection, testing, and maintenance of fire protection systems; and the qualification, drills, and training of facility personnel are in accordance with applicable NFPA codes and standards.

The Purdue University Fire Department periodically tours the buildings in which NRC-licensed materials are used and stored for pre-fire plan coordination. Procedures are in place to allow the Fire Department efficient access to process areas during fire emergencies. Mutual aid agreements exist for additional assistance from other local municipalities.

The NRC staff determined that the applicant has met the applicable guidance provided in the 2008 edition of NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Material." The NRC staff notes that a complete release of the licensed material at Purdue would be highly unlikely, since the material at risk, including sintered uranium pellets in fuel rods, is contained in a hard metal alloy that is unlikely to volatilize or otherwise readily disperse as a result of a fire. Given the low risk to public health and safety of the materials covered by the SNM-142 License, and the guidance provided in Section 7.4.3.2 of NUREG-1520, a formal fire hazards analysis was not required. The NRC staff nonetheless reviewed Purdue's fire protection program and determined that an adequate level of fire protection is maintained to protect public health and safety. The NRC staff concludes that the applicant's equipment, facilities, and procedures provide a reasonable level of assurance that adequate fire protection will be provided.

f) Emergency Preparedness

The NRC staff reviewed the LRA against the 10 CFR 70.22(i)(1) provisions, which require the applicant to either: (1) perform an evaluation that demonstrates that the maximum dose to a member of the public offsite from a release of radioactive materials would not exceed certain specific dose levels, or (2) submit an Emergency Plan (EP). Purdue submitted an evaluation by letter dated February 16, 1993, which was accepted by the NRC staff for the prior renewals. The staff has reaffirmed the previous conclusion that the applicant is not required to submit an EP based on its review of Purdue's 1993 evaluation.

Although no EP is required, Purdue in its LRA provided a link to its Emergency Procedures Handbook. The handbook provides instructions for responses to the anticipated emergencies, including natural phenomena events such as tornadoes and man-made events such as a bomb threat or transportation accident.

The NRC staff reviewed the handbook, which includes the suggested information contained in Chapter 8 of NUREG-1520. The NRC staff reviewed Purdue's emergency procedures against this guidance, and finds the procedures acceptable.

g) Decommissioning

Staff reviewed Purdue's decommissioning funding plan accompanying the LRA. Purdue is a public university and is financially supported by the State of Indiana. Net assets held by Purdue are in excess of $1 billion. This meets the 10 CFR Part 30, Appendix E, financial test applicable to NRC licenses held by universities, requiring that such licensees hold assets of at least $50 million. There is thus reasonable assurance that sufficient funds will be available to cover any future decommissioning costs related to the SNM-142 license.

The staff reviewed the application against the requirements in 10 CFR 70.22 (a)(9) and 70.25 using the guidance in NUREG-1757, Volume 3, "Consolidated Decommissioning Guidance – Financial Assurance, Record Keeping, and Timeliness," which provides an approach for an application for decommissioning a materials license. The tables in Appendix A of NUREG-1757, Volume 3 provide a summary of the types of information that should accompany a request for license termination, and by inference, an acceptable method for presenting the types of information that should accompany an application (or renewal) for a fuel cycle license.

The material in the license renewal application for SNM-142 includes key considerations regarding the levels of contamination that have been identified in historical routine surveys, as well as details of the site and operations that have been conducted in the past. This information is used when characterizing the residual radioactive material that is expected to be encountered at license termination.

None of the enriched uranium fuel rods have been opened. However, some natural uranium rods have been opened, and uranium oxide pellets removed. These tasks were performed in a glove box specially designed for this purpose, with exhaust air filtered by a high efficiency particulate air filter. Air samples were taken during operations, and all samples were negative for uranium in the air exhausted to the ductwork and environment. Sealed sources and calibration sources have remained intact, and have been regularly leak tested. No contamination from sealed sources was found.

All operations formerly conducted with fuel has ceased. The U.S. Department of Energy took possession of and packaged the fuel for disposal in accordance with Amendment 3, dated August 16, 2012.

Historical uses, description and scope of activities, and survey results suggested by Appendix A.3.4 are contained in pages 1 and 2 of the Decommissioning Funding Plan. Descriptions and sizes of components suggested by Appendix A.3.5 are contained in pages 2, 3, and 5 of the Decommissioning Funding Plan. Planning and preparation work hours and labor categories suggested by Appendix A.3.6 are contained in page 4 of the Decommissioning Funding Plan. Work hours and rates for decontamination and final surveys suggested by Appendices A.3.7 and A.3.9 are contained in page 5 of the Decommissioning Funding Plan. Packaging, shipping, and disposal costs suggested by Appendix A.3.14 are contained in page 5 of the Decommissioning Funding Plan. A summary of labor rates, man-hours, disposal fees, as well as a 25 percent contingency are provided in the style suggested by NUREG-1757, Volume 3 are contained on page 6 of the Decommissioning Funding Plan. The result of the information detailed above is a decommissioning cost estimate of $189,563.00.

Purdue is a public university and is financially supported by the State of Indiana. Net assets held by Purdue are in excess of $1 billion. This meets the financial test required by

10 CFR 70.25 and as directed, 10 CFR 30, Appendix E for universities, which specifies at least $50 million in assets.

The staff determined that the Decommissioning Funding Plan contained in the Statement of Intent presented the information required for a renewal application in suitable form and detail, and is therefore acceptable.

h) Waste Management and Disposal

The waste disposal requirements in 10 CFR Part 20, Subpart K, specify the conditions for sampling and disposal of wastes. Waste management operations at Purdue are carried out by trained technicians. These technicians collect radioactive waste from all laboratories. Researchers are prohibited from using sinks or any other means whereby direct disposal to the environment could occur. Waste is segregated based on the radionuclide half-life and form of material (i.e., solid, liquid, mixed hazardous and radioactive). Short half-life materials are stored for a minimum of 10 half-lives prior to disposal. Any liquid material is sampled and analyzed prior to disposal. Combustible solid, long half-life material will be incinerated onsite using an incinerator. Procedures for loading and handling of materials are described in the Radiation Safety Manual. Handling and transfer of sealed sources is governed by the Indiana broad scope license. Scintillation vials are packaged in drums and shipped through a waste broker. Non-combustible, long half-life waste is compacted using Teledyne Industries compactor, which is equipped with an external air exhaust and high efficiency particulate air filter; and is monitored on an annual basis for activity and integrity. The commitments for waste handling are provided in section 11.0 of the LRA.

The requirements in 10 CFR 20.2003 specify the conditions for release of liquid waste into sanitary sewers. If the waste is less than 100 dpm/mL, readily dispersible, and non-hazardous, Purdue disposes it in the sanitary sewer. In the LRA, Purdue commits to sampling and disposal of long half-life liquids into a sanitary sewer, as provided by 10 CFR 20.2003. In accordance with ALARA principles, daily disposal of contaminated liquids is ordinarily limited to levels less than 10 times the 10 CFR part 20 Appendix C values.

The NRC staff notes that the sealed sources licensed under License No. SNM-142 will not generate additional effluents that would warrant modifications to the program developed for Purdue's research reactor under License R-87. The NRC staff determined that the effluent control and monitoring program is sufficient for the materials licensed by SNM-142, and provides reasonable assurance that the radiological effluents will not adversely impact public health, safety or the environment during the license renewal term.

i) Physical Security

The NRC staff reviewed the LRA against the requirements in 10 CFR 70.22(g), which direct a licensee who is authorized to transport or deliver for transport SNM to provide a plan for physical security of the material in transit. Purdue is not authorized to perform such activities; therefore, the NRC staff concludes that Purdue is not required to submit a Physical Security Plan.

j) Material Control and Accounting (MC&A)

The NRC staff reviewed the LRA against the 10 CFR 70.22(b) MC&A provisions. By their terms, these provisions do not apply to operations involving sealed sources. Since the licensed

material under the SNM-142 license – including the fuel rods – is encapsulated, and will remain so during the license renewal term, the NRC staff concludes that the material may be treated as sealed sources as defined in 10 CFR 70.4, and the MC&A requirements referenced in 10 CFR 70.22(b) are not applicable to this license renewal action. Accordingly, Purdue is not required to submit a Fundamental Nuclear Material Control Plan in support of its LRA. Purdue commits to the reporting and record-keeping requirements in 10 CFR 74.11 (theft or loss), an SNM inventory and reporting program consistent with the requirements in 10 CFR 74.13 (material status reports), transfer and receipts of SNM consistent with the requirements in 10 CFR 74.15 (transaction reports), and maintaining the required records in accordance with the requirements in 10 CFR 74.19 (record keeping). The NRC staff finds these commitments acceptable.

IV. ENVIRONMENTAL REVIEW

The NRC staff determined that Purdue's proposed activities under the SNM-142 license during the upcoming 10-year license renewal term would not individually or cumulatively have a significant effect on the human environment. The proposed activities involve the use and storage of radioactive materials for research and development and for educational purposes. Purdue's use of encapsulated radioactive material poses a lower risk to the safety of the workers or the public, and the environment, than any uses involving unsealed radioactive materials. In accordance with 10 CFR 51.22(c)(14)(v), Purdue's proposed activities are categorically excluded from the requirement to prepare a site-specific environmental assessment or an environmental impact statement.

V. CONCLUSION

The NRC staff concludes that the information and commitments provided by Purdue in its LRA provide reasonable assurance of adequate safety during the requested 10-year license renewal term. The NRC staff concludes that granting the LRA will not have an adverse impact on the public health and safety, the common defense and security, or the environment. The staff further concludes that Purdue will continue to meet the applicable requirements in 10 CFR Parts 19, 20, 51, 70, 73, and 74, for the reasons discussed above. The NRC staff accordingly finds that License SNM-142 may be renewed for a period of 10 years.

VI. PRINCIPAL CONTRIBUTORS

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VII. REFERENCES

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