Appendix A.8

Purdue University Research Reactor (PUR-1) ALARA Program

The ALARA program for Purdue University's research reactor (PUR-1) is based on the requirements from 10 CFR 20 and recommendations from ANSI/ANS-15.11-2016, Radiation Protection at Research Reactor Facilities. The scope of this ALARA program is limited to the PUR-1 -.

1.0 Program, policy, and organization

1.1 Radiation Safety Program

The radiation safety program for the PUR-1 will be based on sound engineering and radiation protection principles.

1.2 Management Policy

As the licensee, Purdue University commits to keep exposures to personnel and members of the public As Low as Reasonably Achievable (ALARA).

1.3 Organization and Responsibility

1.3.1 Organization

The reactor facility is an integral part of the Schools of Engineering at Purdue University. Figure 1. shows the chain of command with respect to the oversight of the PUR-1 Reactor. Each box reports to those vertically oriented above and manages those vertically below. Those oriented to the left and right collaborate in their functions with those on the same vertical level.

Purdue University is run and managed by the university President. The President is the final authority on all matters within the University and hires various Vice Presidents and the Provost to aid in the administration of research and student activities. The Provost is Purdue's chief academic officer and reports directly to the President. The Provost works with the deans, collaborates with the Chief Financial Officer and has responsibility for the allocation of financial resources in accordance with academic priorities. The Executive Vice President for Research and Partnerships "works closely with faculty to enhance Purdue's success in attracting federal funding through support of the development of grant applications, management of contracts, and compliance with regulations." This office appoints members to the Radiation Safety Committee.

The Dean of the College of Engineering is directly responsible for the administration of the college and oversees the various college level committees and organizations. The Dean works closely with each department head to ensure the success of each school of engineering. The Dean also appoints members to the Committee on Reactor Operations (CORO). The Head of the School of Nuclear Engineering administers the financial, staffing, and student matters. The Dean hires the Facility Director and helps to determine the path of the PUR-1. The Head hires the Reactor Supervisor and other facility staff.

The Radiation Safety Committee oversees all radiological work at Purdue University and works closely with the university's Radiation Safety Officer.. The RSO acts as a consultant for regulatory compliance for all of Purdue's campuses and serves as the Chair of the Committee on Reactor Operations.

When taken in totality, this operational structure ensures those overseeing the PUR-1 are knowledgeable about the technical requirements to operate a safe facility, are responsible for complying with regulations and license conditions, and will implement a meaningful radiation protection program that will protect the health and safety of the public, the facility users, and the staff.

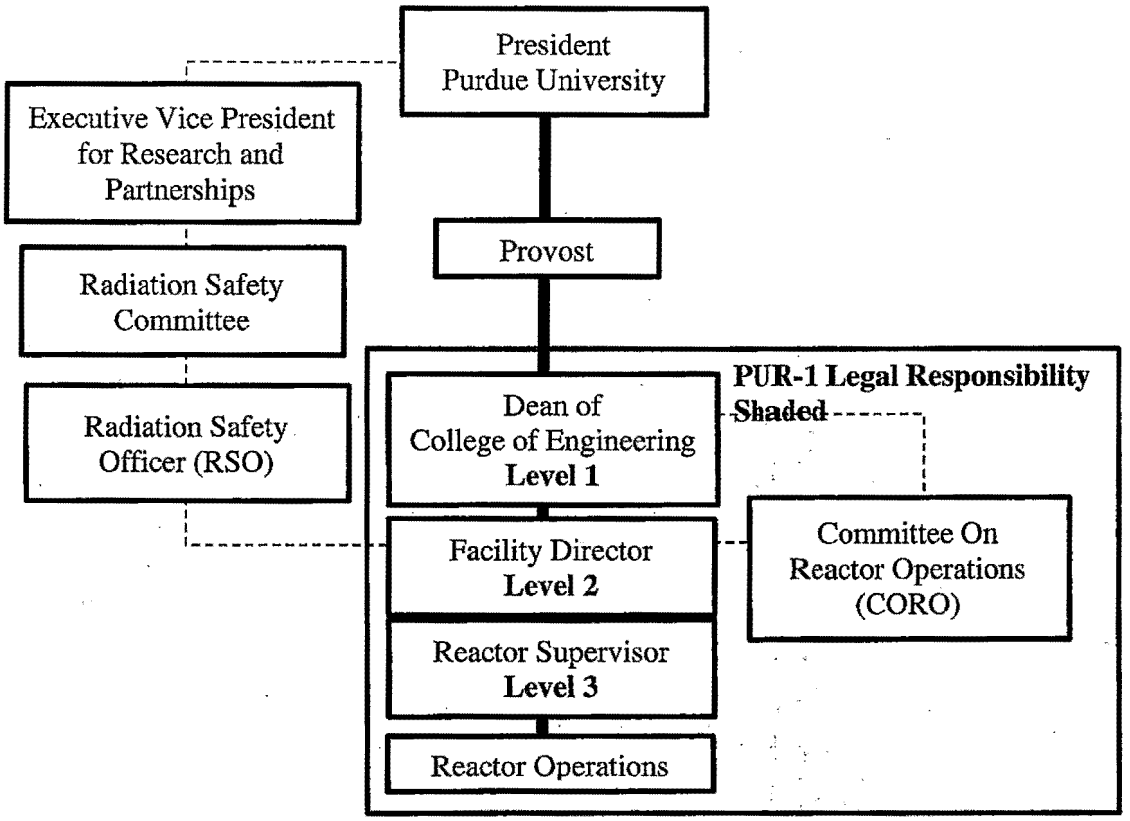

Figure 1.

1.3.2 Responsibility

The Dean of the College of Engineering (Level 1) is the individual responsible for the facility license or charter. The Facility Director (Level 2) or the designated alternate is responsible for overall reactor facility operation. The Reactor Supervisor (Level 3) shall be responsible for the day-to-day safe operation of the PUR-1. The Reactor Supervisor is responsible for assuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license, including the technical specifications and other applicable regulations.

In all matters pertaining to the operation of the reactor and the administrative aspects of these technical specifications, the Facility Director (Level 2) [or the Reactor Supervisor (Level 3) in the absence of the Facility Director] shall report to and be directly responsible to the Dean of the College of Engineering (Level 1). In all matters pertaining to radiation safety, they will work with the Radiation Safety Officer. The Radiation Safety Officer operates under the oversight of the Radiation Safety Committee, whose membership is appointed by the Executive Vice President for Academic Research and Partnerships.

2.0 Training

2.1 Visitors

Training in radiation protection (with the exception of a safety briefing) is not required for visitors to the reactor facility and other restricted areas since they will always be escorted by an individual, as required by the security plan, who has received such training. Visitors are defined as individuals who access the PUR-1 on an infrequent basis, and are not expected to receive an annual dose in excess of 25 mrem. This includes, but is not limited to the following:

a. Members of the public touring the PUR-1
b. Purdue University student use of PUR-1as part of their academic curriculum
c. Purdue University staff providing support, maintenance or repairs who are not authorized radiation workers
d. Private contractors providing support, maintenance or repairs
e. Law enforcement, Fire and EMT
f. U.S. Nuclear Regulatory Commission (NRC) staff

2.2 Radiation Workers

Training in radiation protection is required for radiation workers. Radiation workers are defined as any individual who routinely accesses PUR-1 and could receive an annual dose in excess of 25 mrem. This includes, but is not limited to the following:

a. PUR-1 staff
b. Purdue University Radiation Safety Staff
c. PUR-1 Reactor Operator (RO) Candidates
d. PUR-1 student workers (e.g. Research Assistants, Teaching Assistants, Interns, etc.)

2.3 Initial Training

The initial training will cover the following areas:

a. Properties of radiation
b. Biological effects of radiation
c. Exposure limits
d. Radiation protection for pregnant women
e. ALARA principles
f. Personnel monitoring and exposure history records
g. Radiation monitoring instruments
h. Radiation safety controls
i. Criticality control
j. Radiation survey instruments
k. Posting and labeling requirements
l. Transfer, storage and labeling of radioactive material
m. Responsibilities and process of individuals to report unsafe conditions
n. Emergency response
o. Emergency contacts

2.4 Retraining

A refresher training of the initial training topics will be conducted annually.

3.0 Radioactive Material Control

3.1 Special Nuclear Material

The special nuclear material (SNM) covered by the PUR-1 ALARA program is limited to the U_3Si_2 fuel plates in the core of the reactor and the fuel storage room along with the plutonium startup sources and fission chamber detectors. SNM in the fuel room shall be stored such that criticality is not possible. An inventory of SNM shall be maintained and verified at a frequency not to exceed 12 months.

3.2 Byproduct Material

Control of byproduct material, including material produced by PUR-1, shall be controlled in accordance with Purdue University's Broad Scope License.

3.3 Radioactive Waste

The disposal, storage, and treatment of radioactive waste shall be conducted in accordance with Purdue University's Broad Scope License.

4.0 Radiation Monitoring

4.1 Facility Monitoring

4.1.1 Area Radiation Monitoring

Active radiation area monitors (RAM) shall be used in the PUR-1 facility to measure the gamma dose rates at the pool-top, reactor control console and coolant processing system to alert reactor staff of abnormal conditions involving the reactor and to inform individuals of unusually high radiation exposures. The pool-top RAM alarm set point is determined by the Technical Specifications. The RAM located at the reactor console and coolant process shall have an alarm set point at 7.5 mR/hr or less.

External radiation dose measurements (gamma and neutron) shall be conducted and recorded periodically during reactor operation using portable ionization chambers and neutron survey meters.

4.1.2 Airborne Radioactivity Monitoring

A continuous air monitor (CAM) shall be provided to inform personnel of airborne particulate fission product nuclides so that there will be sufficient time to take the necessary steps to control the exposure of personnel or to evacuate the facility. The CAM shall be operated during reactor operation. The CAM shall have an alarm set point of 2000 pCi/mL which detects particulate activity concentrations at the occupational values of 10CFR20 for 70% of the relevant isotopes in the atomic mass number ranges of 84-105 and 129-149. These ranges of isotopes represent the one percent yield for fission products of ^{235}U.

4.1.3 Radiological Contamination Monitoring

Radiological contamination surveys shall be performed, using appropriate detection methods following any procedures that involves:

- Activation of samples, foils, etc.
- Removal, replacement or movement of core components (i.e. reactor fuel, control rods, detectors, reflectors, etc.)
- Reactor coolant and the coolant processing system (i.e. filters, demineralizing resin, pumps, valves, piping, etc.)
- A reasonable risk of radiological contamination

Routine radiological contamination surveys shall be performed and recorded by REM on a monthly basis. Materials, tools and equipment shall be surveyed for contamination before removal from contaminated areas following the activities listed above.

4.2 Environmental Monitoring

4.2.1 Submersion Nuclide Effluents

According to the Safety Analysis Report (SAR) for the PUR-1, the worst-case radiation exposure to members of the public will come from submersion exposure (cloudshine) from the release of ^{41}Ar into the environment, and gamma and neutron radiation from the reactor core. The dose from this pathway is expected to be minimal. However, as required by the reactor technical specifications, the emissions from the facility will be calculated and recorded on a monthly basis. These records will be maintained for the duration required by the NRC and recommended by the American Nuclear Insurers (ANI).

4.2.2 Area Radiation Monitoring

To measure radiation dose at the facility perimeter and estimate the highest possible dose to a member of the public in locations adjacent and above the PUR-1 facility, passive radiation area monitors consisting of a thermoluminescent dosimeter (TLD) or equivalent will be placed in these locations. The radiation area monitor will be processed on a routine basis by a NVLAP accredited dosimetry provider. Dose records will be maintained for the duration required by the NRC and recommended by the ANI.

4.3 Personnel Monitoring

4.3.1 Visitor Dose Monitoring

Visitors shall be provided with properly calibrated direct reading radiation dosimeters with an appropriate sensitivity. The integrated dose shall be recorded. When the reactor is shut down and not operating a minimum of two dosimeters shall be used for groups numbering between 2 and 15 guests, for 16-30 guests an additional two dosimeters shall be used and so on for each group size that exceeds the previous multiple of 15. For a single guest only one dosimeter is required for them. When the reactor is on and operational all guests shall wear dosimeters when entering the reactor room.

4.3.2 Radiation Worker Dose Monitoring

Workers shall be provided with a thermoluminescent dosimeter (TLD) or equivalent with the ability to measure neutron dose. The dosimeter shall be processed by a dosimetry vendor accredited by the National Volunteer Laboratory Accreditation Program (NVLAP).

4.3.3 Radiological Contamination Monitoring

At a minimum, individuals shall monitor their hands and feet for radiological contamination when leaving potentially contaminated areas after participating in the activities listed in 6.1.3.

4.4 Recordkeeping

Records involving dose monitoring, facility radiological surveys and environmental dose monitoring shall be maintained in accordance with 10CFR20 and ANI Information Bulletin 15-01 "Nuclear Liability Insurance Records Retention."

5.0 Instrumentation

5.1 Range and Spectral Response

The range and spectral response of the instrumentation provided shall cover the kinds of radiation and the levels expected during normal operations and shall extend from these levels through radiation levels postulated for emergency situations.

5.2 Calibration and Testing

Radiation survey and monitoring instruments shall be calibrated or tested for operability at least every 12 months as presented in NUREG-1556 Vol. 11, Appendix O "Instrument Specification and Model Survey Instrument and Air Sampler Calibration Program." Calibration records shall be maintained in accordance with 10CFR20 and applicable license conditions. Instruments shall be recalibrated after maintenance or repair.

6.0 Audits

An audit of the PUR-1 ALARA program shall be performed on an annual basis not to exceed 15 months. Deficiencies shall be identified, and corrective actions identified and applied in a timely manner. The auditor shall transmit the result of the audit to the CORO at the next scheduled meeting for its review and approval.

7.0 Emergency Response

Responses to emergencies shall be consistent with the PUR-1 emergency plan.